Math Objectives

- Students will recognize that the area of a composite shape is the sum of the areas of its smaller parts.
- Students will determine the area of an irregular shape by decomposing it into geometric figures whose areas they can calculate.
- Students will model with mathematics.

About the Lesson

- In this lesson, students will visualize that areas of irregular shapes can be found by determining the sum of smaller, more familiar shapes.
- Student will use the Measurement tools found in the Geometry menu options or model the image using functions on the Graph page.
- Teachers and students can use the TI-Nspire software or iPad app to investigate objects in their own photographs and use proportions to adjust the scale before making measurements to use in calculations with TI-Nspire.
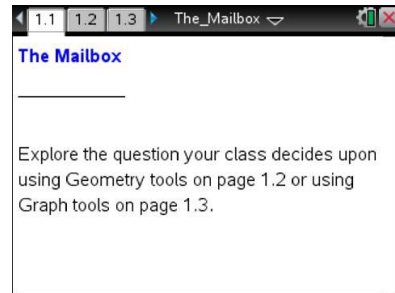
TI-Nspire™ Navigator™ System

- Send out *The_Mailbox.tns* file.
- Use Quick Poll to determine what questions students have about the image and what information they will need to calculate the problem.
- Use Class Capture and Live Presenter so that students can share their thinking with other class members.

Activity Materials

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

The Mailbox

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Explore the question your class decides upon using Geometry tools on page 1.2 or using Graph tools on page 1.3.

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- 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

Lesson Files:
Student Activity

- The_Mailbox_MG _Student.pdf
- The_Mailbox_MG _Student.doc

*TI-Nspire document*

- The_Mailbox.tns

Lesson Procedures, Discussion Points, and Possible Answers

> **Teacher Tip:** To emphasize student inquiry and mathematical modeling to begin this activity, show students the image of the mailbox and then ask students what mathematical question they could explore using the image. Decide which student question to explore during class and then have students work together. Students can calculate the area of an irregular shape by decomposing the irregular shape into familiar shapes.
>
> Students can calculate area and volume using the Geometry tools on page 1.2 or the Graph tools on page 1.3. Sample solutions for determining the volume of the mailbox are shown below.

Move to page 1.2.

Have students observe the image of the mailbox on Page 1.2 and answer questions 1 and 2. The student handout can be useful for encouraging "Think, Pair, Share". Students can write their own initial thoughts and then share with a partner or small group. Then they can discuss their ideas as a whole class.
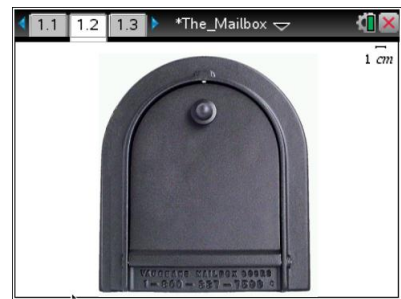
1. What mathematical questions could you explore using the image? What questions can you explore?
   Sample Answers: What is the area of the door? What is the volume of the whole mailbox? Can I fit a package of a certain size in there? What size envelopes can fit without getting bent?

   > **Teacher Tip:** Often with real-world problems, not enough information is given to immediately solve the question. Another step in mathematical modeling is to determine what information is needed.

2. What is the least amount of information you will need to know in order to calculate and answer your questions?
   Sample Answers: One of the dimensions from the image is needed to find the area. To find the volume the depth of the mailbox is also needed.

   > **Teacher Tip:** If students are calculating the area of the front of the mailbox, tell them that the base of the mailbox is 12 in. If they are exploring the volume, also tell them the depth of the mailbox is 21.25 in.

The scale given in the top right of page 1.2 is not correct for the actual size of the mailbox. It can be selected and modified.

3. What information do you need to correct the scale? How can you use that information to do so?
    Sample Answers: Sample solutions using Geometry tools are shown below. Students can use the space in the student handout to record their measurements and explain how proportions or ratios can be used to change the scale.

> **Teacher Tip:** Observe students while they work and determine which students should share their methods for a whole class discussion.

Calculating the volume of the mailbox using the Geometry tools

An important first step in mathematical modeling is to use proportions or ratios of the length to determine the scale of an image. It is necessary to have at least one known length in an image so that other measurements and calculations can be made.

Step 1: Measure the length of the image.

Use the Geometry tools menu to draw a line segment $\overline{AB}$ representing the base of the mailbox. Measure the length of $\overline{AB}$.

> **Tech Tip:** To measure the length of the line segment, have students select **MENU > Measurement > Length** and then select the line segment.

> **Tech Tip:** To measure the length of the line segment, have students select � > **Measurement > Length** and then tap the line segment. Note that in some cases, a student may need to back-out to the main Tools Menu � to see the desired menu option.

Step 2: Calculate the Scale Factor

In order to change the scale so that the measure of $\overline{AB}$ reads 12 inches, calculate the scale factor.

*   Use the Actions menu to create a text box containing $\dfrac{12}{l}$.

*   Use the Calculate tool to calculate the scale factor by selecting $\dfrac{12}{l}$ and by selecting the measure of $\overline{AB}$ for l

### Step 3: Change the Scale

Double-click on the scale in the upper right corner of the screen, and edit the word *1 cm* to contain the **number** calculated and the units **in**. (*i.e 0.678 in*). The measure of $\overline{AB}$ will change to 12 in.

Step 4: Calculate the Area of the Mailbox Door

Use the Geometry tools to create geometric shapes and calculate their areas to determine the total area of the mailbox door.
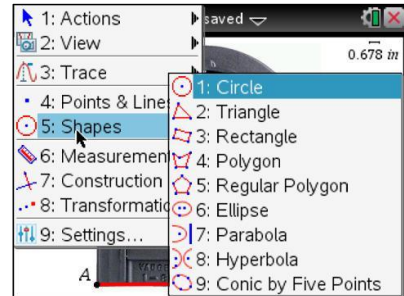
Step 5: Calculate the Volume of the Mailbox

Multiply the total area of the mailbox door by 21.25 in. to determine the volume of the mailbox.

Teacher Tip: If students need a hint for how to find the area of the irregular face of the mailbox, you could ask, "Into what smaller shapes can you decompose the given mailbox?" or "Into what larger shape could you compose the given mailbox?" Allow for creativity. Some students might make a large rectangle and subtract the unused area to get the rounded mailbox shape.
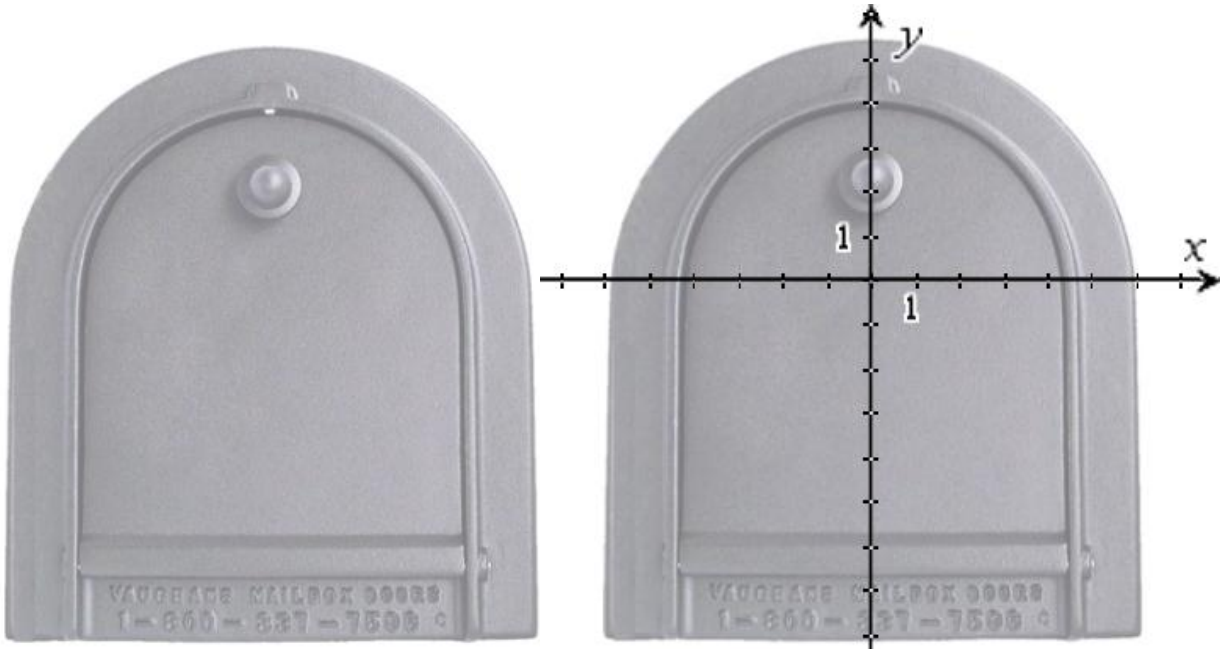

TI-Nspire Navigator Opportunity: *Live Presenter*

Have students show their methods of solving. Select some students to explain their method who used Shape and Measurement tools from the Geometry menu and others who used the Graphing tools.

4. What answer did you get to the question you were solving? The images below are provided to help you explain your method.

Tech Tip: Students *cannot* change the scale on page 1.3 like they did on page 1.2. The base is set up to be 12 units, but the scale can be changed by using right-click, or [ctrl] [menu], when the cursor is over a tick mark on the axes, and select unpin. Similarly the axes can be moved, by using right-click on the mouse, or [ctrl] [menu], on the TI-Nspire handheld or emulator, when the cursor is in any quadrant, and select unpin.

<u>Sample Answers:</u> Answers will vary. The area will be around 140 square inches. The volume is about 3000 cubic inches.

If a circle of radius 5.87 in. is made, the area is 108.1 in^2. Then a rectangle of length 12 inches and height 7.45 in. would have an area of 89.2 in^2. Half of the area of the circle and the area of the rectangle gives 143 in^2. Multiply this cross sectional area by the depth of 21.25 inches gives a volume of 3044 in^3.
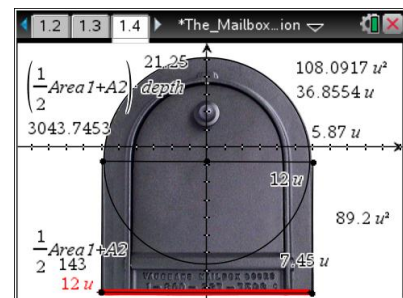
Teacher Tip: Students should attend to precision with the number of decimal places they keep. Similar to how it is reasonable to measure to the nearest millimeter or even to a tenth of a millimeter, it is not reasonable to have more than 3 decimal places when using inches. Discuss with students why they would get different answers. Where is error introduced in finding the solution? Error is introduced in each measurement. The error should be less than 1 inch, but in calculating the volume, the error in a measurement is multiplied.