Objectives

- Students will explore the primary and secondary colors of light and pigment.
- Students will determine strategies for comparing ratios.
- Students will compute scale factors of similar figures.
- Students will use scale factors to transform vertices of a given region.

Vocabulary

- Light
- Pigment
- Scale Factor

About the Lesson

- In this activity, students will be introduced to the light and pigment wheels for color.
- Students should have an understanding of ratios as describing how two quantities vary together.
- Students will use ratios to compare different mixtures of paint.

Activity Materials

- Compatible TI Technologies:

    TI-84 Plus CE *with the latest operating system.*
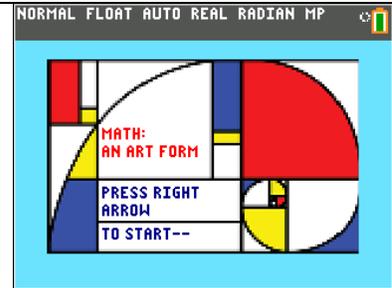
Tech Tips:

- This activity includes screen captures taken from the TI-84 Plus CE.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via TI Connect CE or handheld-to-handheld transfer.

Lesson Files:

- Image0.8ca
- Image9.8ca
- Image1.8ca
- Image1.8ca
- Image3.8ca
- Image4.8ca
- MATH_AN_ARTFORM.8xp

Tech Tip: Make sure when sending the program file MATH_AN_ARTFORM.8xp to your TI-84 Plus CE calculators that the program, and image0, image9, image1, image2, image3, and image4 are also sent.

Art at the intersection of Light, Paint and Ratios

1. Run (execute) the program "MTHARTFM".

2. Read the opening screen. Press ▶ to proceed to the next screen.

3. Read pages 1.2 to 1.5 and make notes as needed. Use ▶ and ◀ to navigate between pages.
    Students may not be familiar with the primary colors of light and pigment. Be sure to give them a little time to study the light and pigment wheels on page 1.6.

4. Navigate to page 1.6. Press enter to start the simulation and use the arrow keys to move the cursor over each button then press enter to show the light and pigment color wheels. Be sure to pay attention to the combinations of colors for light and for pigment.
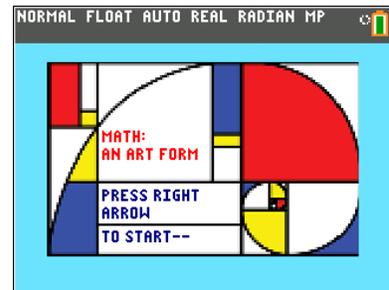
    a. Based on the light wheel, what are the secondary colors of light?
        Answer: Cyan, Magenta, and Yellow
        More info: One important thing to note is how the primary colors of light, when mixed together, add up to what we know as white light. A second thing to note is how individual pairs of the primary colors of light add up to the secondary colors of light. So red light and blue light combine to make magenta light. Green light and red light combine to make yellow light. Green and blue light make cyan.

b. Based on the pigment wheel, what are the secondary colors of pigment?

Answer: Red, Green, and Blue

More info: Since paint is not an emitter of light, the color you see is a result of the colors it absorbs and the colors it reflects. Cyan paint reflects both blue and green light but absorbs red, and magenta paint reflects both red and blue but absorbs green. When you mix magenta and cyan, the resulting color you see is blue, because, magenta and cyan absorb red and green light, but both reflect blue light. Likewise, when cyan and yellow are mixed, the resulting color (green) is a result of the fact that when you mix cyan (reflects green and blue, absorbs red) and yellow (reflects green and red, absorbs blue). So what happens when all three colors of pigment together? In theory red, green and blue light are all absorbed, so no colors are reflected and what you see is no light, black.

c. Describe how the colors of pigment and light are related.

Answer: The primary colors of light are the secondary colors of pigment and the primary colors of pigment are the secondary colors of light.

Once you have shown both wheels, use ▶ or ◀ to continue.

5. Read page 1.7 and then navigate to the color mixing quiz questions on page 1.8. Use the corresponding numbers to select each question and write your answers below.

a. Question 1:

Answer: Magenta and yellow paint mix to make red

b. Question 2:

Answer: Red and green light mix together to make yellow

c. Question 3:

Answer: Blue and green light mix together to make cyan

6. Read pages 2.1 and 2.2

7. On page 2.3 press ⌊enter⌋ to start the simulation. Use ▶ or ◀ to change sides and ▲ or ▼ to change the number of cans of paint in each mixture.

    Be sure students explore and talk about how the mixtures change as they increase or decrease the number of cans in the mixture. There is both an additive pattern (i.e. on the left add 2 red and 3 blue each time) and a multiplicative pattern (i.e. the ratio on the right is always a multiple of 5:6).

8. Use the simulation on page 2.3 to answer the following questions.
    a. What are the ratios for the mixtures of paint?
        Answer: 2:3 and 5:6

    b. Use the up and down arrows to change the mixture on the left. Choose 3 mixtures and fill in the table below.

Red	Blue
6	9
24	36
18	27

    Which of the ratios above is "redder"?
    Answer: student tables may differ, but all the ratios are equivalent so all are the same amount of "redness."

    c. Change the number of cans of red on the left mixture to be 20 by pressing the up or down arrow. Then determine how you can add rows to the right hand mixture to determine which mixture is "redder." Explain your method and state which is redder.
        Answer: Several strategies exist. One is: Change the mixture on the right such that it has the same amount of blue (30), then note that the mixture on the right has more red for the same amount of blue, and is therefore "redder."

    d. Explain at least one other method for determining which of two mixtures is redder.
        Answer: answers will vary. Some possible methods are:
        Set the number of reds the same and compare blue;
        Set the total number of cans equal and compare the fraction of red and blue in each;
        Consider that 1 red and 1 can of blue makes the same color no matter how many pairs, so look at the number of left over blues and the total number of pairs, divide the number of blues by the number of pairs, whichever has the smaller fraction of blues per pair, is the reddest.

9. Read page 2.4 and then navigate to the comparing ratios quiz questions on page 2.5. Select a question by pressing the corresponding number. Use the number keys to respond to the questions on the calculator. Write your answers below.
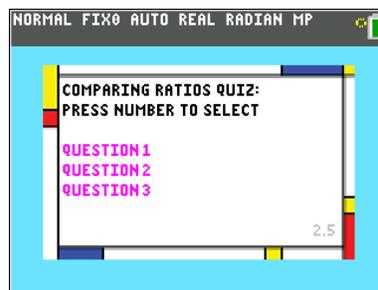
   a. Question 1: Which mixture is "bluer"? Explain your answer.
   Answer: The mixture that is 6:9 is bluer since if you consider adding rows until it is 30:45 and then add rows to the 25:30 ratio until its 30:36, there is more blue in mixture 1 for an equivalent amount of red.

   b. Question 2: Which mixture is "bluer"? Explain your answer.
   Answer: Since one could multiply the ratio on the right by 2 and have an equivalent amount of blue (24) and the resulting ratio is 30:24 while mixture 1 is 32:24, mixture 2 is bluer since it has a smaller amount of red for an equivalent amount of blue.

   c. Question 3: Which mixture is "bluer"? Explain your answer.
   Answer: Mixture 1 is bluer. Consider multiplying the mixture on the left by 3 and have equivalent red (3). The resulting ratio is 3:9 which is bluer than 3:5.

10. Read pages 3.1 and 3.2 and make notes as needed.

11. On page 3.3, press enter to start the scaling simulation. Use the +
and – keys to change the size of the magenta figure. If you need
a calculator press [calc].

a. What is the value of the ratio of the length of the hypotenuse
of the magenta triangle to the length of the hypotenuse of the
white triangle?

Answer: $\dfrac{7.5}{5} = 1.5$

b. How are the lengths of the sides of the white triangle related
to the lengths of the corresponding sides of the magenta
triangle?

**Answer: The lengths of the sides of the magenta triangle
are 1.5 times the length of the white triangle.**

c. Press [enter] to show the scale factor. What does the scale
factor tell you? Verify your thinking by trying different scale
factors.

**Answer: The scale factor tells the amount to multiply the
white triangle by to get the magenta triangle.**

d. AB and A'B' are corresponding sides of two similar figures. If
AB and A'B' have lengths 4 and 18, respectively, what is the
scale factor that relates the two figures?

Answer: Since 18 is 4.5 times larger than 4, the scale

factor is 4.5. $\dfrac{18}{4} = 4.5$

e. If the scale factor 12 is applied to a triangle with side lengths
3, 4, and 5 units, what are the new lengths?

Answer: 36, 48, and 60.

f. Set the scale factor to 2. Suppose the units for length on the magenta triangle are feet and the units for length on the white triangle are inches. Write a ratio including units that shows the relationship between inches on the white triangle and feet on the magenta triangle.

Answer: 5 inches: 10 feet or 1 inch: 2 feet. In words, 1 inch on the white triangle represents 2 feet on the magenta triangle.

12. Move to page 4.1 and read page 4.1 – 4.3 making notes if necessary.

NORMAL FIX1 AUTO REAL RADIAN MP

NOW THAT YOU HAVE A HANDLE ON HOW RATIOS WORK FOR COLOR MIXING AND SCALE, LET'S GET TO REPAIRING THE MURAL. ON THE NEXT PAGE YOU WILL SEE THE MURAL WITH THE DAMAGE IN THE LOWER LEFT CORNER.

4.1

13. On page 4.4 press 2 to answer the question below. If you need a calculator, press 1.

NORMAL FIX1 AUTO REAL RADIAN MP

AT THAT SCALE, HOW MANY INCHES ON THE DRAWING REPRESENT 1 FT ON THE PARKING GARAGE?

PRESS 1 FOR CALCULATOR

PRESS 2 TO SUBMIT AN ANSWER

4.4

a. The mural is 120 feet tall and 160 feet wide. If the original reference rendering was drawn on a sheet of paper 22.5 inches by 30 inches, how many inches on the drawing represent 1 foot on the parking garage?

Answer: $\dfrac{30\ in}{160\ ft} \rightarrow \dfrac{3}{16}\ in : 1\ ft$

b. By what number could you multiply a 1 inch line on the drawing to figure out how long it would be on the mural?

Answer: $1\ in : \dfrac{16}{3}\ ft$ **which means the scale factor is** $\dfrac{16}{3}$
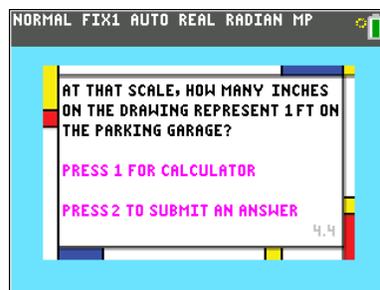
14. Press ▶ and answer the question below. Input your responses on the calculator by pressing 2 to submit a response.

The lower left corner of the parking garage is labeled (0, 0). On the rendering, the rectangular damaged area boundaries: Left boundary $\frac{3}{2}$ in , right boundary $\frac{21}{4}$ in , bottom boundary 0 in, top boundary 9 in. Use the scale computed in part 13 to give the boundaries of the damaged area in feet.

Answer: $\frac{3}{2} in * \frac{16}{3} \frac{ft}{in} = 8\ ft$ **left boundary is 8 ft, right boundary is 28 ft, bottom boundary is 0 ft, and top boundary is 48 ft.**
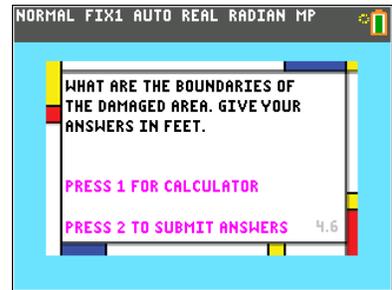
15. Read page 4.7 and make notes. Answer the question below.

All the colors for fixing the damage are mixed except the orange for the background. If the original ratio of yellow to red was 5:3 and we need 64 ounces of orange paint, how many ounces of each are needed?

Answer: Since a total of 64 ounces is needed, the ounces of yellow and red will need to add to 64 ounces. 5 and 3 add to 8. Since 64 is 8 times larger than the sum 8, if we multiply the ratio 5:3 by a factor of 8, it will yield a ratio 40:24 which has a total volume of 64 ounces. So we need 40 ounces of yellow and 24 ounces of red.