



## Pocket Solar System

### Make a Scale Model of the Distances in our Solar System

#### About the Activity

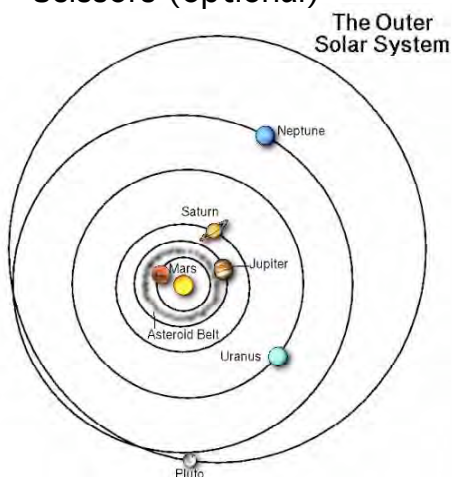
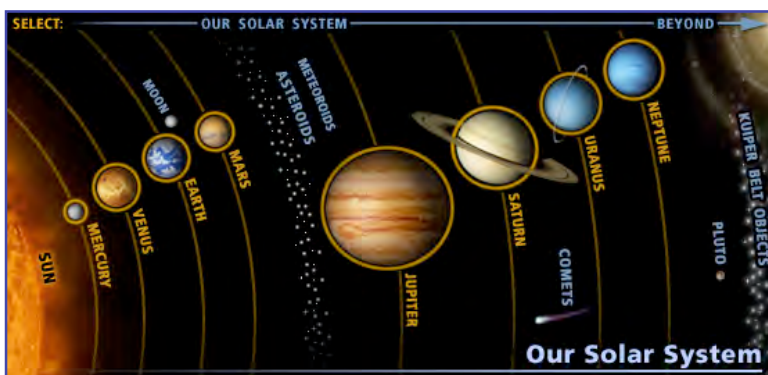
Using a strip of paper, construct a quick scale model of the distances between the orbits of the planets, the Asteroid Belt, and Pluto as part of the Kuiper Belt.

#### Topics Covered

- Scaled distances of orbits in the Solar System
- Types of objects in the Solar System
- Usefulness of models

#### Materials Needed

- Pencils
- Paper tape at least 2" wide (from a cash register)
- Scissors (optional)



Credit: National Schools' Observatory

#### Participants

This activity is appropriate for families, the general public, and school groups ages 7 and up. Any number of visitors may participate.

#### Location and Timing

This activity can be before a star party, in a classroom, or in a general presentation.

Warning: wind can present a challenge.

#### Included in This Activity

Detailed Activity Description

Helpful Hints

Background Information



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Additional astronomy activities can be found here: <http://nightsky.jpl.nasa.gov>

## Detailed Activity Description

### Pocket Solar System

The order of the worlds of the Solar System going out from the Sun and their average distances are:

Object	Avg Distance in kilometers	Avg Distance in miles	Avg Distance in AU*
Mercury	58 million	36 million	0.4
Venus	108 million	67 million	0.7
Earth	150 million	93 million	1
Mars	228 million	142 million	1.5
Ceres ** (representing the Asteroid Belt)	414 million	257 million	2.6
Jupiter	778 million	484 million	5.2
Saturn	1,427 million	887 million	9.5
Uranus	2,870 million	1,784 million	19
Neptune	4,498 million	2,795 million	30
Pluto ** (representing the Kuiper Belt)	5,906 million	3,670 million	40 (range is 30 – 50 AUs)

\*AU stands for “astronomical unit” and is defined as the average distance between the Sun and the Earth (about 93 million miles or 150 million kilometers).

\*\*The International Astronomical Union (IAU), the organization in charge of naming celestial objects, classified these objects as “dwarf planets” in 2006.

#### Leader’s Role

#### Participants’ Role (Anticipated)

#### Objective:

Building scale models of the Solar System is a challenge because of the vast distances and huge size differences involved. This is a simple little model to give you an overview of the *distances* between the orbits of the planets and other objects in our Solar System.

- Provide a quick, easy-to-make and remember scale of the approx distances of the planet’s orbits and orbital distance of other realms (asteroids, Kuiper Belt) from the Sun.
- Introduce basic “realms” of the Solar System: the Sun at the center, the four inner terrestrial planets separated from the four outer gas giants by the asteroid belt, and all of it surrounded by Kuiper Belt.
- Can be referred to and used in other activities.

**Leader's Role**

**Participants' Role (Anticipated)**

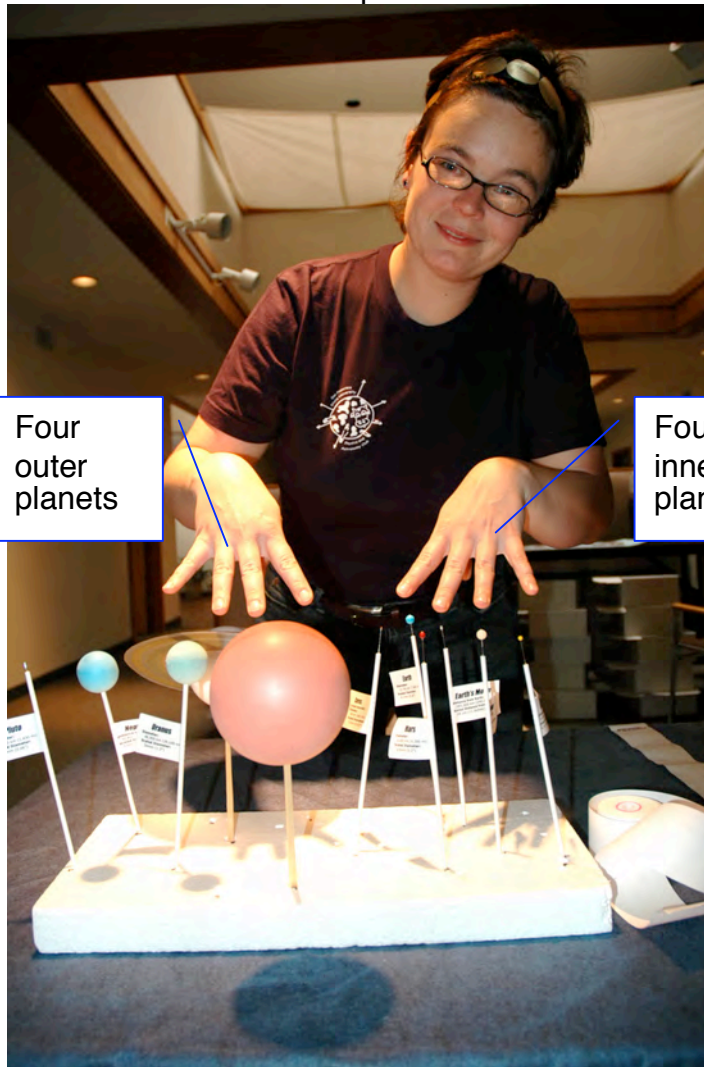
To say:

Let's make a Solar System you can keep in your pocket!

Yeah!


To do:

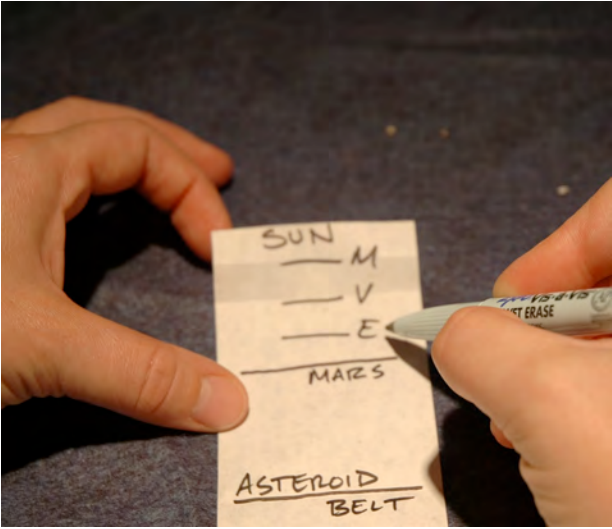
First, establish with your audience the order of the planets. This provides a baseline to work from. List them on a sheet of paper, use the "Solar System to Scale" handout, the lithographs, or the 3-D models of the planets. Be sure to include the Asteroid Belt and the Kuiper Belt.



Pointing to the four inner rocky planets and the four outer gas giant planets.

Leader's Role	Participants' Role (Anticipated)
<p><u>To say:</u> Pull off a strip of register tape about the length of the height of your body – that's about fingertip to fingertip.</p> <p>We're going to make a model that shows the average distances of various orbits from the Sun.</p> <p>Fold over (or cut) the ends so they are straight. Label one end "Sun" and the other end "Pluto/Kuiper Belt." That will be our baseline – the average distance between the Sun and Pluto's orbit.</p> <p>Next, fold the tape in half, crease it, open it up again and place a mark at the half-way point. Let's look at the list of planets in the Solar System. Which planet's orbit do you suppose is half-way between the Sun and the average distance of Pluto's orbit?</p> <p>Let me give you a hint.</p>	<p>Follows directions.</p> <p>Jupiter! Saturn!</p>
<p><b>Presentation Tip:</b> You'll need to be careful about using this hint. It depends on your audience. Some people may be offended. It is quite popular with children, however. Alternatively, just have them guess from the list of planets. "Uranus" is often incorrectly pronounced as "yur-AY-nus." Correct pronunciation is "YUR-uh-nus." For more information: <a href="http://www.nineplanets.org/uranus.html">http://www.nineplanets.org/uranus.html</a></p>	
<p><u>To do:</u> Turn around so your back is to the audience. Hold the Pluto end of the tape at your head so the tape falls down your back to the floor.</p> <p><u>To say:</u> If you hold the Pluto end at your head and the Sun at your feet, what body part is halfway between? Right. Bet you'll never again forget which planet is halfway between the Sun and the average distance of Pluto.</p>	<p>Uranus!</p>
<p><u>To say:</u> Draw a line on the fold and write "Uranus."</p> <p>Re-fold the tape in half, then in half again so you have</p>	

Leader's Role	Participants' Role (Anticipated)
<p>quarters.</p> <p>Then unfold it. Now you have the tape divided into quarters with the Sun at one end, Pluto's orbit on the other, and Uranus' orbit in the middle. Label the fold closer to Pluto as "Neptune" and the fold closer to the Sun as – OK everyone guess.</p> <p>Saturn – draw a line and write Saturn on that orbit.</p>  <p>Here's an easy way to remember the order of the orbits of these three planets.</p> <p>There's a Sun at the center of the Solar System.</p> <p><u>To do:</u> Point to the Sun end of the tape.</p> <p><u>To Say:</u> And there's a "SUN" in the outer planets: (S)aturn (U)ranus (N)eptune S-U-N!</p>	<p>Jupiter? Mars?</p>

Leader's Role	Participants' Role (Anticipated)
<p><b>Presentation Tip:</b> Encourage your visitors to draw a line along the fold marking the orbit and write the name of the planet along that line. This will help keep the writing small enough so the names are less likely to overlap orbits for other planets, especially for the inner planets.</p> <p>An alternative, to speed things up when visitors may not know how to spell all the names of the planets, is to just have them write the initial letter of the planet on each orbit line.</p>	
<p><u>To Say:</u></p> <p>You've mapped out 3/4 of the Solar System and you still don't have all the gas giants. Which gas giant is missing?</p> <p>So we have to fit everything else in that last quarter between the Sun and Saturn! Let's keep going.</p> <p>Place the Sun end of the tape at Saturn's orbit and crease the tape at the fold. What's the next planet in? Label that fold.</p> <p>Fold the Sun out to meet Jupiter's orbit. This is a little tricky. What structure is inside Jupiter's orbit?</p> <p>Right, the Asteroid Belt. Label that.</p> <p>How many more planets do we need to mark?</p> <p>At this point, things start getting a little crowded and folding is tough to get precise distances. Fold the Sun to the Asteroid Belt mark and crease it. Next planet in?</p> <p>Right – Mars. Label that.</p>	<p>Jupiter!</p> <p>Jupiter.</p> <p>Asteroids?</p> <p>Four!</p> <p>Mars!</p>
<p>How many more planet orbits do we need to place?</p>	

Leader's Role	Participants' Role (Anticipated)
<p>Yes, three.</p> <p>Fold the Sun up to meet the orbit of Mars. Leave it folded and fold that section in half again. (See the "Schematic of the Pocket Solar System" on the next page)</p> <p>Unfold the tape and you should have three creases. Mark Earth on the crease nearest Mars, then Venus, then Mercury closest to the Sun.</p> <p>Stretch out your model and take a good look at what you've made. What surprises did you have?</p> <p>Now, just roll it up and put it in your pocket – the Pocket Solar System.</p>	<p>Three – Earth, Venus, and Mercury.</p> <p>Variety of comments.</p>
<p><b>Misconception Tip:</b> Many people are unaware of how empty the outer Solar System is (there is a reason they call it space!) and how close, relatively speaking, the orbits of the inner Solar System are.</p>	

Here are some questions to consider while discussing your Pocket Solar System:

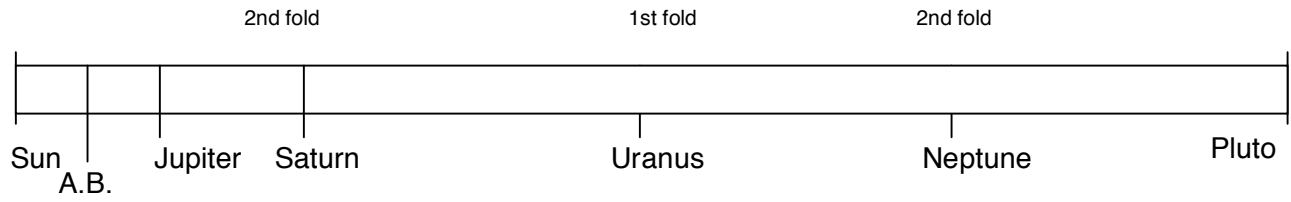
1. If your model is 1.5 meters long (about 5 feet), where would the nearest star be? (1.5m = 40 AUs, Proxima Centauri is 4.3 light years from the Sun, and 1 light year = 63,250 AUs)
2. How big would the Sun and planets be if your model were one and a half meters long?

Answers:

1. The nearest star would be about 10 kilometers or about 6 miles away.
2. The Sun would be smaller than a grain of sand – about the size of the period at the end of this sentence. You couldn't see any of the planets without a strong magnifying glass on this scale!



Schematic of the Pocket Solar System:



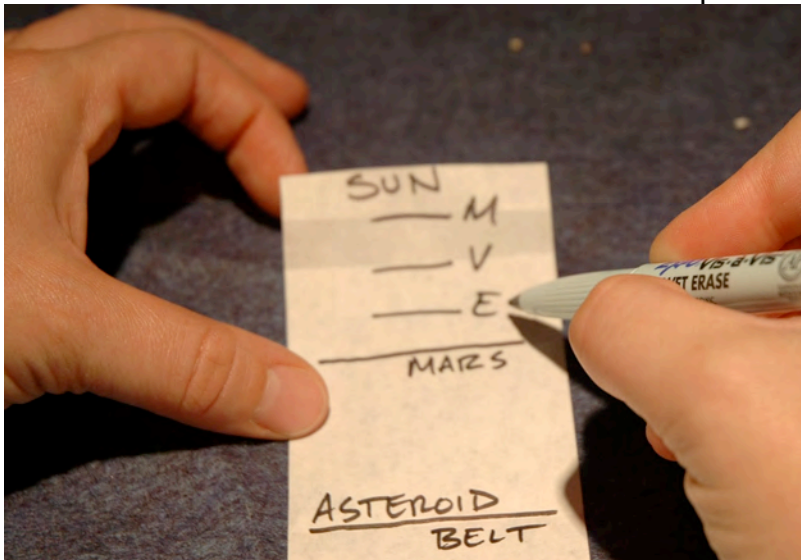
Fold Sun to Asteroid Belt, ("A.B.") mark "Mars" on fold.



Fold Sun to Mars and leave it folded.

Then fold that section in half again.

Unfold it. You should have 3 marks for the three planets closest to the Sun.





## **Helpful Hints**

### **Discussion of Models and their Usefulness**

Models are useful, but their utility is always limited in some ways. It is often helpful to discuss the strengths and limitations of models with your visitors. For example, the paper tape represents the scaled distances to objects in our Solar System. What are some of its strengths as a model? How is it useful? Where does this NOT represent reality? What can't it be used for? These are questions you may want to include in your discussions with your visitors as they explore the Solar System with this model.

### **Common Misconceptions:**

- Planets are perceived to be much larger than they really are
- The distances to the planets are perceived to be much smaller than they really are
- The orbits of the planets are perceived to be evenly spaced between the Sun and Pluto

## **Background Information**

### **Website:**

For additional information on the worlds of the Solar System, use NASA's Solar System Exploration website:

<http://solarsystem.nasa.gov/planets/index.cfm>

### **Website:**

A useful web site for **calculating scale models of the Solar System** is available from the Exploratorium:

[http://www.exploratorium.edu/ronh/solar\\_system/](http://www.exploratorium.edu/ronh/solar_system/)

### ***Pocket Solar System and Bode's "Law"***

The progression followed for the positions of the orbits for the planets of our Solar System, as illustrated by the Pocket Solar System activity, is really just an interesting coincidence.

Bode's Law, also known as the Titius-Bode Law, was developed in the 1700's before the discovery of Uranus, Neptune, Pluto, or the Asteroid Belt. This "Law" is a mathematical way to describe the approximate spacing of the planets from the Sun. It is not a scientific law and does not work for all the planets of the Solar System, Neptune being a notable exception. It also does not appear to work for planetary configurations around other stars.

For more information on this "Law," try one of these websites:

[http://en.wikipedia.org/wiki/Titius-Bode\\_law](http://en.wikipedia.org/wiki/Titius-Bode_law)

<http://milan.milanovic.org/math/english/titius/titius.html>