8.2 Using Variables to Write Pattern Rules

You will need
- pattern blocks
- square tiles
- coloured pencils

GOAL
Use numbers and variables to represent mathematical relationships.

Learn about the Math

Rana described the pattern rule for her pattern as "Start with 2 blue rhombuses and place 1 on top. Then add 1 more block on top each time."

? How can you use symbols to predict the number of pattern blocks needed to build any figure in this pattern?

A. Copy and complete this table.

Figure number	Number of pattern blocks
1	3
2	4
3	

B. Write a word phrase to describe the relationship between the figure number and the number of blocks you would need to build the figure.

C. Use your word phrase to predict the number of blocks needed to build figure 5. Build the figure to check.

D. Use the **variable** n to represent the figure number. Write your word phrase from step B as an **algebraic expression** with the variable n. Explain how you know that your algebraic expression is correct.

variable

a letter or symbol, such as a, b, or x, that represents a number

algebraic expression

a combination of one or more variables; it may include numbers and operation signs; for example, $2 \times d + 5$ is an algebraic expression that could represent two times the figure number plus five

Reflecting

1. a) Why is the variable n a good choice to represent the figure number in the expression you wrote in step D?

b) What other choices could you have used for the variable in the expression? Give reasons for your suggestions.

2. How is writing the pattern rule in words like writing it as an algebraic expression? How are these two representations different?

3. What are the advantages of using an algebraic expression to represent a pattern rule, compared with describing the pattern in words?

Communication Tip

When variables represent quantities that are multiplied together, they are often written without a multiplication sign between them; for example, the expression $2 \times a$ can be written as $2a$.

Work with the Math

Example 1: Using an algebraic expression to describe a pattern

Write an algebraic expression for the number of blocks you would need to build the figures in this pattern.

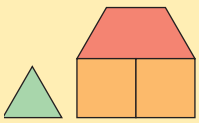


Figure 1

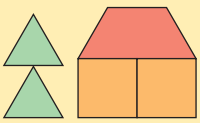


Figure 2

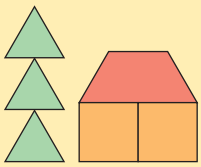


Figure 3

Omar's Solution

My algebraic expression is $t + 3$.

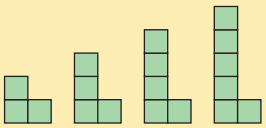
The barn shape does not change, so you always need three pieces to make it.

The number of triangles needed to build each tree is the same as the figure number in the pattern.

I used the variable t to represent the figure number.

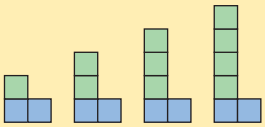
Example 2: Using different expressions to describe the same pattern

Write an algebraic expression for the number of squares you would need to build the figures in this pattern.



Tynessa's Solution

My algebraic expression is $n + 2$.



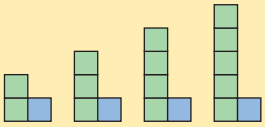
I coloured the two green squares on the bottom blue.

I used the variable n to represent the figure number.

The number of green squares is the same as the figure number.

Colin's Solution

My algebraic expression is $(n + 1) + 1$.



I coloured the vertical squares green, and the one remaining square blue.

I noticed that the number of green squares is always one more than the figure number.

A Checking

4. Use words to describe the pattern rule for the total number of blocks in each figure below. Then use an algebraic expression to describe the pattern rule.

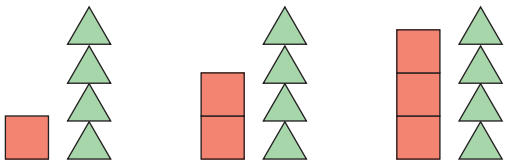
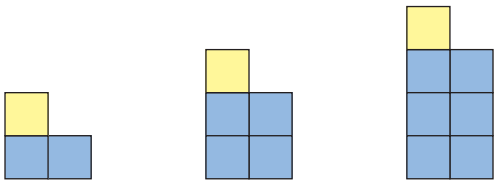


Figure 1 Figure 2 Figure 3

5. a) What stays the same and what changes in this pattern?



b) Describe the pattern rule in words.

c) Write an algebraic expression that describes the pattern.

B Practising

6. a) Copy and complete the table of values for this triangle pattern.

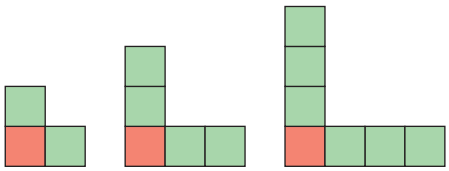
Figure number	Number of triangles
1	4
2	5
3	
4	
5	

b) Describe how the number of triangles is related to the figure number.

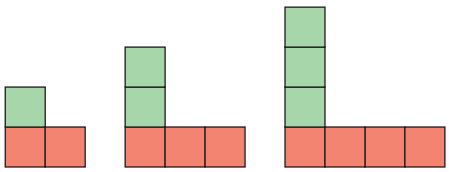
c) Write an algebraic expression for the number of triangles. Use a variable to represent the figure number.

7. Anne, Sanjay, and Robert each wrote an algebraic expression for the pattern of squares. Explain each student's reasoning.

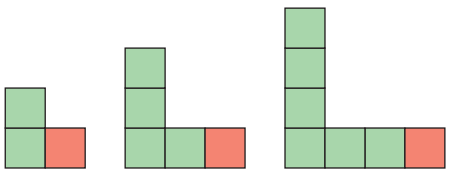
Anne: "My pattern rule is $n + 1 + n$."



Sanjay: "My pattern rule is $n + (n + 1)$."

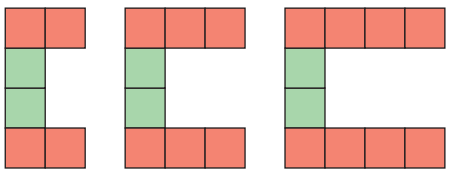


Robert: "My pattern rule is $2n + 1$."

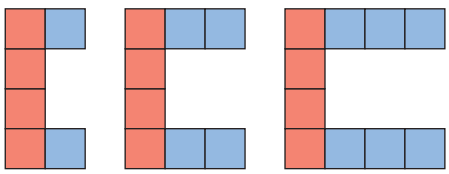


8. The two sets of diagrams below represent the same pattern rule in two different ways.

Kyle's pattern



Meagan's pattern



a) What stays the same and what changes in each representation of the rule?

b) Write the algebraic expression that describes Kyle's pattern.

c) Write the algebraic expression that describes Meagan's pattern.

9. Use each description to create an algebraic expression for the pattern rule.

a) The number of blocks increases by six each time.

b) The number of blocks doubles each time.

c) The number of blocks is the sum of the figure number and 10.

10. Each algebraic expression represents a pattern rule. Draw examples that show possible figures for the first three terms of each pattern.

a) $n + 2$ **c)** $3x + 1$

b) $4s$ **d)** $2b + 1$

11. Two people are looking at the same pattern of blue squares. They write different algebraic expressions to describe the pattern rule.

a) Use diagrams and words to show how this is possible.

b) Write the algebraic expression for each diagram.

12. Why is it helpful to use a variable, rather than just numbers, to describe a growing pattern?

C Extending

13. Create a pattern for which each algebraic expression might be a pattern rule.

a) n^2 **b)** $2(n + 1)$

14. Explain whether you could build a figure with 257 squares using each of the patterns.

a) the pattern in question 7

b) the pattern in question 8