

# An Impossible Alignment: Building a Scale Model of the Solar System

Earth Science

Mr. Traeger

Name: \_\_\_\_\_

Period: \_\_\_\_

Date: \_\_\_\_\_

**Purpose**

The purpose of this assignment is to become familiar with the scale of the solar system. It shows visually the average distance of each planet from the sun if an impossible alignment of the planets were to occur. It also shows the relative diameters of the planets and their angle of tilt.

**Materials**

- 400 cm of 7.5 cm (3+) Adding Machine Tape
- Meter Stick
- Colored Pencils
- Drawing Compass
- Textbook
- Protractor

**Part 1: Drawing the distances from the sun in the solar system to scale**

1. Convert each of the following planetary distances into astronomical units (AU).
2. Once you have converted into AU's, then determine a **scaling factor** that will allow your farthest distance away from the sun to fit on to your 400 centimeter long tape.
3. Convert your distances into centimeters using the scaling factor.
4. Unroll your adding machine tape. Draw in the sun to its appropriate size. Measure the distance that each planet would be away from the sun. Mark these distances on your adding machine tape.

Planet	Average Distance from Sun in Km	Scaling Factor to convert to AU's	Average Distance from Sun in AU's	Scaling Factor to convert to cm	<u>Scale Average Distance from Sun in cm</u>
Mercury	58,000,000				
Venus	108,000,000				
Earth	150,000,000				
Earth's Moon at Full Phase	150,384,400				
Mars	228,000,000				
Asteroid Belt	400,000,000 to 600,000,000				
Jupiter	778,000,000				
Saturn	1,430,000,000				
Uranus	2,870, 000,000				
Neptune	4,500,000,000				
Pluto	5,900,000,000				
Quaoar	6,510,000,000				
Eris	1.0 X 10 <sup>10</sup>				
Heliopause	1.5 X 10 <sup>10</sup>				
Sedna	7.9 X 10 <sup>10</sup>				
Oort Cloud Comets	1.5 X 10 <sup>13</sup>				
Alpha Centauri, our nearest star	4.114995 x 10 <sup>13</sup>				
Center of Milky Way Galaxy	2.46 X 10 <sup>17</sup>				
Andromeda Galaxy	2.08 X 10 <sup>19</sup>				
Oldest Galaxies	1.23 X 10 <sup>23</sup>				

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### Part 2: Drawing the diameters of each planet to scale

1. We will need to make a separate scale to calculate the scale diameter of each of the planets. This is because the planets would appear extremely small if we were going to draw them according to the previous scale that we calculated.
2. We will convert the actual diameters into Earth diameters, or how each planet would compare to the Earth.
3. We want to determine another scaling factor that will allow our largest planet to fit within the confines of a 7.5 cm wide adding machine tape.
4. Once we scale down the diameter of our planets to fit on the adding machine tape, we will draw each planet (using a compass) on our tape. We will draw each planet at the exact location that was determined in Part 1.

Planet	Diameter (Km)	Scaling Factor to Convert to Earth Diameters	Earth Diameters	Scaling Factor to convert to cm	Scale Diameter in cm
Sun	1,392,000				
Mercury	4,880				
Venus	12,104				
Earth	12,756				
Earth's Moon	3,476				
Mars	6,787				
Jupiter	142,800				
Saturn	120,000				
Uranus	51,800				
Neptune	49,500				
Pluto	2,300				

### Part 3: Drawing the Axes of Each Planet

1. Using a protractor, draw the axis of each planet. Note that any planet that has an angle greater than 90° is spinning in the opposite direction of Earth.

Planet	Angle From Vertical	Planet	Angle from Vertical
Mercury	2°	Jupiter	3°
Venus	177.3°	Saturn	27°
Earth	23.5°	Uranus	97.9°
Earth's Moon	7°	Neptune	30°
Mars	25°	Pluto	122°

### Part 4: Making it Look Good

1. Now, using pictures from your book make your Solar System Scale a work of art! **Don't forget to draw the asteroid belt!**

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### Part 5: Questions

1. Why is this activity titled "An Impossible Alignment"? What is impossible about it?

2. The Astronomical Unit (AU) is not an appropriate unit for measuring distances to stars and galaxies. The appropriate unit is the light year. This is defined as the distance that light travels (at the speed of light) in one year. The speed of light is  $3 \times 10^8$  km/s and one light year is  $9.47 \times 10^{12}$  km. Use the following chart to convert the following distances to light years.

Planet	Average Distance from Sun in Km	Scaling Factor to convert to light years	Average Distance from Sun in light years
Mercury	58,000,000	$9.47 \times 10^{12}$	
Venus	108,000,000	$9.47 \times 10^{12}$	
Earth	150,000,000	$9.47 \times 10^{12}$	
Earth's Moon at Full Phase	150,384,400	$9.47 \times 10^{12}$	
Mars	228,000,000	$9.47 \times 10^{12}$	
Asteroid Belt	400,000,000 to 600,000,000	$9.47 \times 10^{12}$	
Jupiter	778,000,000	$9.47 \times 10^{12}$	
Saturn	1,430,000,000	$9.47 \times 10^{12}$	
Uranus	2,870,000,000	$9.47 \times 10^{12}$	
Neptune	4,500,000,000	$9.47 \times 10^{12}$	
Pluto	5,900,000,000	$9.47 \times 10^{12}$	
Quaoar	6,510,000,000	$9.47 \times 10^{12}$	
Eris	$1.0 \times 10^{10}$	$9.47 \times 10^{12}$	
Heliopause	$1.5 \times 10^{10}$	$9.47 \times 10^{12}$	
Sedna	$7.9 \times 10^{10}$	$9.47 \times 10^{12}$	
Oort Cloud Comets	$1.5 \times 10^{13}$	$9.47 \times 10^{12}$	
Alpha Centauri, our nearest star	$4.114995 \times 10^{13}$	$9.47 \times 10^{12}$	
Center of Milky Way Galaxy	$2.46 \times 10^{17}$	$9.47 \times 10^{12}$	
Andromeda Galaxy	$2.08 \times 10^{19}$	$9.47 \times 10^{12}$	
Oldest Galaxies	$1.23 \times 10^{23}$	$9.47 \times 10^{12}$	

3. How small do you feel now? Explain in a paragraph of no fewer than 50 words on the back of this sheet.