

<p><b>Title:</b></p> <p>How Far is It?: A Collaboration between Math and Science CCGPS</p>	<p><b>Grade:</b> 6</p>	<p><b>BIG Idea:</b></p> <p><b>Math:</b> Proportional Reasoning</p> <p><b>Science:</b> Planetary distance from the sun</p>
<p><b>CCGPS Standards Addressed:</b></p> <p><b>S6E1.</b> Students will explore current scientific views of the universe and how those views evolved.</p> <p>c. Compare and contrast the planets in terms of</p> <ul style="list-style-type: none"> <li>• Relative distance from the sun</li> </ul> <p><b>MCC6.RP.3</b> Use ratio and rate reasoning to solve real-world and mathematical problems, e.g. by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.</p> <p><b>Standards for Mathematical Practice:</b></p> <ol style="list-style-type: none"> <li>1. Make sense of problems and persevere in solving them.</li> <li>2. Reason abstractly and quantitatively.</li> <li>4. Use appropriate tools strategically.</li> <li>6. Attend to precision.</li> <li>8. Look for and express regularity in repeated reasoning.</li> </ol>		<p><b>Learning Goals:</b></p> <ol style="list-style-type: none"> <li>1. Students will use proportional reasoning to determine the distance from the sun to each planet.</li> <li>2. Students will use a tabular representation to record the distance from the sun to each planet.</li> <li>3. Students will create a pictorial representation of the distance from the sun to each planet.</li> </ol>
<p><b>Materials:</b></p> <p><b>For Teacher:</b></p> <p>PowerPoint presentation Internet access – optional – to access calculator website in PPT presentation</p> <p><b>Per Student Pair:</b></p>		

Meter stick

Colored pencils or markers

Large sheet of paper – measuring approximately 1.5 meters long; width based on amount of drawing space teacher thinks students will need

Scientific calculator

Table of Planetary Distances – one per student

### Teacher Notes:

Students will use proportional reasoning to determine the distance of each planet from the sun. A length of 100 centimeters, or 1 meter, will be the referent for the distance from the sun to Neptune, the farthest planet from the sun.

- Tell the class they will be making a simple representation of the distances from the sun to the planets. Because of the vast distance involved, their representation will need a manageable scale.
- Pass out meter sticks, and tell students that 100 cm (1 m) represents the distance from the sun to Neptune.
- Ask students why Neptune is the planet chosen to be placed at 100 cm – because Neptune is the farthest from the sun.
- Ask students where the sun should be placed. The sun will be placed at 0 cm, or the beginning of the meter stick.

So far, the ratio below represents the above situation –

$$\frac{100 \text{ cm or 1 meter}}{\text{distance from the sun to Neptune}}$$

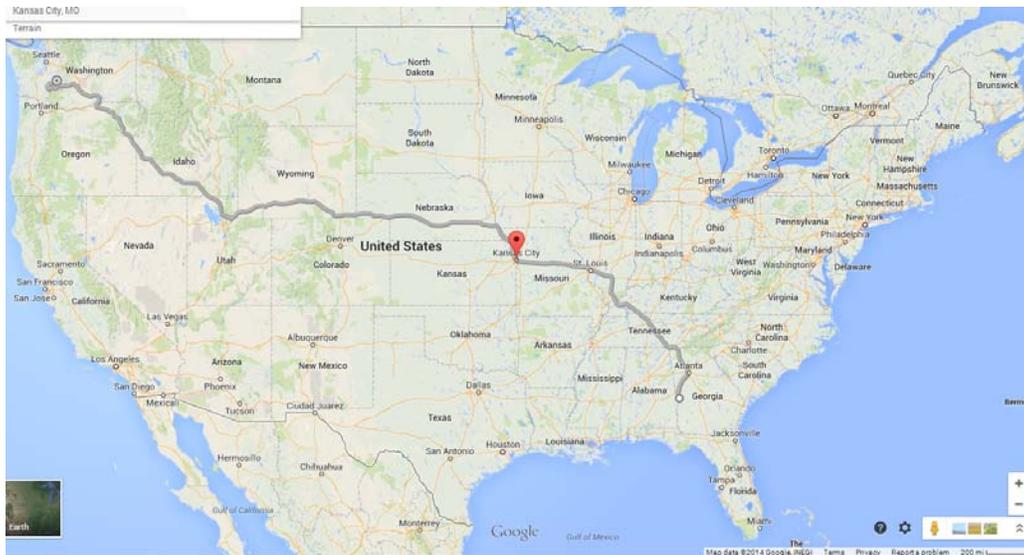
- Tell students that a representation that relies on a comparison between the “real world” and a “model world” is called a *scale* model.
- Ask students to recall examples of scale models with which they are familiar. Some examples include: die-cast cars; Barbie dolls; any toy that is a miniature version of the actual object.
- Ask students to recall features of these “miniature” models – they are the same except for their size. Therefore, their planetary distance model will represent the same distances between the sun and the planets in the Solar System but on a miniature scale.
- Tell students that Neptune is 4,497,000,000 km away from the sun.
- Ask students a good estimate for this distance, i.e., 5,000,000,000 miles.

In order to create a scale model of planetary distances from the sun, students will need to create a proportion. Help students grasp the need to establish a ratio of *scaled distance* to *actual distance*. Remind them that a ratio is a comparison. What are we comparing? Real distances to scaled distances. Note the inclusion of units. See below –

$$\frac{\text{Scaled distance between sun and Neptune (cm)}}{\text{Actual distance between sun and Neptune (km)}}$$

The approximately 5 billion- kilometer distance from the sun to Neptune is too large a number to grasp. Select an attraction in a city with which they are familiar and that is across the country from their location. Use Google Maps or similar website to add real-world significance to the learning situation. See a sample scenario below –

The distance from our school in Columbus, Georgia to Mt. Rainier National Park is approximately 5530 miles roundtrip. Below is the Google Maps image.



- Ask students how many times they would have to travel, roundtrip, to Mt. Rainier National Park to equal to 5 billion miles. First, using proportional reasoning, kilometers must be converted to miles.
- The conversion factor is 1 km = 0.62 miles. A possible online calculator can be found at <http://web2.0calc.com/>

$$\frac{1 \text{ km.}}{0.62 \text{ mi.}} = \frac{5,000,000,000 \text{ km}}{x} \quad 1 \text{ km is to } 0.62 \text{ miles as } 5,000,000,00 \text{ km is to } \underline{\hspace{2cm}} \text{ miles}$$

$$5,000,000,000 \text{ km} \approx 3,100,000,000 \text{ miles}$$

$$\frac{3100000000 \text{ miles}}{5530 \text{ miles}} \approx 56057 \text{ Round trips to Mt. Rainier National Park}$$

Students could make 560,579 round trips to represent the distance from the sun to Neptune.

Now, students are ready to return to the Solar System.

- Remind students that they have *one part* of a proportion. If we want to know all scaled distances from the sun to the planets, how should we finish the proportion? Working with a comparison of scaled to actual distance, we will establish another ratio equal to the current one (i.e., referent ratio).

Our new ratio must maintain the same relationship as our previous ratio -- scaled to actual and centimeters to kilometers.

$$\frac{\text{Scaled distance from sun to Neptune (cm)}}{\text{Actual distance from sun to Neptune (km)}} = \frac{\text{Scaled distance (cm)}}{\text{Actual Distance (km)}}$$

REFERENT RATIO

NEW RATIO

- Remind students that they will always use the meter stick, or 100 cm, to represent the total available distance.
- Using their large paper, have students draw slightly more than a length of 1 meter (e.g., 110 - 120 cm is sufficient).
- Tell students to mark a distance of 100 cm. Label the zero (*sun*) and 100 cm (*Neptune*).
- As the distance to each planet is calculated, place a mark on the line for each planet. The line is for distance marks **only**. Labels/pictures should be placed on the white space.
- Note: Planets closer to the sun will “bunch up” together and **will not be legible**. Encourage students to use different-colored markers for each planet.

To **simplify calculations**, students do not have to use the many zeroes associated with the millions of kilometers distances. Dividing the values in the denominators by 1 million allows us to work with simpler numbers while maintaining equivalence to these values in their original form.

$$4,497,000,000 = 4497 \text{ million } \#$$

Students may write proportions like the following:

$$\frac{100 \text{ cm}}{4497 \text{ km}} = \frac{d}{88 \text{ km}} \#$$

The variable, *d*, is the scaled distance of the planet under consideration. This proportion represents Mercury.

Below are the answers rounded to the nearest tenth of a centimeter.

Planet	Distance from sun (millions of km)	$\frac{\text{Scaled distance from sun to Neptune (cm)}}{\text{Actual distance from sun to Neptune (km)}} = \frac{\text{Scaled distance (cm)}}{\text{Actual Distance (km)}}$ (in millions of km)	Scaled distance from sun (cm)
M	58	$\frac{100}{4497} = \frac{d}{58}$	1.3
V	108	$\frac{100}{4497} = \frac{d}{108}$	2.4
E	150	$\frac{100}{4497} = \frac{d}{150}$	3.3
Mars	228	$\frac{100}{4497} = \frac{d}{228}$	5.1
J	778	$\frac{100}{4497} = \frac{d}{778}$	17.3
S	1427	$\frac{100}{4497} = \frac{d}{1427}$	31.7
U	2871	$\frac{100}{4497} = \frac{d}{2871}$	63.8
N	4497	$\frac{100}{4497} = \frac{d}{4497}$	100

- Remind students that the remaining planets must be placed within this 100 cm distance. Have students complete the table.
- As the students are calculating, lead a discussion and ask questions similar to the following:

A) Are you surprised at how close, on our scale model, that Mercury is to the sun? No, because, relatively, 58 million km is very close to the sun compared to, say, Uranus.

B) How do the placement of Mercury and Venus compare? Venus is approximately twice as far away from the sun as Mercury.

C) Why is Mercury a hot planet? Why is Neptune cold? Use your model to answer. Because Mercury is relatively close to the sun, and Neptune is very far away from the sun.