Distances Between Sun and Planets

Background

Many of the drawings or models of the solar system cannot be drawn to scale. The distances and sizes involved vary too much and are too great to represent in a textbook or poster. Consequently, an understanding of the distances and sizes involved in astronomy is not obtained. This activity will help you gain an understanding of the distances between the Sun and planets in our solar system.

Objective

We are turning the ceiling into the solar system! The solar system will run the entire length of the classroom. Each group will design an arrow and actually mark one planet to scale on the solar system. The end result will be a scaled model of the distance of each planet from the Sun.

Scale

We will represent the solar system by a strip $56\,ft$ long. It will run from the entrance to Mrs. Nowak's office to the other side of the room through the lab. The Sun, scaled to the correct size, is there for you to see.

Now that there is a scale for the entire solar system, we need to find the distance of the eight planets from the Sun. Here is a table showing the distance of each object from the Sun.

Object	Distance (km)	Object	Distance (km)
Mercury	5.7909×10^7	Jupiter	7.7855×10^8
Venus	1.0821×10^8	Saturn	1.4334×10^9
Earth	1.4960×10^8	Uranus	2.8767×10^9
Mars	2.2794×10^8	Neptune	4.5034×10^9

The first thing to figure out is the scale factor. This is how much smaller our model will be than the actual solar system. To account for Neptune's orbit, the scale ratio is

$$4.5 \times 10^9\,km : 56\,ft$$

This isn't useful yet because the units are different. Therefore, you need to convert km to ft since our ceiling tiles are cut exactly to $4\,ft$. You can do this knowing that $2.54cm = 1inch$ and using the following formula:

$$1km = 1km \times \frac{\underline{\quad\quad}\,m}{1km} \times \frac{\underline{\quad\quad}\,cm}{1m} \times \frac{1inch}{2.54cm} \times \frac{1ft}{\underline{\quad\quad}\,inch} = \underline{\quad\quad\quad}\,ft$$

Let's call this number A, so $1\ km = A\,ft$. Now, convert the left side of the scale ratio to feet using the formula:

$$4.5034 \times 10^9\,km \times \frac{A\,ft}{1\,km} = 4.5034 \times 10^9 \times A\ ft \times \frac{km}{km} = 4.5034 \times 10^9 \times A\ ft = \underline{\quad\quad\quad\quad}\,ft$$

Let's call this number B, so B ft = 4.5 x $10^9 km$ × A ft/km. The final step involves converting the scale ratio to the form __#__:1. This is simply done by dividing both sides of the scale ratio by 56ft.

$$\frac{Bft:56\,ft}{56\,ft} = \left(\frac{B}{56}\times\frac{ft}{ft}\right):\left(\frac{56}{56}\times\frac{ft}{ft}\right) = \left(\frac{B}{56}\times1\right):\left(\frac{56}{56}\times1\right) = \frac{B}{56}:1 = \underline{\hspace{3cm}}:1$$

This last number, let's call it C, is the scale factor. It represents how much smaller our model distance are than the actual distances. Our model distances are C times smaller than the actual distances.

Planet Distances
Now that the scale factor C has been determined, we can determine the scaled down distances of the planets. First, convert all the planet distances to ft in the following table.

Planet	Formula (Symbols)	Formula (Numbers)			Distance (ft)
Mercury	M Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Venus	V Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Earth	E Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Mars	M Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Jupiter	J Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Saturn	S Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Uranus	U Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____
Neptune	N Dist. (km) × A	_____ km ×	_____ $ft/km=$		_____

Divide all the planet distances in ft by the scale factor C to determine the scaled planet distance in the following table.

Planet	Formula (Symbols)	Formula (Numbers)			Scaled Dist. (ft)
Mercury	M Dist. (ft) / C	_____ ft /	_____ =		_____
Venus	V Dist. (ft) / C	_____ ft /	_____ =		_____
Earth	E Dist. (ft) / C	_____ ft /	_____ =		_____
Mars	M Dist. (ft) / C	_____ ft /	_____ =		_____
Jupiter	J Dist. (ft) / C	_____ ft /	_____ =		_____
Saturn	S Dist. (ft) / C	_____ ft /	_____ =		_____
Uranus	U Dist. (ft) / C	_____ ft /	_____ =		_____
Neptune	N Dist. (ft) / C	_____ ft /	_____ =		_____

Drawing
Design an arrow to show the location of your planet in the solar system. Include at least the planet name and actual distance to the planet. Why can't we make circles to represent the planet sizes? (Use the "Scale Model of Sun and Planet Sizes" activity and the size of the Sun in this model, right over Mrs. Nowak's office door, to help you determine this.)

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