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Hometown Planets: Scaling the Planetary Orbits to your Hometown

Objective:

Bring the planets to your hometown with Delcastle High School as the center of the universe…at least in this modeling activity. You will use scaling to convert astronomical distances between planets to distances you are familiar with such as miles. With Delcastle as the sun, you will draw the planetary orbits on maps and identify a landmark (example: a building, major, intersection, city, etc.) that falls on each planetary orbit.

Scaling Planetary Orbits to Hometown Distances:

Below is a table of the planets in our solar system and their distance from the sun. However, the unit of distance is in kilometers (*km*) and they need to be in miles (*mi*).

Table 1: Actual distance of planets from the sun

Planet	Distance from the Sun (km)	Planet	Distance from the Sun (km)
Mercury	5.79×10^{7}	Saturn	1.43×10^{9}
Venus	1.08×10^{8}	Uranus	2.87×10^{9}
Earth	1.50×10^{8}	Neptune	4.50×10^{9}
Mars	2.28×10^{8}	Pluto (dwarf planet)	5.91×10^{9}
Jupiter	7.78×10^{8}		

Use the equation below to determine how many miles are in 1.0 kilometer. Since there are 2.54 *cm* in 1.0 *in*, that ratio was used below in the equation. Fill in the remaining blanks with the appropriate ratios and do the math to figure out how many miles are in 1.0 *km*.

$$1.0\ km \times \frac{\underline{1000}\ m}{1.0\ km} \times \frac{\underline{100}\ cm}{1.0\ m} \times \frac{1.00\ in}{2.54\ cm} \times \frac{1.0\ ft}{\underline{12}\ in} \times \frac{1.0\ mi}{5{,}280\ ft} = \underbrace{\underline{0.62137}}_{\text{(number } \mathbf{A}\text{)}}\ mi$$

Let's call this number of miles **A**. Since 1.0 *km* = **A** *mi*, there are **A** *mi* in 1.0 *km* or **A** *mi* per 1.0 *km*. This can be written as a fraction, $\frac{\mathbf{A}\ mi}{1.0\ km}$ and this is the same as **A** *mi/km*. This number **A** will be used to change the planetary orbits from units of *km* to *mi* on the next page with **Table 2**.

(Calc Pluto's orbit as an example for Table 2 with the students and for the calc below!)

To make sure that most of the planetary orbits are within our hometown area, set the largest planetary orbit equal to 40 miles. Write the correct scale ratio below (in *mi*), then write it as a fraction and determine the scale factor (**B**), which you will use for calculations in **Table 3.**

____**3.67×10^{9}**___*mi*: ________**40**_____ *mi* or $\frac{\mathbf{3.67 \times 10^{9}}\ mi}{\mathbf{40}\ mi}$ = ____**9.175×10^{7}**___

(actual distance) (model distance) (number **B**)

Find the scale bar on the map that the planetary orbits are to be plotted. Use a ruler and measure how long the scale bar is in millimeters (*mm*). What is the scale ratio for the map? Divide the ratio as you did above to get a new number (**C**) that you will use in **Table 4**.

(This will vary for students depending on their map's scale bar.)

_________________*mm*: ________________ *mi* or $\frac{\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\ mm}{mi}$ = ______________ $\frac{mm}{mi}$

(number **C**)

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Table 2: Use the actual planetary orbit distances from **Table 1** and conversion number **A** in the formula below. This calculation will change the planetary distances from *km* to *mi*.

Planet	Formula (Symbols)	Formula (Numbers)	Orbit (*mi*)
Mercury	Mercury's orbit (*km*) × **A**	5.79×10^7 *km* × 0.62137 *mi/km*	**3.60×10^7**
Venus	Venus's orbit (*km*) × **A**	1.08×10^8 *km* × 0.62137 *mi/km*	**6.71×10^7**
Earth	Earth's orbit (*km*) × **A**	1.50×10^8 *km* × 0.62137 *mi/km*	**9.32×10^7**
Mars	Mars's orbit (*km*) × **A**	2.28×10^8 *km* × 0.62137 *mi/km*	**1.42×10^8**
Jupiter	Jupiter's orbit (*km*) × **A**	7.78×10^8 *km* × 0.62137 *mi/km*	**4.83×10^8**
Saturn	Saturn's orbit (*km*) × **A**	1.43×10^9 *km* × 0.62137 *mi/km*	**8.89×10^8**
Uranus	Uranus's orbit (*km*) × **A**	2.87×10^9 *km* × 0.62137 *mi/km*	**1.78×10^9**
Neptune	Neptune's orbit (*km*) × **A**	4.50×10^9 *km* × 0.62137 *mi/km*	**2.80×10^9**
Pluto	Pluto's orbit (*km*) × **A**	5.91×10^9 *km* × 0.62137 *mi/km*	**3.67×10^9**

Table 3: Use the planetary orbit distances from **Table 2** and the scale factor (number **B**) for the calculations in the table below. This calculation will scale down the planetary orbit distances from astronomical sizes to model sizes. How many million times smaller is our model?__**90**

Planet	Formula (Symbols)	Formula (Numbers)	Orbit (*mi*)
Mercury	Mercury's orbit (*mi*) ÷ **B**	3.60×10^7 *mi* ÷ 9.175×10^7	**0.392**
Venus	Venus's orbit (*mi*) ÷ **B**	6.71×10^7 *mi* ÷ 9.175×10^7	**0.731**
Earth	Earth's orbit (*mi*) ÷ **B**	9.32×10^7 *mi* ÷ 9.175×10^7	**1.02**
Mars	Mars's orbit (*mi*) ÷ **B**	1.42×10^8 *mi* ÷ 9.175×10^7	**1.54**
Jupiter	Jupiter's orbit (*mi*) ÷ **B**	4.83×10^8 *mi* ÷ 9.175×10^7	**5.27**
Saturn	Saturn's orbit (*mi*) ÷ **B**	8.89×10^8 *mi* ÷ 9.175×10^7	**9.68**
Uranus	Uranus's orbit (*mi*) ÷ **B**	1.78×10^9 *mi* ÷ 9.175×10^7	**19.4**
Neptune	Neptune's orbit (*mi*) ÷ **B**	2.80×10^9 *mi* ÷ 9.175×10^7	**30.5**
Pluto	Pluto's orbit (*mi*) ÷ **B**	3.67×10^9 *mi* ÷ 9.175×10^7	**40.0**

Table 4: Use the model planetary orbit distances from **Table 3** and conversion number **C** in the table below. This calculation will change the planetary distances from model *mi* to model *mm*.

Planet	Formula (Symbols)	Formula (Numbers)	Orbit (*mm*)
Mercury	Mercury's orbit (*mi*) × **C**	0.392 *mi* × ____________*mm/mi* =	Will vary
Venus	Venus's orbit (*mi*) × **C**	0.731 *mi* × ____________*mm/mi* =	depending
Earth	Earth's orbit (*mi*) × **C**	1.02 *mi* × ____________*mm/mi* =	on different
Mars	Mars's orbit (*mi*) × **C**	1.54 *mi* × ____________*mm/mi* =	maps.
Jupiter	Jupiter's orbit (*mi*) × **C**	5.27 *mi* × ____________*mm/mi* =	
Saturn	Saturn's orbit (*mi*) × **C**	9.68 *mi* × ____________*mm/mi* =	
Uranus	Uranus's orbit (*mi*) × **C**	19.4 *mi* × ____________*mm/mi* =	
Neptune	Neptune's orbit (*mi*) × C	30.5 *mi* × ____________*mm/mi* =	
Pluto	Pluto's orbit (*mi*) × **C**	40.0 *mi* × ____________*mm/mi* =	

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Mapping the Planetary Orbits

Whew, now all of the math is finished we can get on to the fun stuff! Using the planetary distances you calculated above from **Table 4** and a compass (the kind with a pencil not the kind that points north!), plot the orbits on the map with Delcastle as the sun. Once the orbits have been plotted identify a landmark along each planet's orbit. For example, the planetary orbit may fall on a well-known building, a major intersection or a nearby city. List at least one landmark for each planet in the table below.

Planet	**Landmarks Identified on Hometown Model Map**
Mercury	Railroad track by Delcastle
Venus	Intersection of Rt 141 and Rt 2
Earth	Prices Corner Shopping Center, Best Buy
Mars	Intersection of Rt 7 and Rt 2, Stanton Middle School on Rt 7
Jupiter	Intersection of Rt 2 and Rt 72, Delaware Memorial Bridge (DE side), Intersection of I-95 and Rt 202
Saturn	White Clay Creek Park (PA/DE/MD intersection), Rt 202 crossing from DE to PA, Kennett Square in PA
Uranus	City of Middletown
Neptune	City of Smyrna
Pluto	City of Dover