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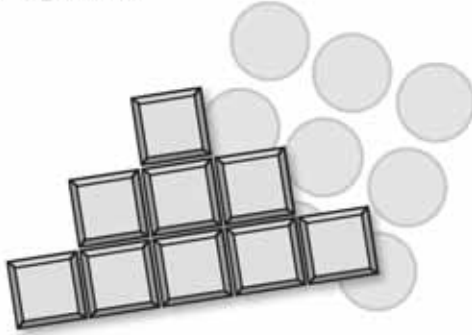
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# More Patterns of Geometric Figures

Connecting Geometric and Algebraic Patterns

IN THIS SECTION we explore more patterns modeled by geometric figures.

Step-by-step we will add shapes to the figures to create a pattern.



THE PURPOSE OF THIS SECTION IS TO:

- Extend a pattern modeled by geometric figures
- Derive an explicit rule to describe the pattern

MATERIALS YOU WILL NEED:

- Straightedge
- Sticks or straws
- Square tiles (optional)
- Chips (optional)
- Grid paper (optional)

## Strategies for Finding Patterns: A Review

Here is a pattern of squares.

Count the number of small squares in each figure.



Figure 1  
2 squares



Figure 2  
4 squares



Figure 3  
6 squares

Figure 4  
\_\_\_\_\_ squares

Figure 5  
\_\_\_\_\_ squares

Follow this pattern and draw Figures 4 and 5.

Notice that the number of small squares along the base of each figure is 2.

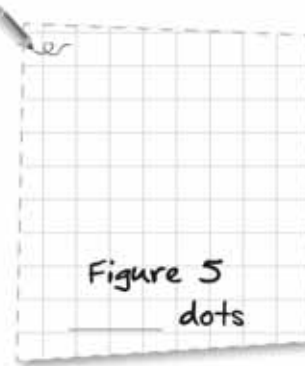
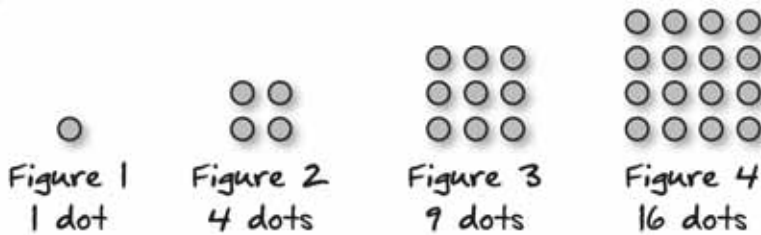
The number of small squares along the height of each figure is the same as the figure number.

1. Write the rule connecting the figure number ( $n$ ) and the number of small squares ( $s$ ).

$$s = \underline{\hspace{2cm}}$$

2. If there are 34 small squares in a figure, what is the figure number ( $n$ )? \_\_\_\_\_

# D O T P A T T E R N S



1. Draw Figure 5.
2. Complete the input/output table for Figures 5 and 6.
3. a. What do you notice about the relationship between the number of dots along the base of a figure compared to the number of dots along the height?
  - b. How does the number of dots along the base or height of a figure help you find the total number of dots in that figure?

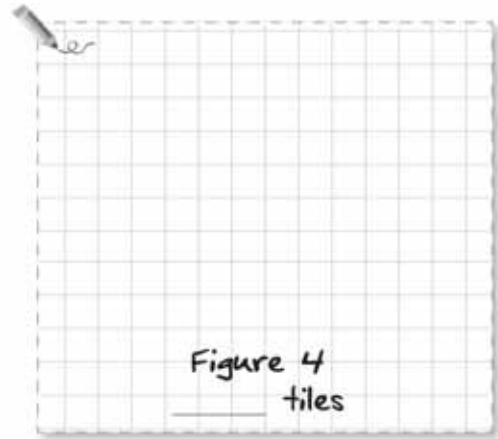
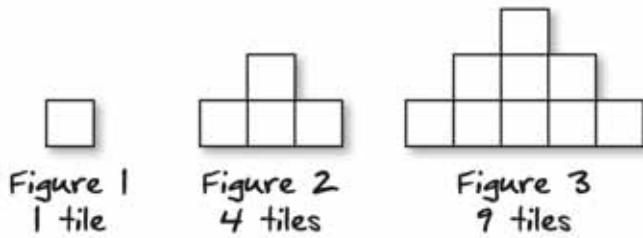
Figure Number ( $n$ )	Number of Dots ( $d$ )
1	1
2	4
3	9
4	16
5	
6	
$n$	

4. What do you notice about the figure number and the number of dots along the base or height of the figure?
5. What is the explicit rule that can be used to find how many dots ( $d$ ) there are in any size figure ( $n$ ) in this pattern?  
**Write the expression in the table to represent the number of dots in the  $n^{\text{th}}$  figure.**
6. Using the explicit rule, find how many dots are needed for Figure 20. \_\_\_\_\_
7. Using the explicit rule, find how many dots are needed for Figure 100. \_\_\_\_\_

# TILE TOWERS



Even though the pictures are new to us, the numerical pattern will look familiar.



- Following the pattern, draw Figure 4 in the space above.
  - How many tiles are in Figure 4? \_\_\_\_\_
  - Where did you add the new tiles?
- How many tiles are in Figure 5? \_\_\_\_\_  
Explain how you found the number of tiles.

Figure Number ( $n$ )	Number of Tiles ( $t$ )
1	1
2	4
3	9
4	
5	
6	
12	
$n$	

- Describe how you see the shape and number of tiles changing from one figure to the next.

Try rearranging the tiles to make a more familiar shape.

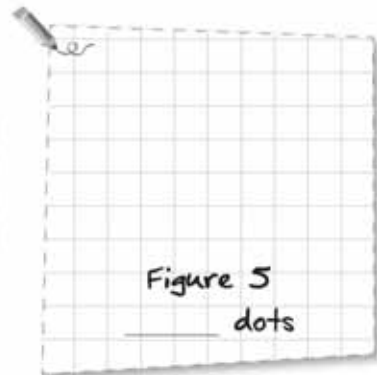
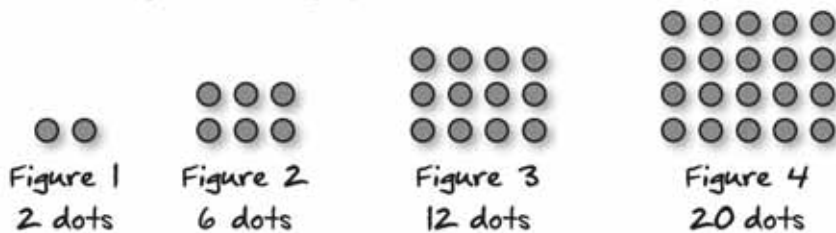
- Using the pattern you have found, **complete the table**.
- Write the explicit rule for this pattern that allows you to find the number of tiles ( $t$ ) needed for any figure number ( $n$ ).

\_\_\_\_\_

How is the figure changing?  
Is there a common difference?  
Is there a common multiple?  
Is there a combination of operations?  
Are squares involved?

# MORE DOT PATTERNS

Rectangular numbers can be represented in a rectangular array. These arrays grow following a pattern.



- Following the same pattern, draw Figure 5 above.
- How many dots are in Figure 5? \_\_\_\_\_
- Complete the input/output table for Figures 5 through 8.

4. What do you notice about the relationship between the number of dots along the base of the figures compared to the number of dots along the height?

- How does the number of dots along the height compare to the figure number?
- How does the number of dots along the base compare to the figure number?

Figure Number ( $n$ )	Number of Dots ( $d$ )
1	2
2	6
3	12
4	20
5	
6	
7	
8	
$n$	

6. Using the information from #5, what is the explicit rule that can be used to find how many dots ( $d$ ) there are in any size figure ( $n$ ) in this pattern?

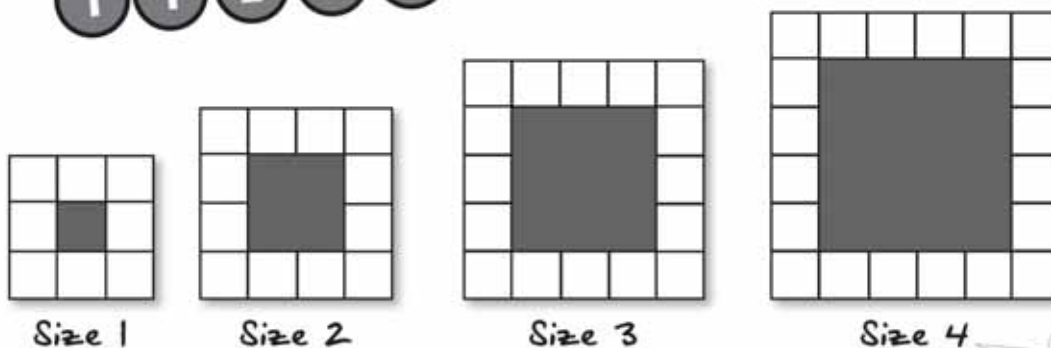
**Write the expression in the table to represent the number of dots in the  $n^{\text{th}}$  figure.**

Explicit Rule (in words): \_\_\_\_\_

Explicit Rule (equation): \_\_\_\_\_

- Using the explicit rule, find how many dots are needed for Figure 25. \_\_\_\_\_
- Using the explicit rule, find how many dots are needed for Figure 100. \_\_\_\_\_

# BORDER TILES



The size is the length of a side of the shaded square.

Bob drew the pattern above. Small white tiles surround shaded squares. The shaded squares each have different side lengths.



- Complete Bob's table.
- Bob thinks that he will need a total of 50 white tiles to surround a shaded square with a side length of 12.

Is Bob correct? How do you know?

Length of Side of Shaded Square ( $s$ )	Number of Small White Tiles ( $w$ )
1	8
2	12
3	16
4	
5	
6	
7	

- How many small white tiles are needed to surround a shaded square with a side length of 12? \_\_\_\_\_
- Write the explicit rule that can be used to determine the correct number of white tiles ( $w$ ) for any size square ( $s$ ), in words **and** in algebraic notation. Refer to the geometric figures in your explanation of your rule.
- Use the answer for a shaded square with a side length of 3 to check your rule.

Adapted from MARS

# HEXAGONS PERIMETER



1 Tile  
 $p = 6$  in.



2 Tiles  
 $p = 10$  in.



3 Tiles  
 $p = \underline{\hspace{2cm}}$  in.



4 Tiles  
 $p = \underline{\hspace{2cm}}$  in.

5 Tiles  
 $p = \underline{\hspace{2cm}}$  in.

Maria has some hexagonal tiles. Each side of her tiles measures 1 inch. She arranges her tiles in stacks; then for each stack she finds the **perimeter**. Then Maria begins to make a table to show her results.

The **perimeter** includes the lines on the edge of each figure, and not the lines inside the figures.



- Following the pattern above, draw 5 stacked hexagons.
- What will be the perimeter of 6 tiles? \_\_\_\_\_
  - What will be the perimeter of 10 tiles? \_\_\_\_\_  
Explain why.

Number of Hexagons ( $n$ )	Perimeter ( $p$ ) in Inches
1	6
2	10
3	
4	
5	
6	
10	
$n$	

- Complete Maria's table following the pattern shown.
- Write the explicit rule for finding the perimeter of a stack of hexagonal tiles when you know the number of tiles in the stack. (Let  $n$  be the number of tiles, and let  $p$  be the perimeter.)

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