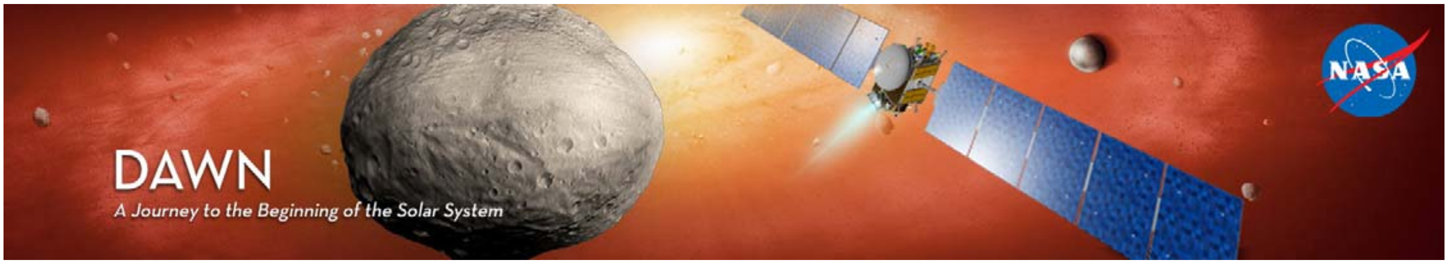


Vesta Mosaic: Art Informing Science

STUDENT ACTIVITY

The Dawn spacecraft entered orbit around the asteroid Vesta in July 2011. As it approached, the framing camera (one of the instruments on board) began taking beautiful images, like the one in Figure 1*.* Before Dawn's arrival at Vesta, the best source of that information was a set of images taken by NASA's Hubble Space Telescope in 1994 and 1996 (see Figure 2 below). The Hubble pictures were little more than "fuzzy circles," in shades of gray. That's because Vesta was 131 million miles away when Hubble took the pictures! Though one of the largest members of the main asteroid belt, Vesta is small compared to say, Mars, and tiny compared to Jupiter.

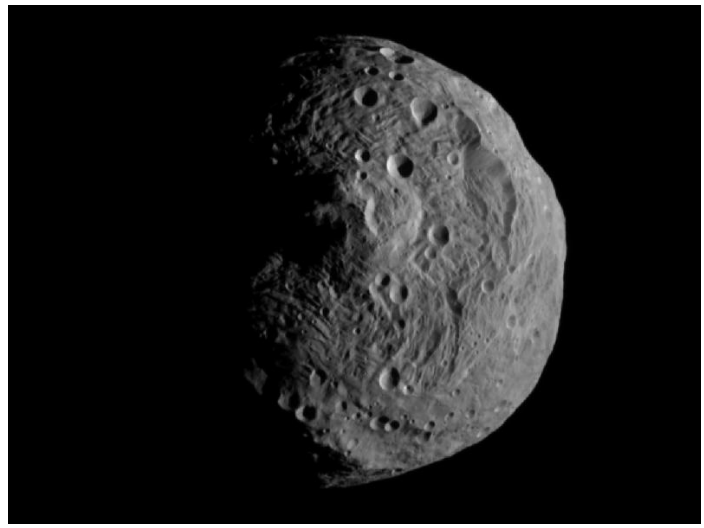


Figure 1**: NASA's Dawn spacecraft's framing camera captured on July 17, 2011. It was taken from a distance of about 9,500 miles (15,000 km) away from the asteroid Vesta. Each pixel in the image corresponds to roughly 0.88 miles (1.4 kilometers).**

Have you ever wondered how we get pictures from space? Images of large and small bodies in the solar system taken from spacecraft are acquired as a table of numbers. Each number represents the brightness of one "square," or pixel, in an image. Look at the Hubble picture of Vesta (Figure 2). Can you see the "squares" in the picture? The Hubble image represents average values (from 0 to 100) of lots of individual small squares that are then put together to make the bigger image. Those squares are the *pixels*!

Albedo is the amount of "whiteness" of an object. Another way to think of it? Albedo is the amount of light reflected from a surface (think of light reflecting off snow vs. a dark road surface). Measuring the amount of light reflected from planets, moons, or asteroids gives us information about their composition and topography.

For a more in-depth experience with albedo, explore the activity "Seeing Circles" in the development section of the *History and Discovery of Asteroids* module at http://dawn.jpl.nasa.gov/DawnClassrooms/1_hist_dawn/

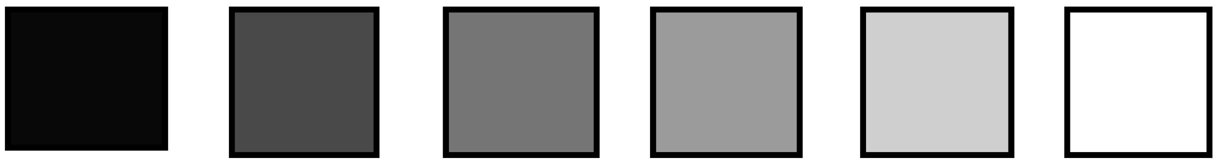
Pixels are the individual photo elements, or the smallest units, of a picture that can be represented by the instrument taking the photo. "Higher resolution" images contain more detail than "low resolution" images. Sometimes the resolution is a function of the instrument taking the photo; but sometimes resolution can also be a function of the distance that you are from the object itself. In other words, if you are very far away from something, you will get a fuzzier picture than if you take a picture closer to that object. That's why, even though the framing camera on the Dawn spacecraft is a lower resolution camera than can be found on the average cell phone nowadays, it is taking crisp, clear pictures of Vesta. The Dawn spacecraft is a lot closer to Vesta than we are here on Earth! The caption under Figure 1*,* above, notes: "Each pixel in the image corresponds to roughly 0.88 miles (1.4 kilometers)." That means that the smallest thing you can see in the picture is at least 0.88 miles in size. Smaller features are "lost" in the averaging of the pixel.

When scientists are recreating pictures from a table of numbers transmitted from a spacecraft, the numbers are assigned “brightness values” and those values are assigned to each pixel. For example, 0 can represent black and 100 can represent white, with each number in between representing a different shade of gray. This measure of “brightness” is termed *albedo* (see text box for more on albedo).

Let’s do some activities to help make sense of all this!

<u>Part A</u>

Estimate the brightness (where 0= black and 100= white) of these example pixels. Discuss with a partner how and why you decided on the values between 0 and 100.



a. 0　　b. _____　　c. _____　　d. _____　　e. _____　　f. 100

Figure 2 below is the best image we had of Vesta before the Dawn mission. In Figure 3, we have magnified 97 pixels of varying brightness that represent a small sample of the larger area (640 by 480 = 307,200 pixels) in Figure 2. For planetary remote sensing, the numbers are first recorded on the spacecraft, and then transmitted back to Earth where they can be reconstructed into images.

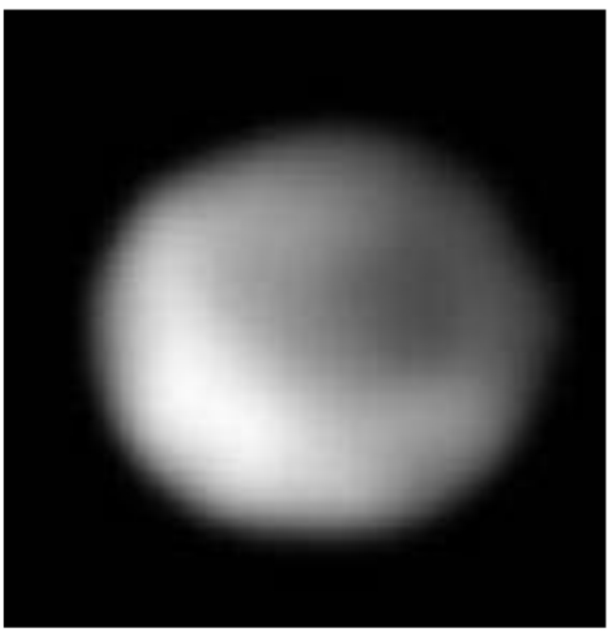


Figure 2: Image of Vesta from the Hubble Space Telescope

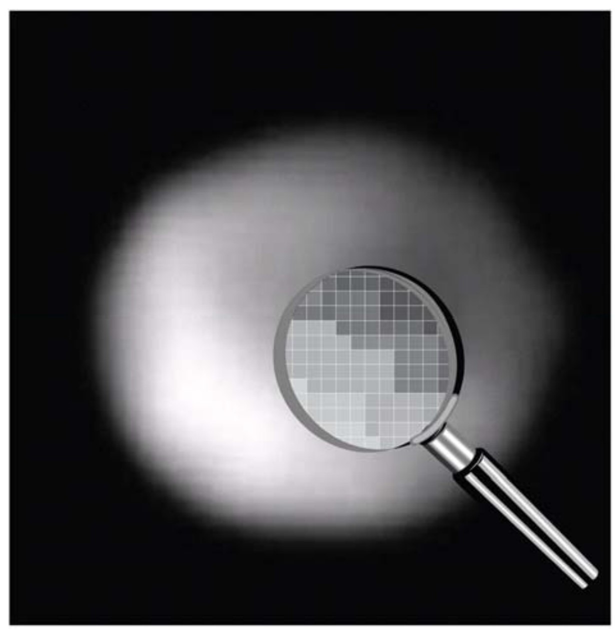


Figure 3: Enlarged area showing individual pixels

Figure 4: A larger image of the magnified area in Figure 3

Activity:
Using the larger image of the magnifying glass in Figure 4, work with a partner to outline around each region of similarly colored pixels. Next, estimate a brightness value between 0 and 100 for each region of similar pixels, where 0 = black and 100 = white.

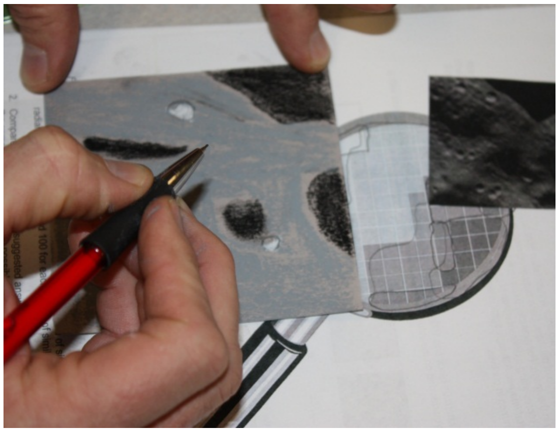
Once you have agreed on your areas and assigned values, answer these questions.

1. Compare your answers to the suggested answers in the Leader Guide and to other groups working on the same image. Are they the same? If not, why do you think that you outlined different areas?

2. How might these challenges be similar to the ones faced by scientists studying Vesta today? Write down your ideas then discuss your thoughts with a partner.

Part B

Science and Art have concepts in common. For example, in Art, ***value*** is the term used to describe light and dark in an image. This light and dark is similar to the "brightness" (or ***albedo***) of a pixel in a digital image from space.



You will be given a small portion of an image. Draw that image on a larger piece of paper.

Tips:

- Pay close attention to the lights and darks
- Enlarge as necessary to maintain the original scale
  - o Some people find sketching a light grid on the image square helps them transfer the features accurately.

Once you have finished drawing your small portion, or "pixel," look on the back of your image. There is a number and an arrow. Use that number and arrow to orient your square onto the large grid hung on the wall by your teacher or group leader. The arrow points to the top of the image. Be sure to affix your drawing in the correct orientation (i.e., make sure "up" is "up").

Once you have contributed your "data" to the group, answer the following questions. Use this sheet or another piece of paper, if necessary.

1. What challenges, if any, did you face in drawing your small image onto a larger piece of paper?

2. Look closely at the larger image you have created collectively as a group. Describe the physical features that are light. Describe what you see that is dark.

3. Observe the larger image created by the whole group. How was your process was similar, and different, from the creation of digital images from the framing camera data transmitted from the Dawn spacecraft

4. Now take what you have learned by looking with care: what might have caused the unusual features the Dawn Mission found on Vesta? How might that help us understand the history of our solar system?

EXTENSION!

ALL WELCOME to join Dawn's Citizen Science project, Asteroid Mappers at http://dawn.jpl.nasa.gov/DawnCommunity/asteroid_mappers.asp. Interpret more images with a cool interactive program and contribute to Dawn's science team!