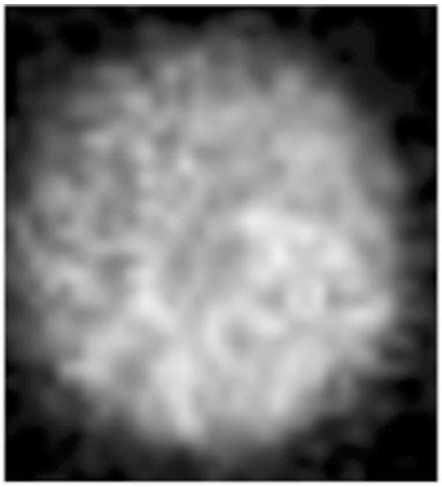
Mystery Asteroid

History and Discovery of Asteroids

ANSWER KEY FOR TEACHER REFERENCE

Below are two images of the same asteroid, taken at two different times by the Hubble Space Telescope. Based on what you have learned in this module, describe the characteristics of this asteroid that you can infer from these images.



1. Description of this asteroid: Include a description of its albedo and any possible surface characteristics. Also, include whatever conclusions you might reach about its three-dimensional shape.

The following responses can help assess student's understanding of module content and concepts. (Note: Descriptions should include only features that can be observed in the images.)

Albedo: *Some variation in albedo (areas that are lighter/darker than others). Areas of differentiation are small, so, on the whole, the asteroid seems bright, which suggests a fairly high albedo. Answers could include a numeric estimate of albedo, based on the scale derived in the activity, "Seeing Circles." Students may indicate that the image on the left looks brighter, thus implying that the albedo varies from one side of the asteroid to the other.*

Surface Characteristics: *From variations in albedo, students may infer that dark areas are craters, small depressions, or areas covered with low albedo surface material, while light areas or areas of very high reflectivity may suggest higher elevations or high albedo surface composition. Students may describe the surface as rough and, from the edges of the images, may determine some cratering.*

Shape: *Most students will suggest that the object is spherical or "golf ball-shaped (dimpled)." Students who feel that one image is slightly larger may deduce that the asteroid is not completely spherical. Perhaps, some students may suggest the possibility that the asteroid could be "cigar-shaped," rotating around its long axis, and the images are each of the ends.*

2. Why do you think the two images look different?

The following responses can help assess student's understanding of module content and concepts.

Since images were taken at two different times, most students will infer that the asteroid has rotated, exposed different surfaces and, therefore, the images are of two different views of the asteroid. Some students may further develop their explanation and suggest that either the Sun may be shining: a) on the asteroid from different angles; b) on the asteroid from different distances; c) on different surface areas of the asteroid; or d) the surface of the asteroid is not the same all over.

3. How does this asteroid compare with what you learned about Vesta in this module?

The following responses can help assess student's understanding of module content and concepts.

Vesta is not as spherical as the "mystery asteroid" appears to be. This asteroid may not be as bright as Vesta. The areas of high albedo (more reflective surfaces) and low albedo (less reflective surfaces) are larger on Vesta, which suggests that the "mystery asteroid" is either not as severely cratered as Vesta or has more consistency in surface composition than Vesta.

4. What difficulties did you face in trying to describe this asteroid? Why did you have these difficulties?

The following responses can help assess student's understanding of module content and concepts.

Most students will comment about the lack of detailed information. The images are unclear, fuzzy, or blurry, so only differences in reflectivity or degrees of brightness can be seen. Some may compare the number of available images to Vesta and explain that there were not as many views of the "mystery asteroid." Some may comment on the difficulties of interpreting surface characteristics from a two-dimensional image.

From the unclear image, students may infer that the asteroid must be far away. They may deduce that the picture was taken with less sophisticated imaging technology or that perhaps the asteroid was only recently discovered and hasn't yet been investigated up close.

Additional Facts

This asteroid:

- has a volume that is six times larger than Vesta.
- is only 2.6 times more massive than Vesta.
- has a density that is less than half of that of Vesta.
- is smoother than our moon, based on radar observations.
- may be covered with a dry clay-like material.
- may have a polar ice cap during its winter.
- has an absolute magnitude of 3.34 (Vesta's absolute magnitude is 3.20).

Also:

- We do not know of any meteorites that have come from this asteroid.

5. Did we find this information by studying images or by other means? Describe how you think this information was obtained.

The following responses can help assess student's understanding of module content and concepts.

Students should respond "by other means" (and possibly other images) since it would not be possible to obtain all of the information from the blurry images provided. Students may list some of the technology they learned about in the module vignettes: photographic, electronic (CCD), spectroscopic, light curves, and radar techniques, as sources of these other facts.

Some students may tell which technique could have been used to obtain specific facts, such as: radar provided information about surface covering; photographic technology was used to determine absolute magnitude, etc.

6. What questions do you have about the mystery asteroid and would like to have answered? Why?

The following responses can help assess student's understanding of module content and concepts.

Questions: *What is its actual shape? What is the surface made of? How far away is it? How close is it to Earth? What is its period of rotation? Is it on a collision path with Earth at some point in the future? Why does it seem to differ so much from Vesta? Why is it less dense and bigger than Vesta? Is it cratered like Vesta? Does it have a core/mantle structure? Does it have an atmosphere? Is there any water on the surface? What are the temperatures? Is there evidence that it was ever hot?*

Explanations: *When students explain why they want answers to their list of questions, they may suggest that answers would help better determine the "mystery asteroid's" composition; when it formed; how it compares to other asteroids; whether it could support life; whether there are resources available that could be used as fuel; and the origins of the solar system.*

7. How might scientists find the answers to these questions?

The following responses can help assess student's understanding of module content and concepts.

While some of the students' questions may be answered by experts, research, or previous scientific findings, ultimately the best way for scientists to find answers to the remaining questions would be to send a spacecraft to the asteroid, gather, and analyze the scientific data.

Since students acquired a significant amount of background knowledge and information during this module, they may (and hopefully will) refer specifically to the objectives of NASA's Discovery Program and the Dawn mission.