

Measuring Cosmic Scale

Use observation data to compare features and orbital distances.

MS-ESS1-3 "Analyze and interpret data to determine scale properties of objects in the solar system. Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes..."

NAME _____

DATE _____

1 READ AND MARK _____ Read it twice

YOUR JOB Underline each numerical scale measurement or comparison in the passage. Draw a line from each underlined measurement to the instrument or observation source that supports it.

Tools That Measure Space

- ① Scientists determine scale by connecting a measurement to the tool that produced it. NASA's Mars Global Surveyor carried a laser altimeter that measured Olympus Mons at about 22 kilometers above nearby plains. Mars Reconnaissance Orbiter images show that the volcano's base is about 600 kilometers wide. On the Moon, Lunar Reconnaissance Orbiter's laser altimeter measured Tycho crater at about 85 kilometers across. These data show that a feature can be tall, wide, or both, so one number alone does not describe its scale.
- ② Orbital scale can be measured by tracking an object's position over time. Repeated observations from Earth-based telescopes give Mars an average orbital radius of 1.52 astronomical units, or AU. The same type of observations give asteroid Vesta an average orbital radius of 2.36 AU. One AU is the average distance from Earth to the Sun, a value established by radar measurements of planets and spacecraft tracking. Because Vesta's average orbital radius is larger, Vesta travels around the Sun farther out than Mars.
- ③ Space-based telescopes can add another kind of evidence. In 2017, Hubble Space Telescope images measured Jupiter's Great Red Spot at about 16,350 kilometers wide. That width is about 27 times the 600-kilometer base of Olympus Mons. Hubble photographs also show the spot's changing shape, while orbiter data describe a volcano fixed to a solid surface. A scientist should state which measurement is being compared, such as width, height, or orbital radius. Comparing unlike measurements, such as a crater's width and an orbit's radius, does not show which object is larger.

2 ANSWER WITH EVIDENCE _____ Use the passage

- 1** Use the orbital-radius data to determine whether Mars or Vesta travels farther from the Sun. Include the values and the observation source in your answer.

- 2** A student compares Tycho crater's 85-kilometer measurement with Olympus Mons's 22-kilometer measurement. Explain why these numbers alone cannot show which feature is larger.

- 3** What two widths are compared in the statement that one feature is about 27 times wider than the other? Name the observation source for each width.

- 4** Which observation source provides the data needed to decide whether Vesta or Mars has the larger average orbital radius? Explain why that source is useful.

3 YOUR TURN _____ Your own words

Use this study data: A spacecraft camera measured a 48-kilometer-wide crater on asteroid A. A space telescope image measured a 144-kilometer-wide storm on planet B. Earth-based tracking found asteroid A's average orbital radius is 2.0 AU. Write exactly two sentences comparing the feature widths and explaining why the orbital-radius value cannot decide which feature is wider. Cite the source of each number you use.

PART 1 • READ AND MARK

Underline each numerical scale measurement or comparison in the passage. Draw a line from each underlined measurement to the instrument or observation source that supports it. Accept any marking that follows this job and points at the right text.

PART 2 • ANSWERS

#	QUESTION	ANSWER
1	Use the orbital-radius data to determine whether Mars or Vesta travels farther from the Sun. Include the values and the observation source in your answer.	Vesta travels farther from the Sun. Earth-based telescope observations give Vesta an average orbital radius of 2.36 AU, compared with Mars at 1.52 AU.
2	A student compares Tycho crater's 85-kilometer measurement with Olympus Mons's 22-kilometer measurement. Explain why these numbers alone cannot show which feature is larger.	The 85-kilometer measurement is Tycho crater's width, while the 22-kilometer measurement is Olympus Mons's height. Width and height are different scale properties.
3	What two widths are compared in the statement that one feature is about 27 times wider than the other? Name the observation source for each width.	The comparison uses the Great Red Spot's width of about 16,350 km from Hubble Space Telescope images and Olympus Mons's base width of about 600 km from Mars Reconnaissance Orbiter images.
4	Which observation source provides the data needed to decide whether Vesta or Mars has the larger average orbital radius? Explain why that source is useful.	Repeated Earth-based telescope observations provide the orbital-radius data. Tracking each object's position over time allows scientists to determine its average distance from the Sun.

PART 3 • YOUR TURN (SAMPLE ANSWER)

The space telescope measured planet B's storm as 144 kilometers wide, three times the 48-kilometer crater measured by the spacecraft camera on asteroid A. Earth-based tracking measured asteroid A's 2.0-AU orbital radius, but orbital radius cannot be compared with feature widths to decide which feature is wider.

Accept equivalent comparisons that use the correct values, scale properties, and observation sources. For the open task, students must compare the two widths, identify the storm as three times as wide, and explain that orbital radius is not a feature width.