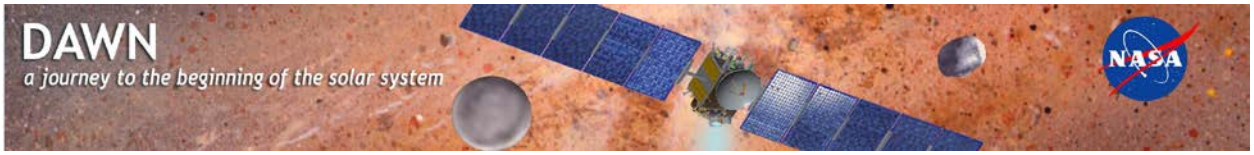


History and Discovery of Asteroids

Where Are You?

STUDENT ACTIVITY—SCALE MODELING OF VESTA AND CERES IN THE SOLAR SYSTEM

If you were to look through the most powerful telescope from the 19th century on a clear, cloudless night, an asteroid such as Ceres or Vesta would appear only as a tiny point of light.[1] You may wonder: *How big are these asteroids really? How far away are they from Earth? And how can I get a better view of these points of light?* In this activity, you will create a model to help you answer these questions. This model will help you to develop an understanding of both the size and distance of Ceres and Vesta relative to Earth.

Part 1: Size to Scale

1. Using food items, you will create a scaled-down model of a portion of our Solar System. The table below lists several planets and asteroids along with their approximate diameters measured in kilometers. Your job will be to convert the diameter to the scale of **1 centimeter (cm) = 500 kilometers** (km) Then based on your calculations, assign foods to represent the Solar System objects. Mercury has been completed for you as an example.

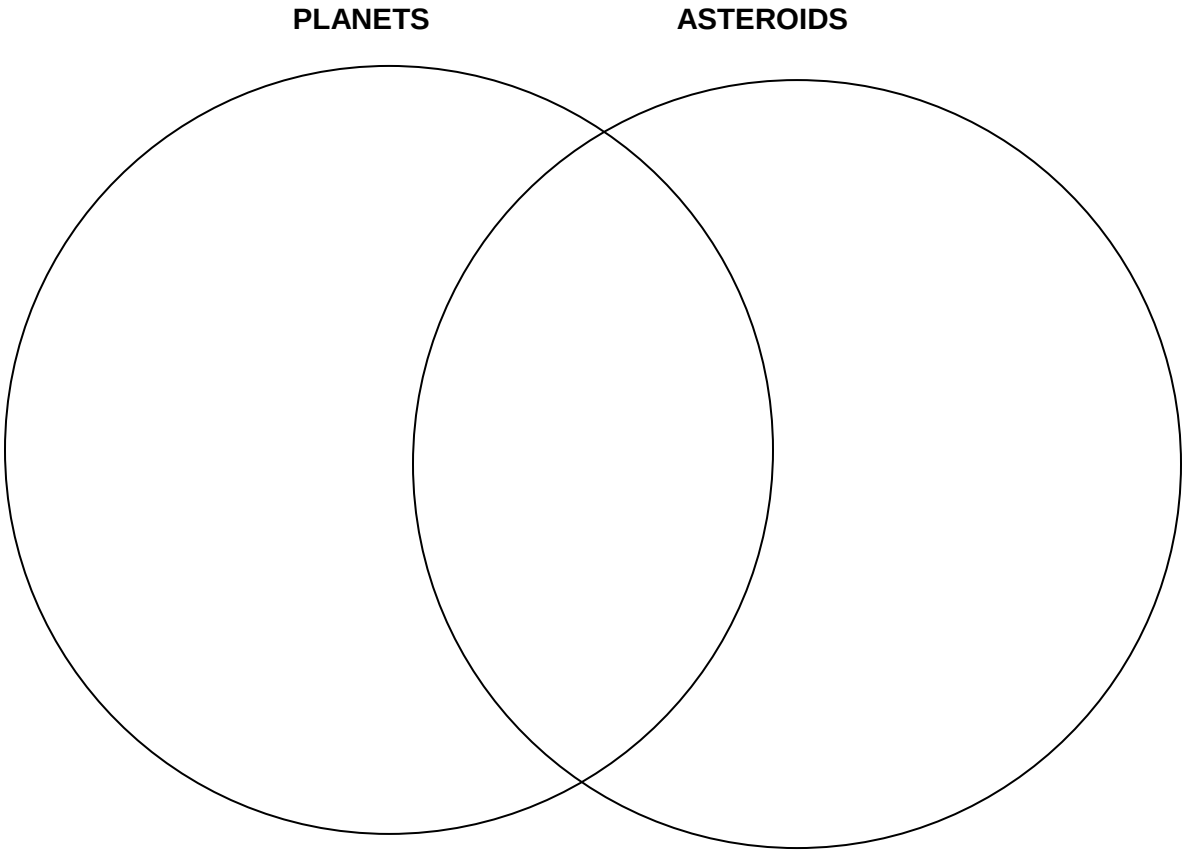
Solar System Bodies	Diameter in km	Convert to Scale 1 cm = 500 km	Scaled-down Size in cm	Food Item
Mercury	***4, 880***	$\frac{1\ cm}{500\ \cancel{km}} \left(\frac{4{,}880\ \cancel{km}}{1} \right)$ $= \frac{4{,}880\ cm}{500}$ $= 9.76\ cm$	***9.76***	***Orange***
Earth	***12,756***			
Mars	***6,794***			

[1] See vignette "What Can You See with a Telescope?"

Solar System Bodies	Diameter in km	Convert to Scale 1 cm = 500 km	Scaled-down Size in cm	Food Item
Vesta	***525***			
Ceres	***933***			

Gather the foods you have selected as representations of Earth, Mars, Vesta, and Ceres. Use observation to respond to the questions below.

2. What features do these model planets and asteroids have in common? What differences can you find? Note the similarities and differences in the Venn diagram below.



3. The first and oldest theory of the origins of asteroids suggested that asteroids were pieces of an exploded planet. Another theory proposed that asteroids were free solar system material that never fully developed into planets. How does the model you created support or oppose these theories?

4. If you were to expand this model, the next planet would be Jupiter. Jupiter is so massive that its gravitational pull is what interrupted the development of asteroids in the asteroid belt into fully formed planets. Jupiter's diameter is 142,984 km. Using the same scale (1 cm = 500 km), how large should a model Jupiter be? What object could you use to model Jupiter?

Part 2: Distance to Scale

The table below shows the approximate distances of Earth, Mars, Vesta, and Ceres from the Sun. Refer to the table as you answer the questions below.

Solar System Bodies	Diameter in km	Distance from the Sun in km
Earth	***12,756***	***149,597,890***
Mars	***6,794***	***227,936,640***
Vesta	***525***	***353,400,000***
Ceres	***933***	***413,900,000***

5. If you were to model the distances of these four Solar System bodies in relation to each other using a standard 100-yard football field, could you use the same scale for both size and distance (1 cm = 500 km)? Explain.

6. To describe the distances of solar system bodies, astronomers use a special unit of measurement called ***Astronomical Unit*** or ***AU*** for short. AU indicates a planet's or asteroid's mean distance from the Sun. The approximate distances from the Sun (rounded to the hundredths) in AU are:

Earth	**1.0 AU**	**Vesta**	**2.36 AU**
Mars	**1.52 AU**	**Ceres**	**2.77 AU**

Why do you think AU is the preferred unit of measurement for distance in our Solar System?

7. Now you along with three of your classmates will model the distances between Earth, Mars, Vesta, and Ceres, using the approximate scale of **1 AU = 20 meters (or 2000 centimeters)** Rather than measure out 20 meters for each AU, you will measure in walking strides. To do this, you should first measure the length of each person's stride in centimeters. Record each stride measurement in the table below. Complete the table to determine how many regular walking paces each person in your group will need to take to show the distance of their assigned solar system body from the Sun.

Student Name	Measurement of one stride in centimeters	Solar System Bodies	Distance from the Sun in AU	Number of Strides
		Earth	***1.0***	
		Mars	***1.52***	
		Vesta	***2.36***	
		Ceres	***2.77***	

8. Each person should get the food item that represents his/her planet or asteroid. Find a large open space such as a gymnasium, football field, or long hallway for this activity. Designate a line to represent the Sun. Holding the food item, each person should walk the appropriate number of strides to show the distance of his/her planet or asteroid from the Sun or starting line. When each person arrives at his or her designated spot, stop and hold the food item up for others to see. After you have had the opportunity to observe the model, discuss and respond to the questions below with members of the group.

9. Were Ceres and Vesta visible from Earth in your model? Describe your observations.

10. The model you just created uses two different scales. The foods were sized to a scale of 1 cm = 500 km. The distances reflect the scale of 1 AU = approximately 20 meters. Try to use the same scale for both size and distance.

a. Begin by converting the distance scale into kilometers and centimeters. 1 AU equals approximately 150,000,000 km, whereas 20 meters is the same as 2000 centimeters. How many kilometers would be represented by one centimeter in this scale?

b. If you were to substitute the old size scale (1 cm = 500 cm) with the new scale (in a above), what portion of the food items would most appropriately represent the sizes of the solar system bodies?

11. Do you feel this was a helpful model of the portion of our Solar System that includes the asteroid belt? Explain your response based on your experience.

12. How could this model be improved so that it more accurately reflects the size and distance scale of Earth in relation to the asteroid belt?

13. In order to study asteroids like Vesta and Ceres up close, what technology would astronomers need?