Rubric for activity

Task 1

Comparing and Scaling Planet Sizes

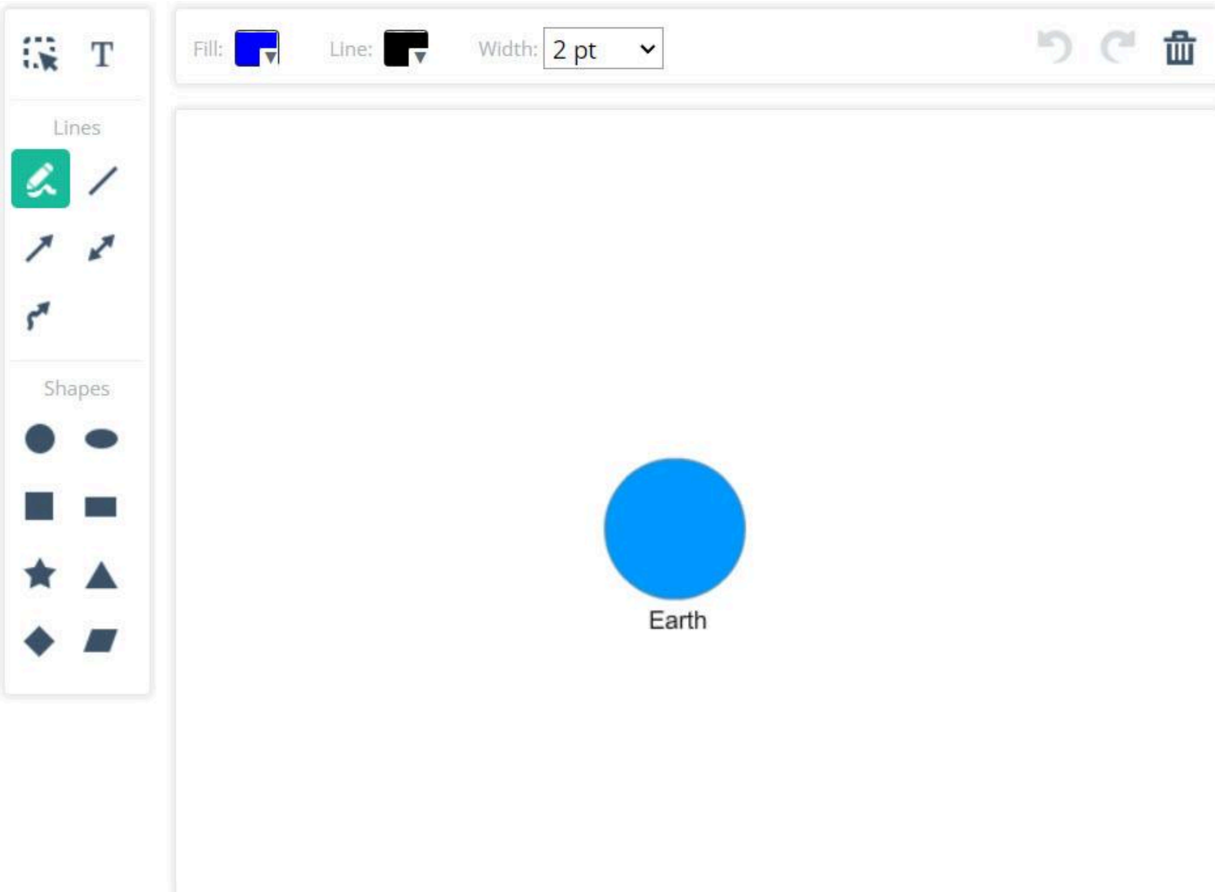
Scale drawings and models are used to represent objects that are too large or too small to be drawn or built at actual size, such as a planet. While the size of a scale model is different than the actual object, the model and the object should be proportional. Scaling uses a ratio called the scale factor, which compares the measurements of the drawing or model to the measurements of the real object. Consult the Math Review for more help with scale factors.

In this task, you will scale the diameter of each planet in our solar system and start building a model of the solar system.

Part A

Question

The circle represents Earth. Based on the size of Earth, predict the relative sizes of Earth's moon, Jupiter, and Mercury by drawing them next to Earth. Remember that Jupiter is the largest planet in our solar system, and Mercury is the smallest. Draw your prediction in the space provided and label your circles.



If you're having trouble using our software, please let me know so I can create a video that demonstrates its features for you.

Part B

The table lists the planets in our solar system in order of their average distance from the Sun, along with their corresponding diameters. The first step in creating a model of the solar system is to scale these large diameters into smaller, more manageable numbers. Eventually, we'll represent these numbers using circles drawn on paper.

Increasing Distance from the Sun→								
	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (km)	4879	12,104	12,756	6792	142,984	120,536	51,118	49,528
Scaled Diameter (cm)			3.5	1.9				

The ratio between Earth's actual diameter and its scaled diameter can be used to find the scaled diameter of the other planets. Earth's diameter of 12,756 kilometers is scaled to 3.5 centimeters as shown in the table. Now let's find the scaled diameter of Mars as an example. Using the calculations shown, Mars's diameter of 6,792 would be scaled to 1.9 centimeters.

$$\frac{12{,}756 \text{ km}}{3.5 \text{ cm}} = \frac{6{,}792 \text{ km}}{d}$$

$d \times 12{,}756 = 6{,}792 \times 3.5$

$d = 1.9$ cm

Use this same process to complete the table with the scaled diameters of the other planets. Round each answer to the tenths place. If you need additional math help, visit the Proportions section of the Math Review.

Your table is the same as the one above, except you are to fill in the spaces.

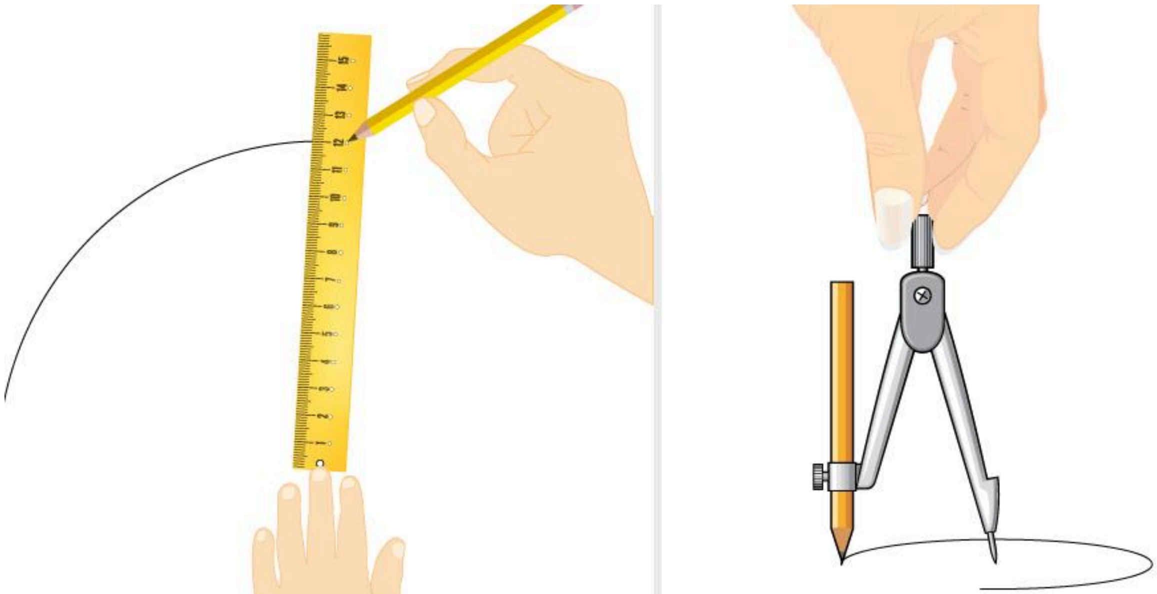
Increasing Distance from the Sun→								
	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Diameter (km)	4879	12,104	12,756	6792	142,984	120,536	51,118	49,528
Scaled Diameter (cm)			3.5	1.9				

Show how to complete at least one calculation using units and setting up the equation with variables first. Not Earth or Mars, those are done for you.

Part C

Draw each planet on paper using the scaled diameter found in part B. Use a ruler and, if possible, a compass to draw your planets as shown in the images. Notice that in both of these images, the radius (half the diameter) is used to create a circle.

If you need help with circles, visit the Properties of Circles section of the Math Review. For assistance with taking measurements, visit Lab Instruments and Measurements.



Be sure to label each planet with its name, and then cut them out. Place the planets in order based on their average distance from the Sun, shown in the table in part B. Now, compare the sizes of the planets. What relationship do you observe between a planet's size and its proximity to the Sun? If possible, snap a photograph of your model. ~~Click the Insert Image button to add your image file (.jpg or other) in the answer space~~.

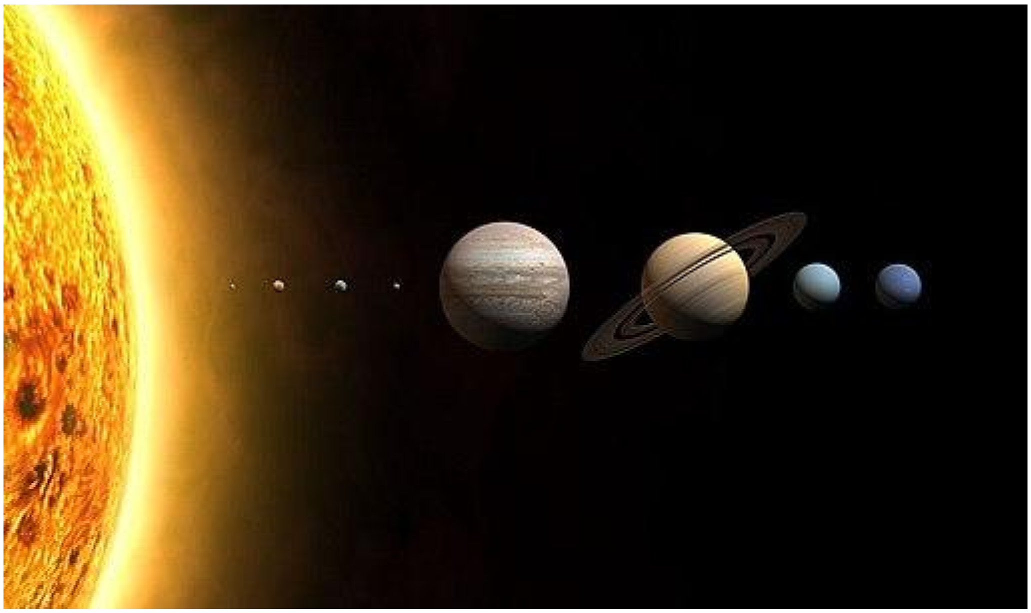
I can never see the images that are in the tiny answer spaces. Please attach your image as a JPG file where you submit the assignment.

The guide sheet to show you how to upload files is here:

https://docs.google.com/document/d/14qx2CaYt-OGYf2a2dRCQueAQHpMQQwWf72jMt4B11Ow/edit?usp=sharing

If you can’t do this part of the activity, answer this question in the answer space:

When you look at a picture of the planets, are the larger planets closer or farther away from the sun?



Part D

The Sun has a diameter of approximately 1,391,400 kilometers. How big would the Sun be in your scaled-down model of the solar system? Explain how you scaled the Sun’s diameter to fit into your model, and describe how its size compares to the planets.

Hint:

12,756 km
3.5 cm

Is now equal to

1,391,400 km
D

You need to solve for d. Show your work. How do you do the calculation?

That is supposed to be ratio and proportion, but I don't see an equation editor in Google Docs.

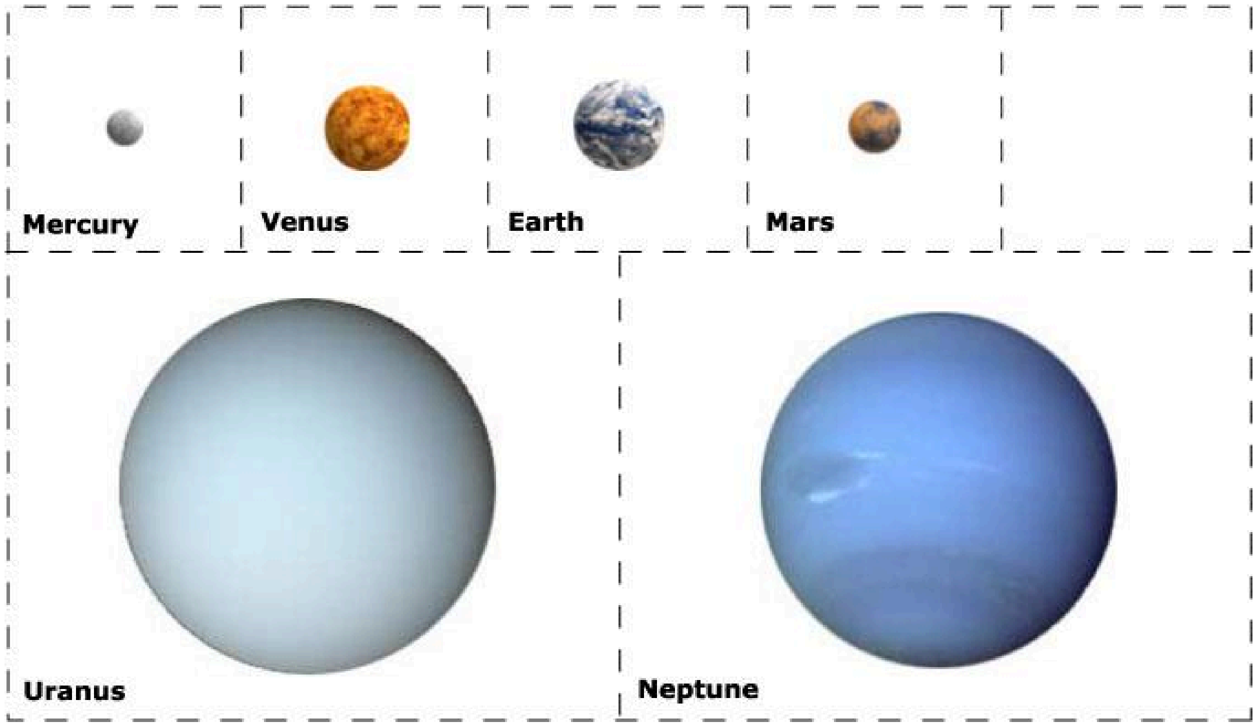
Task 2

Comparing and Scaling Planet Distances

Now that we have the size of the planets scaled, we need to know how far apart to place them in order to complete our model. In this task, you will scale the distances between the planets and the Sun and complete your model of the solar system. Once again, consult the Math Review as needed for help with scale factors and proportions.

Part A

Arrange the cut-out planets you made in Task 1 in order according to their proximity from the Sun, as shown below. As an alternative, you may cut out the scaled planets.



Sun	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune

At a large desk or on the floor, choose a position to represent the Sun, and place Mercury a few inches from it. Predict the relative distances between each of the other planets, and space them out accordingly. Do you think the average distances between each of the planets stay relatively consistent or vary greatly? What leads you to this conclusion?

Part B

In a similar way to how you scaled the size of the planets, you'll also scale the distances between each of the planets and the Sun. The table contains the planets in our solar system and their average distances from the Sun.

To more easily compare these distances, you'll scale them down using sheets of toilet paper.

Increasing Distance from the Sun→								
	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Average Distance from the Sun (million km)	57.9	108.2	149.6	227.9	778.6	1433.5	2872.5	4495.1
Scaled Distance (sheets of toilet paper)			5.0	7.6				

The ratio between Earth's distance from the Sun and its scaled distance can be used to find the scaled distance for the other planets. Earth's distance of 149.6 million kilometers to the Sun is scaled to 5.0 sheets of toilet paper as shown in the table. Now let's find the scaled distance between Mars and the Sun as an example. Using the calculations shown, Mars's distance to the Sun of 227.9 million kilometers would be scaled to 7.6 sheets of toilet paper.

$$\frac{149.6 \text{ million km}}{5.0 \text{ sheets}} = \frac{227.9 \text{ million km}}{d}$$

$d \times 149.6 = 227.9 \times 5.0$

$d = 7.6$ sheets

Use this same process to complete the table with the scaled distances for the other planets. Round each answer to the tenths place. If you need additional math help, visit the Proportions section of the Math Review.

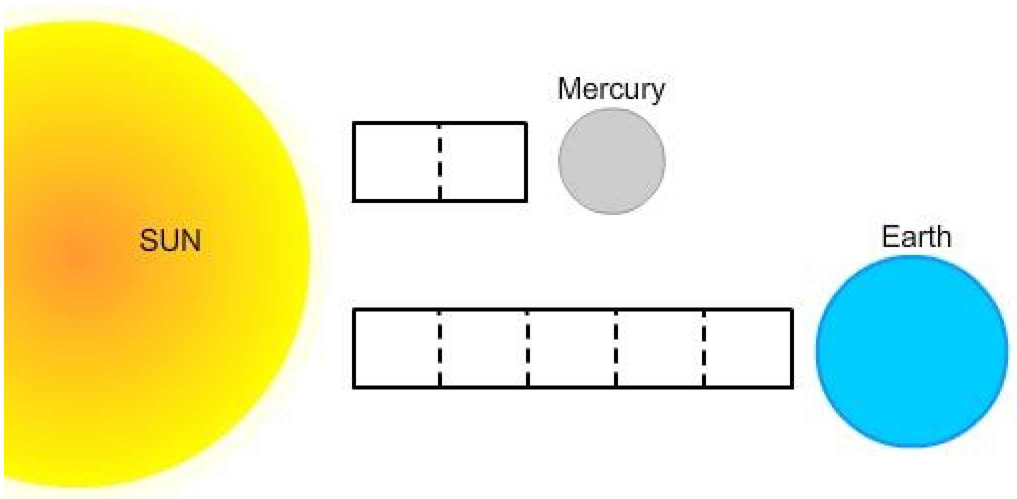
Same data table that you fill in.

Increasing Distance from the Sun→								
	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune
Average Distance from the Sun (million km)	57.9	108.2	149.6	227.9	778.6	1433.5	2872.5	4495.1
Scaled Distance (sheets of toilet paper)			5.0	7.6				

Show the math for at least one calculation.

Part C

Using the data from part B, show the distance from the Sun to each planet by rolling out the correct number of sheets of toilet paper. Place each scaled planet you created in Task 1 at the end of the sheets of toilet paper. For example, Earth would be 5 sheets away from the Sun, while Mercury would be 1.9 sheets away.



Now that you've created a scale model of the solar system, describe the relative distances between the planets. What patterns, or similarities, do you notice? How do these distances affect the amount of time it takes each planet to orbit the Sun? If possible, snap a photograph of your model. ~~Click the Insert Image button to add your image file (.jpg or other) in the answer space~~. Please attach the jpg image where you can attach files before submitting your activity.

Part D

Astronomers believe that there is a large cloud of frozen comets called the Oort cloud, which surrounds our solar system. It lies approximately 50,000 times farther from the Sun than Earth. Approximately how many squares of toilet paper would you need to put the Oort cloud on your model? Explain how you arrived at your answer.

Hint:

Earth’s average distance from the Sun is 149.6 million kilometers. If the Oort cloud is 50,000 times farther, it is 7,480,000 million kilometers (or 7.48 x 1012 km) away. Using the same math steps in part B, I calculated that the Oort cloud would be_______________ sheets of toilet paper away from the Sun.

$$\frac{149.6\text{million km}}{5.0\text{sheets}} = \frac{7{,}480{,}000\text{million km}}{d}$$

$$d \times 149.6 = 7{,}480{,}000 \times 5.0$$

$$\frac{d \times 149.6}{149.6} = \frac{7{,}480{,}000 \times 5.0}{149.6}$$

$$d = \text{xxxxxxxxx sheets}$$

Part E

Check out how large the Sun appears when the Moon is one pixel wide using this online model of the solar system. Unlike this website, we used one proportion, or scale factor, for the planets’ diameters and another scale factor for the planets’ distances from the Sun. Why do you think it is common to use two different methods of scaling for the planet’s diameters and distances when creating a model?

Part F

Compare your finished model of the solar system to the predictions you originally made about the planets' comparative sizes and distances. In what ways were your original predictions about the scale of the solar system correct or incorrect? How has your understanding of the scale of the solar system changed?

Task 3

My Cosmic Address

Beyond your city, state, country, and continent, the next organizational level would be your planet, Earth, followed by our planetary system, known as the solar system. Answer the questions below by researching each hierarchical step beyond the solar system level, until you arrive at the final, broadest level—the universe. You can use any online resources of your choice. Find reputable resources for this activity, such as this site about the depths of the solar system.

Part A

A galaxy is a system of millions or billions of stars, combined with gas and dust, that are held together by gravitational attraction. Within which galaxy does the Sun and its solar system belong? As you are researching, list at least three characteristics that you learned about this galaxy.

These links may help:

- https://www.maas.museum/observations/2016/05/01/discovering-our-cosmic-address/#:~:text=Maybe%20someday%20soon%20we%20will,One%3F
- https://www.travelandleisure.com/trip-ideas/space-astronomy/earth-cosmic-address
- https://isequalto.com/iet-app/daily-edition/PSnn4036-What-is-our-address-in-the-universe?
- http://avilaastro.weebly.com/

Part B

Next, our galaxy can be organized into a galaxy group. This galactic group is a collection of about 50 galaxies that are gravitationally bound to each other. What is the name of the galaxy group in which our galaxy belongs? As you are researching, list at least three characteristics that you learned about our galaxy group.

These links may help

https://earthsky.org/clusters-nebulae-galaxies/what-is-the-local-group/

http://www.atlasoftheuniverse.com/localgr.html

https://astronomy.com/magazine/2019/08/the-local-group-our-galactic-neighborhood

http://spiff.rit.edu/classes/phys230/lectures/local_group/local_group.html has images

Part C

Groups of galaxies are organized into superclusters. Superclusters can contain hundreds or thousands of galaxy groups. What is the name of the supercluster that our galaxy group belongs to? As you are researching, list at least three characteristics that you learned about our supercluster.

These links may help

https://www.forbes.com/sites/startswithabang/2017/02/24/cosmic-superclusters-the-universes-largest-structures-dont-actually-exist/?sh=3ae7d3cd15c1

https://youtu.be/rENyyRwxpHo

Maybe https://bigthink.com/starts-with-a-bang/laniakea-dark-energy/

Part D

The last and final organizational structure is the observable universe. Given the information that you just researched, create your very own cosmic address for your home or school using the following template.

Name	
Street	
City	
State	
Country	
Planet	
Planetary System	
Galaxy	
Galaxy Group	
Galaxy Supercluster	
Region of the Universe	