Chapter 8: Scale Size of the Solar System

Student Worksheet

Objective:

To calculate and illustrate the scaled sizes of the planets and the Sun in the solar system.

Engage:

Sketch a picture of the Sun, Jupiter, Earth, Venus, and Mars on a separate page. Do your best to draw the sizes of the objects to scale.

Introduction:

Throughout your life you have probably seen models and posters of the solar system. Mostly likely the models were not to scale either in terms of their size or their distance. Today you will comprehend the challenge in making a scale size model of the solar system. In this activity you will model the planets and the Sun in our solar system true to their sizes. You will choose a large object to represent the Sun and then calculate the sizes of the planets accordingly.

Procedure:

1. Choose an object the size of a basketball or larger to represent the Sun. You may draw a circle to the size you want if there is not a ball large enough. The bigger, the better.

2. Measure the diameter of your ball or circle in meters. If you are using a ball, make sure you think about the best way to measure the diameter of the ball first.
   Use Table 1 below to record your scale factor.

3. Divide the diameter of the Sun by the diameter of your ball or circle. This becomes the scale of your model.
   For example: The Sun has a diameter of 1.39 x 10^9 m. A basketball has a diameter of 0.242 m. You would be making a model with a scale of (1.30 x 10^9)/0.242= 5.74 x 10^9 /1 You can say the basketball is 5.74 billion times smaller than the sun, or you could line up 5.74 billion basketballs across the diameter of the Sun.
   Use Table 1 to record your scale factor.

4. Use this scale to determine the size of the 8 planets, the Moon, and 3 dwarf planets. To do this, divide the real diameter by the scale factor.

For example: The Earth has a diameter of 12,756,000 m. The needed diameter of Earth in your model would be found by dividing the diameter of the Earth by the scale 12,756,000/(5.74×10^9) = 0.0022 m. Your scaled Earth would have a diameter of 0.0022m, or 0.22 cm.

Use Table 1 to record your answers.

Table 1

Model Sun's diameter:		Real Equatorial Diameter of Sun: 5.74×10^9m
Scale factor:		
Solar System Object Name	**Real Equatorial Diameter in meters**	**Scale Diameter**
Mercury	4,880,000	
Venus	12,104,000	
Earth	12,756,000	
Earth's Moon	3,474,800	
Mars	6,792,000	
Ceres	975,000	
Jupiter	142,984,000	
Saturn	120,536,000	
Uranus	51,118,000	
Neptune	49,528,000	
Pluto	2,320,000	
Make-Make	1,420,000	

5. Make, find, or draw spheres to represent each of the objects in Table 1 according to the sizes you calculated. Check with your teacher if you are unsure of the available materials. Label each object with a small name tag.

6. Compare with others in the class.

7. At this point you may be eager to put the objects not only in order of their distance from the Sun, but at their scaled distances from the Sun. In order to see why you will not do that in today's class complete Table 2 with the scaled distances. Use the same scale factor you used in Table 1. To do this, divide the "real distance to the Sun in meters" by the same scale factor you used in Table 1. **Record your results in Table 2.**

Table 2

Scale Factor:		
Solar System Object Name	**Real distance to the Sun in meters**	**Scale Distance to the Model Sun in meters**
Mercury	5.79×10^{10}	
Venus	1.08×10^{11}	
Earth	1.50×10^{11}	
Earth's Moon	1.50×10^{11}	
Mars	2.28×10^{11}	
Ceres	4.16×10^{11}	
Jupiter	7.79×10^{11}	
Saturn	1.43×10^{12}	
Uranus	2.87×10^{12}	
Neptune	4.50×10^{12}	
Pluto	5.91×10^{12}	
Make-Make	6.89×10^{12}	

Conclusion:

1. Look back at the drawing you made before starting the activity. How well did you do? Comment on your results/insights.

2. How large a space would you need to make a scale distance model of your model solar system?

3. Using the scale of your model, how large would a model of the red giant star, Betelgeuse be? The estimated diameter of Betelgeuse is about 1.46×10^{12} m.

4. How much space would Betelgeuse take up in your model? *As a thought reference: The Sun is predicted to grow to nearly the size of Betelgeuse in about 5 billion years when it goes through a red giant phase.*

5. How big would the model sun have to be in order to represent Earth with a common globe? Assume the diameter of a globe is: 0.34 m

6. The closest neighbor star to our Sun is Proxima Centauri. Its diameter is about 7 times smaller than the Sun's and it lies at a distance of 4.2 light years or 3.97×10^{16} m from the Sun. How big an object and at what distance would your model of Proxima Centauri be?

Extend:

- Make an installation project of a scale size and scale distance model of the solar system using your data from Tables 1 and 2. Sidewalk chalk is a great resource for this activity. Make your model in a place where many might see and learn from it.

- Make a scale size and distance model of the galaxies in our Local Group.

- Choose two objects in the solar system of interest to you—e.g., asteroids, comets, moons, planets, belts, atmospheres-- and compare them. A great deal can be learned about a topic when you have something against which to compare it. Make a pamphlet, poster, or Venn diagram to house your results.