Math: An Artform

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

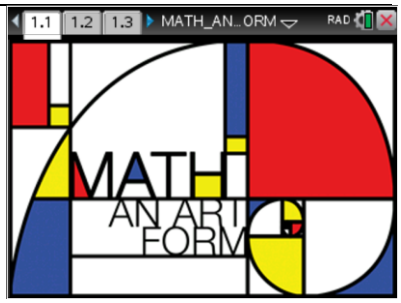
- In this activity, students will be introduced to the light and pigment wheels for color.
- Students should have an understanding of ratios as describing how two quantities vary together.
- Students will use ratios to compare different mixtures of paint.

TI-Nspire™ Navigator™

- Send out the *MATH_AN_ARTFORM.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to spotlight student answers.

Activity Materials

Compatible TI Technologies : TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



Tech Tips:

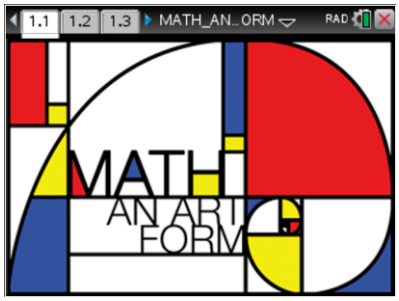
- This activity includes screen captures taken from the TI-Nspire CX.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire Apps. Slight variations to these directions may be required if using technologies other than the handheld.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials
- Any required calculator files can be distributed to students via handheld-to-handheld transfer.

Lesson Files:

- MATH_AN_ARTFORM.tns

Art at the intersection of Light, Paint and Ratios

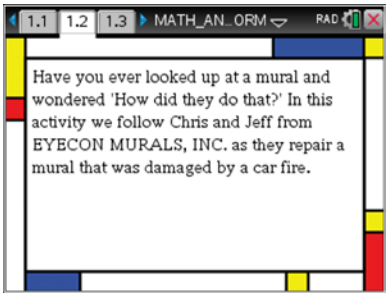
Open the TI-Nspire document *MATH_AN_ARTFORM.tns*



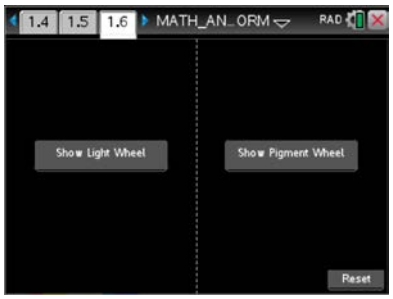
In this activity you will explore the primary and secondary colors of light and pigment. You will use your knowledge of colors, along with your skills with ratios, to determine how best to mix colors to "repair" a mural.

1. Read pages 1.2 to 1.5 and make notes as needed.

   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.



2. Navigate to page 1.6.
   - Select the "buttons" to show the light and pigment color wheels.
   - Be sure to pay attention to the combinations of colors for light and for pigment.
   - Grab and drag the squares to see how pairs of colors mix.



   a. Based on the light wheel, what are the secondary colors of light?

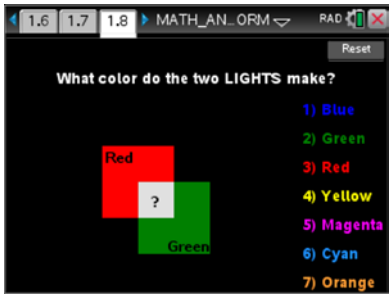
      Answer: Cyan, Magenta, and Yellow

      More information: 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 together, 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). 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.

3. Read page 1.7 and then navigate to the color mixing quiz questions on page 1.8.
   - Answer three questions. (Your questions may differ from others around you.)
   - Write the questions and your answers below.



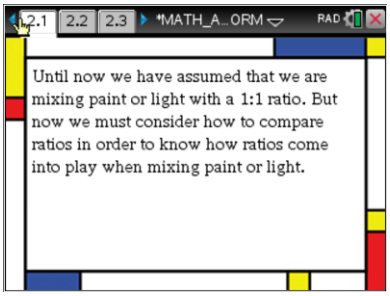
Note: Answers may differ since questions are generated randomly.

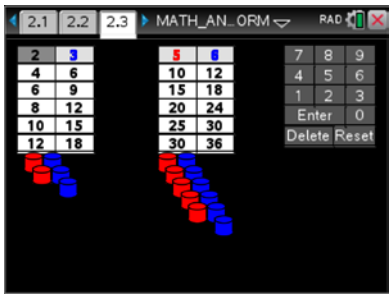
a. Question 1:
Answer: Red and green light mix together to make yellow

b. Question 2:
Answer: Blue and green light mix together to make cyan

c. Question 3:
Answer: Yellow and cyan pigment mix together to make green

4. Read pages 2.1 and 2.2





5. Move to page 2.3
   - Use the up and down arrows to change levels in the table.
   - Use the left and right arrows to change between tables.
   - Observe what happens as you make changes on the page.

   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).

6. 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 arrow to change the mixture on the left. Choose 3 mixtures and fill in the table below.

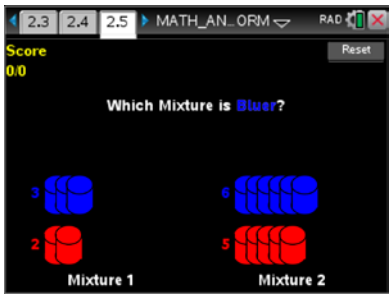
Red	Blue
6	9
10	15
12	18

      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 blue on the right mixture to be 12 by pressing the up or down arrow. Then determine how you can choose a row in the left 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 left such that it has the same amount of blue (12), 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.

7. Read page 2.4 and then navigate to the comparing ratios quiz questions on page 2.5. Answer the questions by selecting a mixture using the number keys or taping the mixture. Write the mixture s and your answers below.



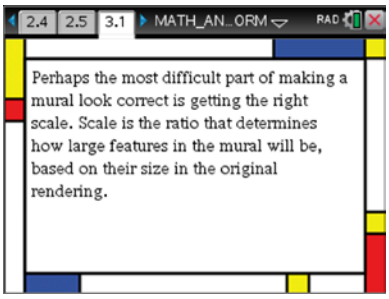
   Note: Questions are generated randomly so students will have different answers. TI-Nspire™ Apps for iPad® tap anywhere for a new question.

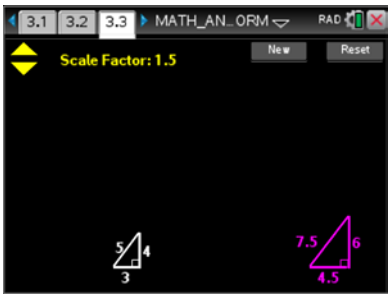
   a. Question 1: Which mixture is “bluer”? Explain your answer.
   Answer: 2 red:3 blue vs. 5 red: 6 blue
   The mixture that is 2:3 is bluer since if you consider adding such that there is equivalent number of blues, it will have less red cans (4:6 as compared to 5:6).

   b. Question 2: Which mixture is “bluer”? Explain your answer.
   Answer: 8 red:6 blue vs. 5 red:4 blue
   Since one could multiply the ratio on the right by 1.5 and have an equivalent amount of blue (24) and the resulting ratio is 7.5:6 while mixture 1 is 8:6, 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: 1 red: 3 blue vs. 3 red:5 blue
   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.

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





9. On page 3.3, use the + and – keys to change the size the magenta figure.

   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: $\frac{7.5}{5} = 1.5$

   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 sides of the magenta triangle are 1.5 times the length of the white triangle.

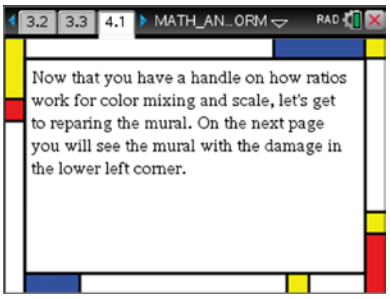
   c. What does the scale factor tell you? Verify your thinking by trying different scale factors.
   Answer: The scale factor tells the amount to multiply the white triangle by to get the magenta triangle.

   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. $\frac{18}{4} = 4.5$

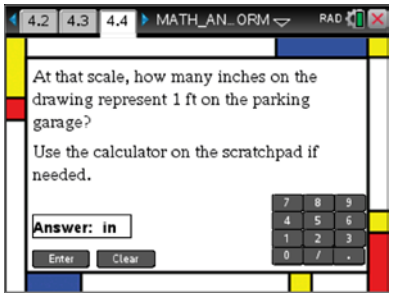
   e. If the scale factor 12 is applied to a triangle with side lengths 3, 4, and 5 units, what are the new lengths?
   Answer: 36, 48, and 60.

   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.

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



11. On page 4.4 and answer the question below. If you need a calculator, use the scratchpad.



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

    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: $1\ in : \frac{16}{3} ft$ **which means the scale factor is** $\frac{16}{3}$

12. Move to page 4.5 and answer the question below. Input your responses on the calculator.

    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.**

13. 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.