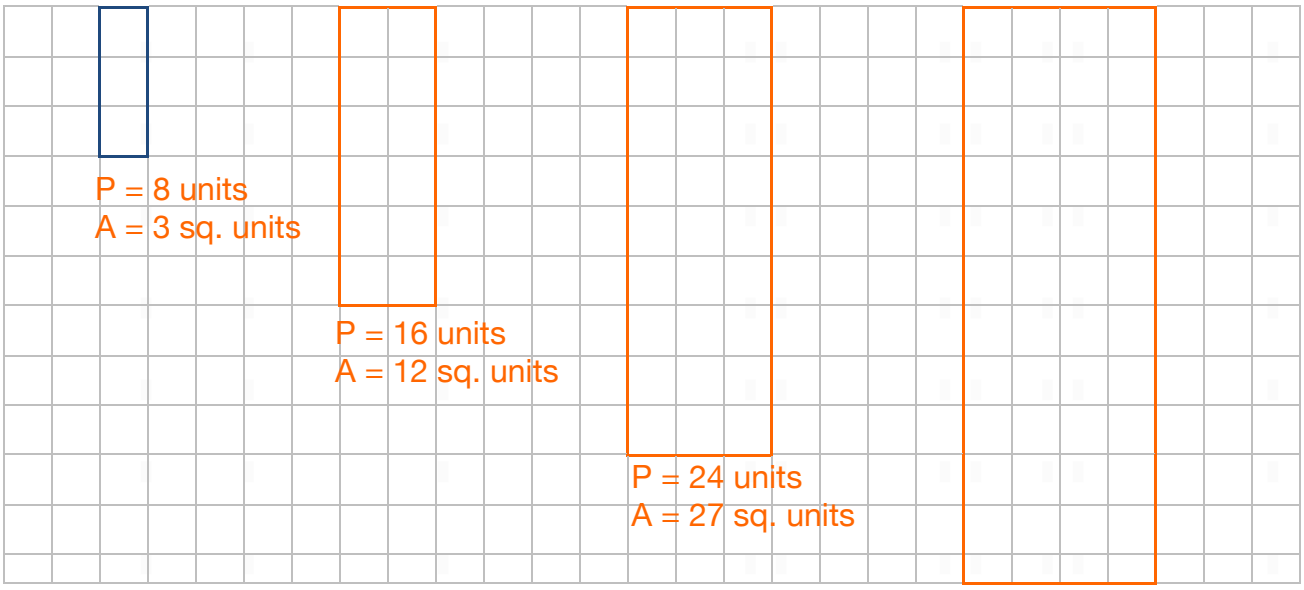
Changing Dimensions: Area
Use What You've Learned
Answers and Explanations

1. Sketch three different rectangles that are similar to the one shown below using the following directions:
   Rectangle 1: Double the base and the height (scale factor = 2).
   Rectangle 2: Triple the base and the height (scale factor = 3).
   Rectangle 3: Quadruple the base and the height (scale factor = 4)



2. Find the perimeter of each of the rectangles.

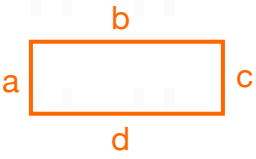
3. Find the area of each of the rectangles.

4. Study your results for problems 1 - 3. What happens to the perimeter and area of the rectangle when you double the dimensions, triple the dimensions, quadruple the dimensions, or make the dimensions n times as large (scale factor = n)? Record your answers in the following table.

Scale Factor	Perimeter	Area
1	8 units $(1 \cdot 8)$	3 sq. units $(1^2 \cdot 3)$
2	16 units $(2 \cdot 8)$	12 sq. units $(2^2 \cdot 3)$
3	24 units $(3 \cdot 8)$	27 sq. units $(3^2 \cdot 3)$
4	32 units $(4 \cdot 8)$	48 sq. units $(4^2 \cdot 3)$
n	$n \cdot 8$ units	$n^2 \cdot 3$ sq. units

5. Describe how the perimeter of a rectangle changes when you make each dimension n times as large. Justify your answer.

When you make the dimensions of a rectangle n times as large, the perimeter becomes n times as large. The following explanation is one way to justify this answer:



The perimeter of a rectangle is equal to the sum of the measures of the sides.

$P = a + b + c + d$

Doubling each dimension is the same as doubling each side. When you double each side, you double the sum of the sides.

$2a + 2b + 2c + 2d = 2(a + b + c + d)$ (distributive property)

Doubling the sum of the sides is the same as doubling the perimeter.

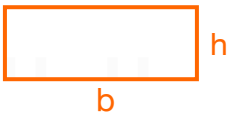
$2P = 2(a + b + c + d)$

You can replace 2 with any number, n.

$nP = n(a + b + c + d)$

6. Describe how the area of a rectangle changes when you make each dimension n times as large. Justify your answer.

When you make the dimensions of a rectangle n times as large, the area becomes n^2 times as large. The following explanation is one way to justify this answer:



The formula for area of a rectangle is base times height.

$A = bh$

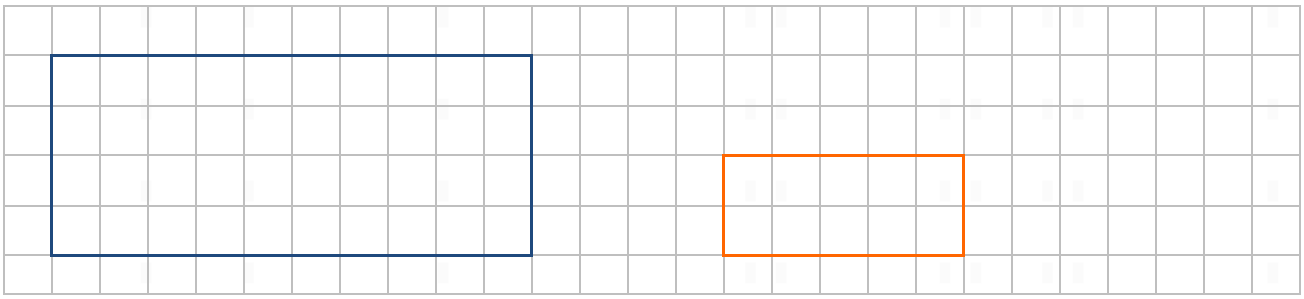
Doubling both dimensions is the same as taking 4 times the base times the height. This is 4 times the original area.

$(2b)(2h) = 4bh$

If you replace 2 with any number, n, the area is n times n, or n^2 times as large.

$(nb)(nh) = (n^2)bh$

7. Sketch a rectangle that is similar to the following rectangle. Make the base and height one half of the original base and height. What happens to the perimeter and area of a rectangle when you make the dimensions ½ as large? Does this follow the pattern you described above?



The perimeter of the larger rectangle is 28 units and the perimeter of the smaller rectangle is 14 units. When you make the dimensions of a rectangle ½ as large, the perimeter is also ½ as large (½ • 28 = 14). Yes, this follows the pattern determined in previous problems.

The area of the larger rectangle is 40 square units and the area of the smaller rectangle is 10 square units. When you make the dimensions of a rectangle ½ as large, the area is ¼ as large (¼ • 40 = 10). When the scale factor is ½, the area factor is $(½)^2$, or ¼. Yes, this follows the pattern determined in previous problems.

8. Samantha used four balls of yarn to knit a doll blanket. Now she wants to knit a similar blanket that is three times as long and three times as wide. How many balls of yarn will she need to complete the larger blanket?
If the new blanket is 3 times as long and 3 times as wide, the scale factor is 3. If the scale factor is 3, the area factor is 3^2 or 9. If the area of the new blanket is 9 times as large as the doll blanket, Samantha will need 9 times as much yarn. She needs 36 balls of yarn (9 x 4 = 36).

9. Emma plans to make the area of her garden four times as large as it was last year. Her old and new gardens are similar rectangles. Emma wants to use her existing fence to enclose the new garden, but knows she will not have enough. How much of the new garden can she enclose with the existing fence?
If the area factor is 4, the scale factor is 2. That means each dimension of Emma's new garden is 2 times as large as her old garden and that the perimeter is 2 times as large. The perimeter of the old garden was $\frac{1}{2}$ the perimeter of the new garden, so Emma can enclose $\frac{1}{2}$ of the new garden with the existing fence.

10. Jason and Jared have a lawn-mowing service. They charge $20 per hour. One lawn was 150 ft. by 100 ft. and it took 1½ hours to mow. They charged $30. How much should they charge for a similar lawn that is 300 ft. by 200 ft.?
If the new lawn is twice as long and twice as wide, the scale factor is 2. If the scale factor is 2, the area factor is 2^2 or 4. That means the area is 4 times as large and it will take 4 times as long to mow the lawn. Jason and Jared should charge 4 times as much money, or $120 (4 x 30 = 120).