UNIT 1: LESSON 4

Understanding Perimeter with Formulas

OVERVIEW	
Unit Title: Exploring Area and Perimeter with Landscape Design	**Length of Lesson in # of Hours:** 3 **# of Classes:** 1
How does this lesson connect to previous or future work as exemplified by the Standards in your scope and sequence? This lesson revisits the idea of perimeter and both contextualizes and formalizes it. This lesson builds on work with expressions and the distributive property by having students construct formulas for perimeter. Explorations with perimeter in this lesson are continued as explorations with scale drawings in Lesson 5. Connections to area are also made.	

LESSON OBJECTIVES

At the end of this lesson, students will be able to:

- create simple equations related to perimeter and area
- compare different strategies for finding the perimeter of a rectangle
- use simple symbols to create equations

STANDARDS

Citation	
3.MD.8	Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.
4.MD.3	Apply the area and perimeter formulas for rectangles in real world and mathematical problems. [Students should be able to do this once they have derived the formulas themselves.]
5.OA.1	Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.
5.OA.2	Write simple expressions that record calculations with numbers and interpret numerical expressions without evaluating them.
6.EE.2	Write, read, and evaluate expressions in which letters stand for numbers. [Only with whole numbers and simple one- and two-step expressions.]

1 - 3 MATHEMATICAL PRACTICE(S) ADDRESSED IN THIS LESSON	ELEMENTS OF RIGOR
MP 4: Model with mathematics. MP 7: Look for and make use of structure. MP.8 Look for and express regularity in repeated reasoning.	*Which aspect(s) of Rigor do the targeted Standard(s) require?* ☒ Conceptual understanding of key concepts ☐ Procedural skill and fluency ☐ Rigorous application of mathematics in real-world contexts

ESSENTIAL QUESTIONS
How can I represent different strategies for finding perimeter?

EVIDENCE OF LEARNING
Ways I and my students will know the extent to which the objectives have been met.
Students will be able to write equations that describe the perimeter and area of a rectangle.

LEARNING PLAN - Vocabulary
N/A

LEARNING PLAN - Introduction	MATERIALS	TIME
1. Say that we've been working with the areas of rectangles for a while and ask students if they can think of other ways they might talk about how big a rectangle is or what else they could calculate about a rectangle. [You are trying to bring their attention back to the idea of perimeter.]		
2. As a review of the meanings of area and perimeter and the distinction between them, hand out *Seeing Perimeter and Area* and have students complete it on their own.	EMPower *Over, Around, and Within: Geometry and Measurement,* Practice (Student Book, p. 56) Colored pencils	

3. Ask students what kind of unit might be used to measure the perimeter of the shapes and how they might do that. [The perimeter might be measured in inches or centimeters and they might find it by laying a string around the shape and then measuring the string (for the one without straight sides) or by measuring the sides with a ruler and adding up the measurements (don't actually do this).]		
4. Ask students what kind of unit might be used to measure the area of the shapes. The areas of these shapes can be measured in square inches or square centimeters, but it is much harder because the squares don't cover it exactly. Brainstorm strategies that might be used to find the areas of the shapes (but don't actually do it!). Some options are to cut up the shapes and try to rearrange the pieces into rectangles or to trace the shapes on graph paper and estimate the area by counting the squares and parts of squares that it covers. [Since the focus of this lesson is mainly on perimeter, you may want to skip this step if students struggle with the previous one.] **Segue:** Say that today we are going to turn our attention back to the idea of perimeter.		
LEARNING PLAN – Body of the Lesson	**MATERIALS**	**TIME**
The Garden Fence Challenge		
1. Distribute the handout *Garden Fence Challenge* and set up the situation: Students have 100 feet of fencing to enclose a rectangular garden. They must use all of the fencing (no overlapping or gates). What will be the size of their garden? Encourage students to use the string, 1" square tiles, graph paper, and/or rulers to show how they will use all 100 feet of fencing. ***Note to teacher:*** *There are many answers to this question, but that probably won't be obvious to students. Let them explore and discover for themselves. When they find one solution, ask them to see if it is possible to make another size.*	*Garden Fence Challenge* handout U1.L4 String cut in 100 cm lengths 1" square tiles Graph paper Colored pencils Rulers	
Finding perimeter		
2. Have students share their various size rectangles. At the same time, capture on the board the various ways that they checked to ensure that the perimeter totaled 100 units.		
3. Ask students to compare the various strategies that they used by asking them to check to see if they all total 100 units. Simply introduce (or remind students about) using parentheses to illustrate how to order what gets done first. For example, if a student says he added 30 + 30 and then 20 + 20 and writes it as 30 + 30 + 20 + 20, ask if he knows how to show that he first added		

the two separate sets of addition. If no one can answer, illustrate by showing that 30 + 30 + 20 + 20 can be rewritten as (30 + 30) + (20 + 20). Then suggest other ways to use the parentheses to represent different orders, such as [30 + (30 + 20) + 20, or 30 + (30 + 20 + 20)].		
4. Then ask: *What did each of you do to find the perimeter?* They should be clear that they added the lengths and widths (or doubled the length and width). Explain that, whenever there is a rule that always works, in this case, finding the perimeter, the rule can be written as an equation or formula. Then introduce the variable to replace the numbers that students used in their examples. ***Note to teacher:*** *Even though students will use actual lengths, look for examples where they do the following: L + L + W + W. You can use this later to rewrite as 2L + 2W or L + W + L + W (the equivalence of these two expressions illustrates the distributive property which you will want to informally recognize through students' own work.) In turn, you can later rewrite these two expressions as 2(L + W).*		
5. Use students' strategies to also introduce simple equations by building on their expressions. For example, if a student said his strategy was the following: 20 + 20 + 30 + 30, illustrate how you can add an equal sign and 100 to show equality: 20 + 20 + 30 + 30 = 100. Be sure to stress the meaning of the equal sign. (Many students think the equal sign means to put the result of a calculation. In fact, it indicates that the things on each side have the same value. One way to emphasize this is to write the equation in the other direction: 100 = 20 + 20 + 30 + 30.)		
6. Ask students to sketch a rectangular garden that has a length of 40 units and a total perimeter of 120 units. Ask them to figure out what the missing width is. Once everyone has had a chance to figure out the missing dimension, ask the class to describe what they would do to figure out the missing dimension. Then ask volunteers create a simple equation to show how they could figure out the unknown. ***Note to teacher:*** *Accept responses when the student writes something like, 2(40) + 2w = 120. Even though the variable is not isolated on its own on one side of the equation, that is a fine starting place. Nudge students by asking, "What would you do to figure out what w represents? Is there another way to write that equation based on what you just told me?" This is not the place to establish rules for solving equations. Allow students to reason in ways that make sense to them and, if necessary, help them use symbolic notation to represent their reasoning.*	*Finding Perimete*r handout U1.L3	
7. Distribute the handout *Finding Perimete*r and encourage students to first try the problems on their own, then share their thinking with a partner. ***Note to teacher:*** *If students have difficulty with composite shapes, you may want to spend class time on EMPower Over, Around, and Within: Geometry and Measurement, Lesson 6 (Teacher Book, pp. 69-73)*		

which focuses on students creating composite shapes. If not, you may want to assign the student pages from that lesson for homework.		
LEARNING PLAN – Closure / Conclusion	**MATERIALS**	**TIME**
Formative Assessment: 1. Have each student take a piece of graph paper and draw one garden that they worked with during the lesson. They should write equations to give the perimeter and the area of the garden. Have the students line up in order of the areas of their gardens, from smallest to largest and hold up their drawings so everyone can see them. Ask what they notice and what they wonder. 2. Check to make sure all the perimeters are 100 ft. and that the areas are reasonable. If students stuck to whole numbers, the areas should be between 49 sq. ft. (for a 1' by 49' garden) and 625 sq. ft. (for a 25' by 25' garden) ***Note to teacher:*** *Students might notice that longer and skinnier gardens have smaller areas and gardens that are closer to square have larger areas. They might wonder whether it is possible to make a garden with an even smaller area than the smallest one in the class or an even bigger area than the biggest one in the class.*	Graph paper	
ADDITIONAL PRACTICE	**MATERIALS**	
For further practice with the relationship between area and perimeter	EMPower *Over, Around, and Within: Geometry and Measurement* Activity 1 (SB, p. 62) [Drawing Four Rectangles] Activity 2 (SB, p. 63) [Making a Composite Shape] Practice (SB, p. 64) [Area of 24 Sq. Cm]	

Garden Fence Challenge
U1.L4

I have 100 feet of fencing.

I want to make a rectangular garden that has a fence all the way around it.

What size will the garden be?

Show how you know you will use all 100 feet of fencing.

Extra: How much space will I have in my garden?

Garden Fence Challenge (Answer Key)
U1.L4

I have 100 feet of fencing.

I want to make a rectangular garden that has a fence all the way around it.

What size will the garden be?

Show how you know you will use all 100 feet of fencing.

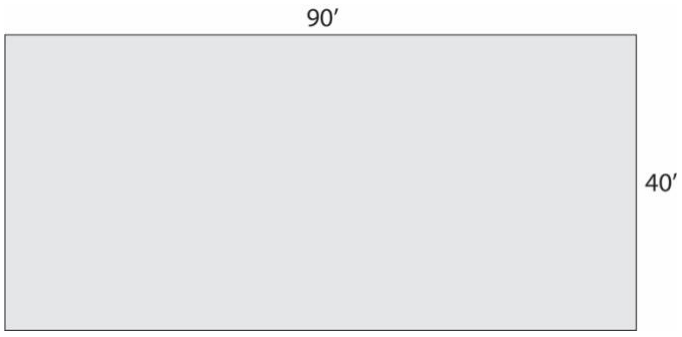
Student responses to the dimensions will vary but all rectangles should have a total perimeter of 100' (with two sides always totaling 50' since it's half of the fence). Obviously, there are many answers to this question, but it probably won't be obvious to students. Let them explore and discover for themselves. When they find one solution, ask them to see if it is possible to make another size.

Extra: How much space will I have in my garden?

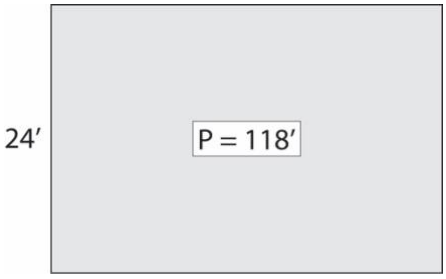
Student responses to the dimensions will vary based on the dimensions used to create the rectangle. For example, dimensions of 2' x 48' yield an area of 96 sq. ft. Yet, dimensions of 7' x 43' produce an area of 301 sq. ft. Encourage students to visualize why this works by demonstrating with the string or drawings a variety of dimensions.

Finding Perimeter
U1.L4

1. Determine the amount of fencing needed to surround the garden and show two ways to solve this.



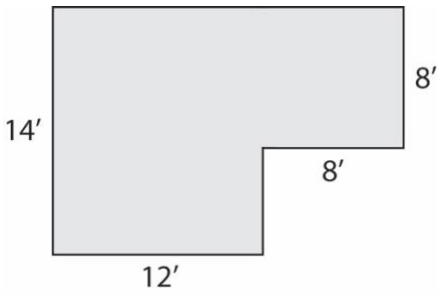
2. Given the length of the garden below, write an equation to show how to figure out the missing (width) dimension.



3. Jake wants to fence in the yard around his property. Assuming that the gates are part of the fencing, how much fencing would he need if his property is 100 feet by 80 feet? Write an equation to show to figure the amount of fencing needed.

4. Demetria wants to trim a tablecloth. She has 80 feet of lace trim. She knows her tablecloth is 6’ x 8’. Does she have enough trim? How do you know?

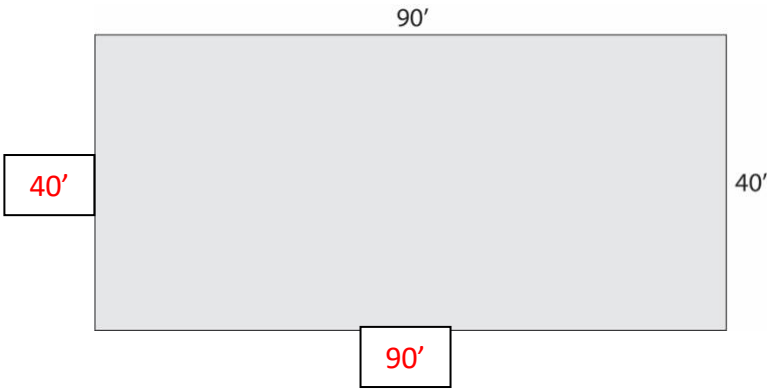
5. Based on the dimensions below, what is the perimeter of the shape?



6. Mary Jane decided to create an herb garden that was 4 feet on each side. What are some ways you could figure out the perimeter of her garden?

Finding Perimeter (Answer Key)
U1.L4

1. Determine the amount of fencing needed to surround the garden and show two ways to solve this.



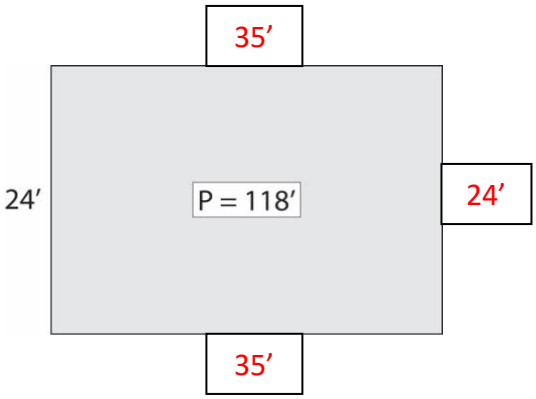
The amount of fencing for the garden is

90′ + 40′ + 90′ + 40′ = 260′

The labels on the left show how students may label the diagram.

Sample missing dimension equation:
P = 2L + 2W OR P = 2(L + W)

2. Given the length of the garden below, write an equation to show how to figure out the missing (width) dimension.



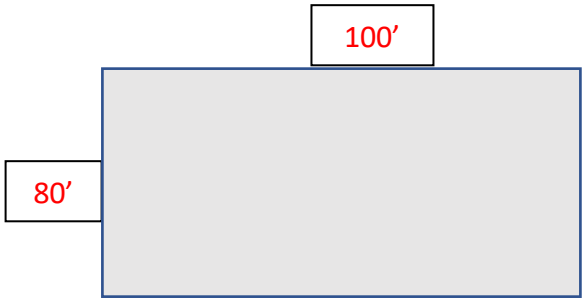
The width of the garden is 35′.

The labels on the left show how students may label the diagram.

Sample missing dimension equations:
P – L – L = Width of 2 sides
118 – 24 – 24 = 70
70 total width of both sides ÷ 2 sides = 35′ (width of garden)

OR P = 2L + 2W
118 = 2(24) + 2(W)

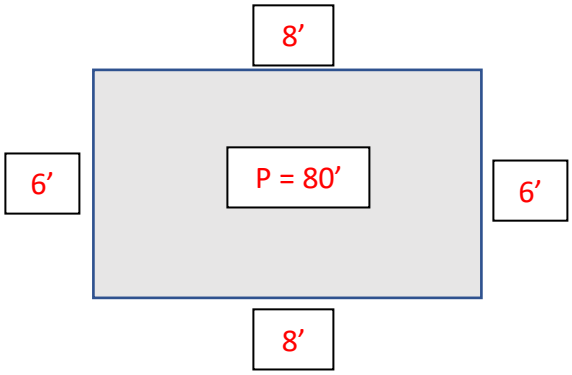
3. Jake wants to fence in the yard around his property. Assuming that the gates are part of the fencing, how much fencing would he need if his property is 100 feet by 80 feet? Write an equation to show to figure the amount of fencing needed.



The amount of fencing for the property is
100′ + 80′ + 100′ + 80′ = 360′

Sample equation to find the perimeter:
P = 2L + 2W OR P = 2(L + W)
P = 2(80) + 2(100) OR P = 2(80 + 100)

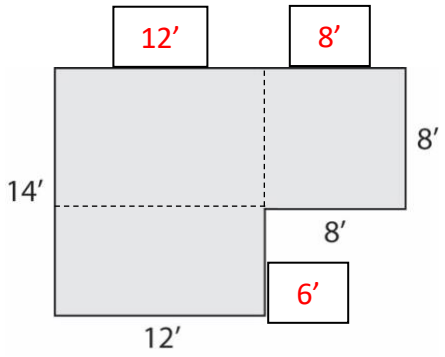
4. Demetria wants to trim a tablecloth. She has 80 feet of lace trim. She knows her tablecloth is 6’ x 8’. Does she have enough trim? How do you know?



Demetria would need 28’ of trim for one tablecloth, so she has more than enough trim.

P = 8 + 6 + 8 + 6 = 28’

5. Based on the dimensions below, what is the perimeter of the shape?

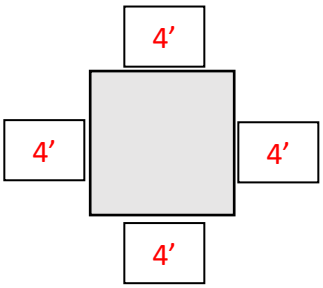


The perimeter of the shape is 68’.

P = 12 + 8 + 8 + 8 + 6 + 12 + 14
P = 68’

Students also could “shift” the dimensions of the lower-right corner to the outer edges of the other dimensions to make a large rectangle. Make sure students understand this works for perimeter because no new sides are created (only moved); however, it will not work for area because it creates more space in the shape.

6. Mary Jane decided to create an herb garden that was 4 feet on each side. What are some ways you could figure out the perimeter of her garden?



Sample answers:

P = 4 + 4 + 4 + 4 = 16’

P = 4(4’) = 16’

P = 2(4 + 4) = 16’

P = 2(4) + 2(4) = 16’