Solar System Scale Model

Overview: Today you get to make a scale model of the solar system. By scale model, I mean both the sizes of the planets will be to scale as well as the distances between the planets. Your job is to make it as accurate as you can.

What to Learn: You will learn how our solar system is mostly made up of empty space and that the distances between the objects is *huge.* You'll also find out where that pesky dwarf planet Ceres (which was discovered in 1801 and thought to be a planet, but quickly was demoted to an asteroid and later a dwarf planet) lives.

Materials

- Measuring tape
- Ruler (metric or inches)
- Popsicle sticks
- Markers
- Index cards
- Tape
- Tennis ball
- Grassy field or outdoor area to spread out

Experiment

1. First, draw the solar system on a sheet of paper. Once you've completed this step, proceed to the next step. (No peeking!)
2. Most students will tend to draw the planets evenly spaced apart. You'll learn how to correct this mistake the next time after you've worked through this experiment.
3. When building this model, start by marking off the location of the Sun (you can use chalk, a paper circle cut to 2.63" (66.8 mm) or place a tennis ball as a placeholder for the Sun). The rest is for them to figure out.
4. On one end of each stick, write the name of each planet/object from the data table.
1. On the other end, draw the scale size of the planet. If the planet is larger than the Popsicle stick, draw it on an index card and tape it to the stick. Use the fraction-to-decimal converter if needed (depending on your ruler).
2. Place your tennis ball at one end of the area marked off for your experiments. This is the Sun.
3. Using the table and the measuring tape, measure the distance from the Sun to Mercury. Have a lab partner hold one end of the measuring tape at the center of the tennis ball (or an X you've marked on the ground that's under the tennis ball). At 10.4 inches, place your Popsicle stick into the ground so it stands up. If you're on concrete, lay it down with the dot representing Mercury 10.4 inches away from the Sun.
4. Continue with the rest of the planets, as far as you have room to go. Which planet did you have to stop at because your area wasn't big enough? Or didn't you?

Solar System Data Table

All distances are measured from the center of the Sun. The Sun is 2.63" (66.8 mm) in diameter.

Planet/Object	Object Diameter		Distance from the Sun	
Mercury	0.009 inches	0.2 mm	10.4 inches	0.264 m
Venus	0.023 inches	0.5 mm	1 foot 7.4 inches	0.493 m
Earth	0.024 inches	0.6 mm	2 feet 2.9 inches	0.682 m
Mars	0.013 inches	0.3 mm	3 feet 4.9 inches	1.039 m
Jupiter	0.27 inches	6.8 mm	11 feet 7.76 inches	3.649 m
Saturn	0.22 inches	5.5 mm	21 feet 4.3 inches	6.51 m
Uranus	0.089 inches	2.2 mm	42 feet 11.5 inches	13.094 m
Neptune	0.086 inches	2.1 mm	67 feet 4.2 inches	20.529 m
Pluto (dwarf planet)	0.004 inches	0.1 mm	88 feet 6 inches	36.975 m

Reading

How large of a sheet of paper do you need to make a scale model of the solar system if the Sun was as big as a beach ball? You would need a sheet of paper nearly a mile long!

How would you measure the distance of a football field if you only had a ruler? How would they measure how high a tree is (without climbing it) using the same ruler? How would you measure the distance to the Moon?

One of the first ways we figured out the distances to the planets. Since the planets move in their orbits, scientists had to take that into account when they did their measurements and calculations. In order to get the hang of how big and far away celestial objects really are, we're going to make a scale model of the solar system.

A Greek mathematician, Eratosthenes, was the first person to measure the Earth's circumference as well as calculate the tilt of the Earth's axis, both with remarkable accuracy. Scientists think he was also the first to correctly calculate the distance from the Earth to the Sun. His system of latitude and longitude is still used today.

The diameter of our solar system is a little harder to figure out, since the exact boundary still hasn't been explored thoroughly yet in order to provide enough information about what should be included and what doesn't belong. For measuring large distances, astronomers use "AU" or "au" meaning *astronomical unit*. One AU is the distance from the Earth to the Sun, or 93 million miles (150 million km).

Gian Domenico Cassini made the first good planet measurements in 1672 by using parallax. Here's how he did it: If you hold your hand out at arm's length and look at it with only one eye at a time, you'll see your hand shift slightly back and forth. This is called parallax. This happens because your eyes are separated by a couple inches. If we know how far apart your eyes are, and carefully measure the how far your hand appears to shift, we can find out how long your arm is.

Now imagine doing this but instead the distance between your eyes, we'll use the distance the Earth moves when it's on one side of the Sun versus the other, like in winter and summer. The spacing between the eyes now isn't a couple inches; it's nearly 2 AU's apart. By carefully measuring how much an object appears to shift, we can find out how far that object is from us.

Today we use a radio signal and time how long it takes the signal to travel from the Earth to a spacecraft parked in orbit around another planet. Since the signal travels at the speed of light (186,000 miles per second), it's easy to find out how far away the object is. Scientists also bounce radar signals off a planet and time how long it takes to echo back to Earth, much the same way the police can find out your speed using a radar gun.

Exercises

1. What do you notice about the position of the rocky terrestrial planets?

2. Are the ice giants further apart from each other than the gas giants are?

3. Mariner 10 took 147 days to reach Mercury from Earth. How long do you think it would take to get to Neptune?

4. If the Earth is 93 million miles (150 million km) from the Sun, and Ceres is 413 million miles (665 million km) from the Sun, where would you place it in your scale model?

Answers to Exercises: Solar System Scale Model

1. What do you notice about the position of the rocky terrestrial planets? (They are all bunched up together close to the Sun.)

2. Are the ice giants further apart from each other than the gas giants are? (Neptune-Uranus is 9.8 AU and Saturn-Jupiter is 5 AU when they are on the same side of the Sun.)

3. Mariner 10 took 147 days to reach Mercury from Earth. How long do you think it would take to get to Neptune? (Approximately 12-22 years, depending on the flight path and the speed chosen.)

4. If the Earth is 93 million miles (150 million km) from the Sun, and Ceres is 413 million miles (665 million km) from the Sun, where would you place it in your scale model? (Ceres is 4.4 AU or 3 meters or 9.91 feet away. If your students haven't covered this yet, it's okay to eyeball the distance and approximate Ceres to be about four times the distance from the Sun that the Earth is.)