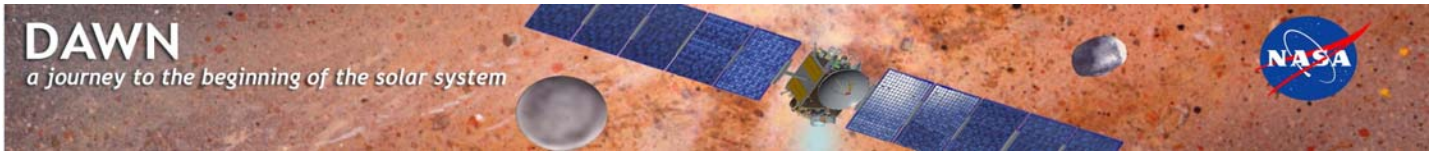


Art in Science: Value and Albedo

LEADER GUIDE

Procedure:

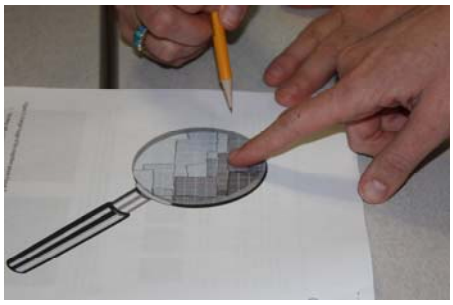
1. Start the discussion by asking students what they know about light.
2. Suggested questions:
    a. What's the difference between light that is reflected and that which is emitted?
    b. How does light interact with white objects?
    c. Is that different from how light interacts with black objects? Why or why not?
    d. How is light related to photography?

3. Have students read the introduction to the Student Activity entitled "Art in Science: Value and Albedo." Discuss their thoughts about the reading. Point out the text box explaining that ***albedo*** is the amount of whiteness of an object or the amount of light that is reflected from a surface.
    a. The term is used in astronomy to describe how much light is reflected from planets, moons, or asteroids.
    b. Albedo is one of the measures that help scientists understand the surface compostion of objects in the solar system.
    c. For a more in depth experience with albedo, you can also use 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/.)

4. Explain to students that image data from large and small bodies in the solar system taken from spacecraft are originally acquired as a table of numbers, where each number represents the brightness of one pixel (square) in the image. For example, 0 can represent black and 100 can represent white, with each number in between representing a different shade of gray. These numbers can be transmitted back to Earth and converted into digital images. Although digital imaging was first developed and heavily used by the space industry for spacecraft images, it is now common in our lives.

5. Part A: Have students practice classifying enlarged pixels using the first set of squares on the next page. Suggested answers include a = 0, b = 20, c = 50, d = 60, e = 75, f = 100. Have students discuss their decisions with a partner.

6. Point out that the magnified area in *Figure 3* is within the full image of *Figure 2*. Explain that students are now going to put their digital imagery analysis skills to work by analyzing an image of Vesta. Tell students to estimate the albedo of each area within the large magnifying glass by assigning brightness (or albedo) values to similarly colored gray regions. Have students complete the exercise using *Figure 4*. Suggested regions are outlined below, however it is important to recognize evidence versus interpretation – not everyone will interpret the images the same way even though they are looking at the same evidence. That is okay! Use the class discussion to highlight the importance of interpretation of evidence to the scientific process.



7. When students have completed the exercise, have them answer the questions that follow *Figure 4*.

8. Part B:
   In Art, *value* is the measure of light and dark in an image. Value corresponds to the scientific concept of albedo. Through this activity, students will be able appreciate the concept of albedo through carefully examining and rendering the light and dark areas of a small portion of an image.

   Now let's have students work with a higher resolution photo of Vesta. Explain that they will collectively recreate a photo from Vesta as if they only had access to only one "pixel" and needed other scientists' data to complete the image. Using pencils or pastels, students will "scale up" a small portion of an image by rendering it onto a larger piece of paper (i.e. they will "scale up" their smaller square).
   a. Start with a copy of an image that is large enough for students to see some detail. You may choose an image from the Dawn website (http://dawn.jpl.nasa.gov/multimedia/index.asp) or any other appropriate image from space.
   b. Depending upon how many students you have, draw a grid onto the back of your chosen image. You may need two or more images to accommodate all of your students, depending upon the size of your class. Number each square and indicate which direction is "up." If using multiple images, number accordingly (i.e. 1a, 1b, 2a, 2b…).

      For example, a 16-square grid might look something like this:

1 ↑	2 ↑	3 ↑	4 ↑
5 ↑	6 ↑	7 ↑	8 ↑
9 ↑	10 ↑	11 ↑	12 ↑
13 ↑	14 ↑	15 ↑	16 ↑

(back of the image)

   c. Cut out the image squares and set them aside.
   d. Decide how much larger you want the image to become. For example, an 8" by 8" image could be scaled up 2x by making the drawing squares in the grid 4" by 4". This would result in a drawing that is 16" by 16".
   e. Measure and cut out the appropriate number of drawing squares. (Note: If using a black and white image, using gray paper for the drawing squares makes the students pay closer attention to light and dark areas.)
   f. Draw a corresponding grid onto a larger piece of paper. This grid will "hold" the larger, rendered squares and be the conglomerated picture of student drawings. Put the grid up so that it hangs on a wall, whiteboard, etc. (Note: When numbering your grid, start in the upper right corner and move to the left, as shown below.)

4	3	2	1
8	7	6	5
12	11	10	9
16	15	14	13

(Number the grid on the wall opposite from your image.)

   g. Using drawing pencils or pastels have each student render their image square onto their larger, drawing square. Their "pixels" will recreate the image.
   h. As each student completes their image, have them affix it to their associated square on the wall.

i. Explain that these squares are like pixels used to comprise a digital image. Each one represents a small piece of data and together they create the whole picture.

Below is an example of a collection of drawings ("pixels") that came together to create the larger image of Capparonia crater.

9. For more information on digital imagery and Vesta, have students read "The Rest of the Story" in the flashback *More Discoveries...Better Descriptions* located at http://dawn.jpl.nasa.gov/DawnCommunity/flashbacks/fb_10.pdf. There are also helpful websites listed in the "Additional Resources" section.