

Our Solar System

10 billion times smaller!

Introduction

The solar system is very large. You can see the numbers in a table of values and never really appreciate this fact. The only way that really works is to go outside and recreate the solar system on a grand scale. The more ambitious members of the class will play the parts of the major members of our system of planets. If you have a favorite planet, speak up and claim it as your own.

We will also try not to get bogged down with the mathematics of the situation. The scale which will be used will be very easy to calculate. When the entire model is done, it is amazing how small the planets are and how big space is!

The Scale

Below you see an incomplete table showing sizes and distances in the solar system. You are given the actual measurements in kilometers and will need to calculate the scale measurements in meters. Here's how it is done. To change from the actual size in kilometers to the scale size in meters, take each value in the table and multiply it by 10^{-7} , that is, one hundred millionth. This is straightforward since all you need to do is move the decimal point to the left by seven spaces. For example, the actual diameter of the Sun is 1,490,000 km. Using our scale, this converts to 0.149 meters or 14.9 centimeters. So the Sun will be a sphere 14.9 mm in diameter. You have, available to you, a paper plate which was trimmed to be a 14.9 mm circle to represent the Sun. The values for Mercury have been done for you so you can see the pattern.

	Actual	Scale	Actual Distance	Scale Distance
	Diameter (km)	Diameter (mm)	from Sun (km)	from Sun (m)
Sun				
Mercury	4900	0.49	58,000,000	5.8
Venus	12100		108,000,000	
Earth	12800		150,000,000	
Mars	6800		228,000,000	
Ceres	960		412,000,000	
Jupiter	149000		778,000,000	
Saturn	121000		1,427,000,000	
Uranus	51100		2,870,000,000	
Neptune	50000		4,497,000,000	
Pluto	2200		5,914,000,000	

After you have determined who will be the Sun, select ten members of the class to represent the nine planets and the large minor planet called Ceres. Each of these students will get the appropriate card which will have a circle showing the scale diameter of their planet. The person doing Earth will note that our Moon is shown at the proper distance on their sheet as well. The actual Moon is 3480 km in diameter and is 380,000 km from Earth. You will also need to select a Pacer, someone who will be responsible for measuring the distances. Finally, and most importantly, someone will have to serve as The Prime Contractor, whose job it is to decide if everything is being done correctly.

Now, let's go outside and set up the solar system. Here at Cranbrook, I would suggest that we use the biggest open area possible, the oval. Have the Sun be at the extreme eastern end of the oval, near the academic building.

If everyone in the class wants to be very picky and take hours to do this exercise, you could measure all of the scale distances accurately using a meter stick. My experience, however, is that pacing the distances out works just as well. You will need someone who will step off the distances and mark the same distance between each step with some regularity. For most people, the distance between each footfall is about a meter, or so. Maybe you could at least see who, in the class, would be best at marking off this distance.

By the way, as you do this exercise, it will soon seem as if you must be doing something wrong. The planets are so small. These distances are so great. This doesn't look at all like the diagrams you have seen in the books and on posters. That is precisely the point. This exercise is unique in that you see the relative sizes and distances correctly for the first time. Keep this in mind when you study the planets this year.

Name _____

Thought Questions

⇒ Place the planets Mercury, Venus, Earth and Mars, as well as the minor planet Ceres at their proper scale distances.

How would an observer at Earth see these other terrestrial planets? Are they nearby? Are they very far away? _____

⇒ Have someone who is not doing anything represent an Apollo space craft, traveling from the Earth to the Moon. This journey took three days. Let's see if this person can show how fast that is on our scale model.

Did the Apollo spacecraft travel fast or slow? _____

⇒ Now someone else can be the starship Enterprise, traveling at the speed of light. You may find it useful to know that light goes from the Sun to the Earth in eight minutes and twenty seconds. Remember, nothing can go faster than the speed of light.

Is light fast or slow? _____

⇒ Now place the other planets out there in your scale model. We would guess that you are not going to get to Uranus and Neptune, and certainly not Pluto.

Where, on the Cranbrook campus, would these planets be, if you took the time to put them in the proper place? You might use a scale map of the campus. _____

How much smaller is our scale model solar system than the real thing? You can express your answer in scientific notation or in words. _____

Is the solar system big or small? _____

Here is a map of the Cranbrook campus with a 500 meter long line drawn on it. Place the planets of the solar system on this map at the appropriate scale distance. Label each planet.

