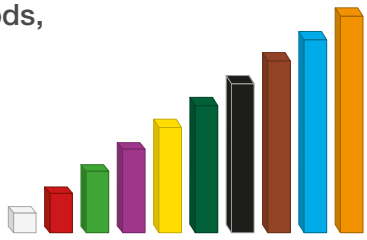
Growing Every Day

OBJECTIVE

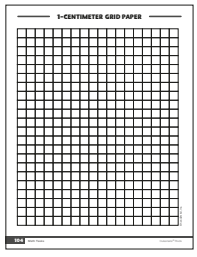
Students will create and extend growth patterns and make and check predictions based on those patterns.

WHAT YOU WILL NEED

Cuisenaire Rods,
1 set per pair



1-Centimeter
Grid Paper, page 104

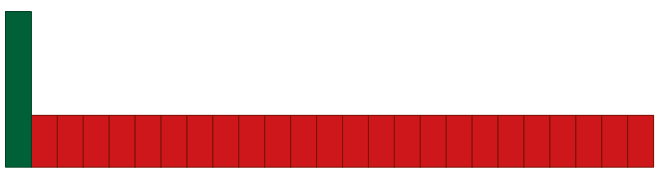


OVERVIEW

In this activity, students build, extend, and analyze growth patterns made with Cuisenaire Rods. They use their analyses to make predictions about the future growth of these patterns.

THE BIG IDEA

Growing Every Day has students use rods to make a structure and then decide for themselves how they are going to make the structure grow. Building the Day 2 and Day 3 structures helps students articulate the growth rule they have devised. As they write their descriptions of what the structure will look like on Day 20, most students combine visual and numerical observations in their predictions. For example, "On the first day, our structure had a dark green rod lined up next to a red rod. On the twentieth day, our structure will look like this. We added 1 red rod to the right each time to get to the next day, so there will be 20 red rods in all. The upright part of the L-shape always stays dark green, so we would need 40 white rods (20 reds times 2) plus 6 white rods (1 dark green) for a volume of 46."



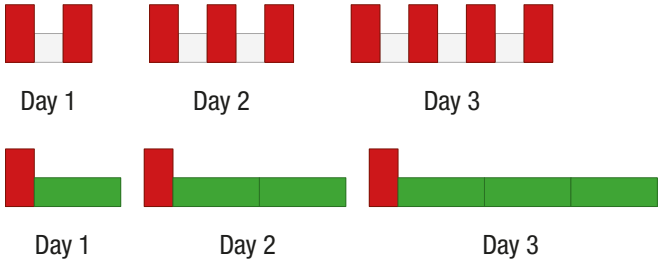
Encouraging students to describe the growth by constructing statements, such as "We added 1 red rod to the right each time to get to the next day" helps them to approach formula-like thinking. Some students may be able to connect this growth to the numbers in their volume data. For example, the data that would accompany the shape previously described could be organized in a chart like the one below. Some students may be able to see that the difference between the numbers in the volume column represents the volume of the additional rods they added each day.

Day	Volume
1	8
2	10
3	12

A difference of 2 represents the new red rod added each day.

Students may have difficulty figuring out the growth rule when presented with the other pair's sketches of Day 1, Day 2, and Day 3. If this is the case, students may benefit by concentrating on just two consecutive structures at a time and the number of rods by which they differ. This strategy can prevent them from becoming overwhelmed and can help them to focus on finding a rule that will help them find the fourth and twentieth structures. Even after they have correctly built the fourth structure, some students may feel that they have to build all 20 structures, especially if a very complicated growth pattern with many different colors of rods was used.

It is very likely that two or more different sequences of structures may produce the same data, as shown below.



Day	Volume
1	5
2	8
3	11

When students see that identical data can describe different structures, the fact that the differences in volume between consecutive structures represent numbers of white rods and not the numbers of non-white rods added on is reinforced.

Some students may be able to formulate a general rule for finding the volume of any structure in their growth pattern. For example, in the chart above, tripling the day number and then adding 2 results in the volume column. Thus, the twentieth structure would have a volume of $20 \times 3 + 2$, or 62. In fact, for any structure, the volume would be $n \times 3 + 2 = V$, where n = the day number and V = volume.

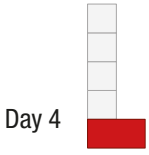
Organizing data into a chart makes it easier to see patterns and write equations. Once an equation is formulated, however, the original growth patterns may be difficult to identify. This is true in the example above. The equation, $V = n \times 3 + 2$ can be related to the red-light green structures but not to the red-white-red structures. In the former growth pattern, the 3 is the length of the light green rod and the 2 is the length of the red rod.

Activities like *Growing Every Day* prepare students for algebra, in which they will be creating data, analyzing the data to find a pattern, and then writing the pattern as an equation. For example, in the pattern given in On Their Own, students might notice that the total number of red rods corresponds to the number of the day. From this, they can conclude that on Day 20, there will be 20 red rods and 1 dark green rod, so the volume may be found with the following arithmetic: $20 \times 2 + 6 = 46$ white rods. Some students may even express this as an equation, $n \times 2 + 6 = V$, in which n is the number of the day and V is the volume.

1 INTRODUCTION

- Show students the following sequence of Cuisenaire Rod structures:

- Ask students to predict what the structure will look like on Day 4.
- When the class is in agreement, build the structure to look like the one shown at right.



- Ask students to find the volume of each of the structures. Invite students to summarize their work in a chart like the one shown below.
- Ask students to predict the volume of the twentieth structure in this pattern.
- Establish that 22 rods (20 whites and 2 more to replace the red rod) would be needed to build the twentieth structure.

Day	Volume
1	3
2	4
3	5
4	6

2 ON THEIR OWN

Students will complete the On Their Own. During this time, the teacher's role is to:

- ask probing questions to guide and extend
- record student thinking
- record student conversation that promotes collaboration

Use the information gathered to inform the Math Talk.

3 MATH TALK

Use prompts such as these to promote class discussion:

- What was easy about describing a Day 20 structure? What was hard?
- What patterns in your data helped you to describe your Day 20 structure and find its volume?
- What patterns in the other partners' data helped you to describe their Day 20 structure and its volume?
- (Point to each chart.) What patterns do you see in this chart?
- How are any two patterns alike or different?
- Which did you like better—creating a pattern or predicting a pattern? Why?

4 EXTENSION

- Have students predict the volume of their structures on the 39th, 100th, or 1,000th day.
- Have students make a graph of their data. They can plot the days from 1 to 20 along the horizontal axis and the volume along the vertical axis.
- Challenge students to use the data in the chart at the right to build a structure and show how it will look on Days 1, 2, 3, 4, and 5.

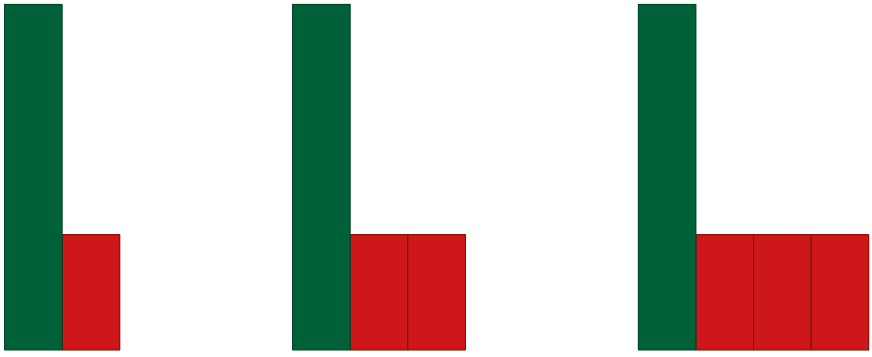
Day	Volume
1	7
2	12
3	17

Growing Every Day

ON THEIR OWN

Can you figure out the daily growth pattern of a Cuisenaire Rod structure, then use it to predict how the structure will look on another day?

1. Work with a partner. Create a structure that grows in a predictable way. Here is an example: Each day this structure grows by 1 red rod. One red rod is equal to 2 white rods. The volume (or number of white rods) of the structure increases by 2 each day.



Day 1
Volume: 8

Day 2
Volume: 10

Day 3
Volume: 12

2. Build your own structure. Show how it looks on Day 1, Day 2, and Day 3. Find the volume for each day.

3. Record each structure and its volume on grid paper. On the back of the paper, describe how the structure will look on Day 20. Then find and record its volume.

4. Exchange recordings with another pair of partners. Keep the recordings data side up. Don't peek at the Day 20 structures on the back.

5. Predict, then build, the other pair's Day 4 structure and find its volume. Then describe and find the volume of the Day 20 structure. Check to see if you are correct. If you are not, discuss your results with the other pair.

FOLD

4 Exchange recordings with another pair of partners. Keep the recordings data side up. Don't peek at the Day 20 structures on the back.

5 Predict, then build, the other pair's Day 4 structure and find its volume. Then describe and find the volume of the Day 20 structure. Check to see if you are correct. If you are not, discuss your results with the other pair.

GROWING EVERY DAY

B

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GROWING EVERY DAY

A

Can you figure out the daily growth pattern of a Cuisenaire Rod structure, then use it to predict how the structure will look on another day?

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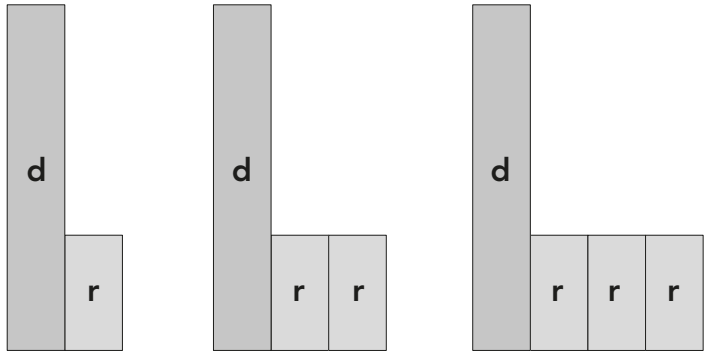
2. Build your own structure. Show how it looks on Day 1, Day 2, and Day 3. Find the volume for each day.
3. Record each structure and its volume on grid paper. On the back of the paper, describe how the structure will look on Day 20. Then find and record its volume.



Day 1
Volume: 8

Day 2
Volume: 10

Day 3
Volume: 12

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