MA.5.AR.3.1

Overarching Standard: ***MA.5.AR.3*** *Analyze patterns and relationships between inputs and outputs.*

Benchmark of Focus

MA.5.AR.3.1: Given a numerical pattern, identify and write a rule that can describe the pattern as an expression.

> *Examples:* The given pattern 6, 8, 10, 12 … can be describe using the expression $4 + 2x$, where $x = 1, 2, 3, 4$ …; the expression $6 + 2x$, where $x = 0, 1, 2, 3$ … or the expression $2x$, where $x = 3, 4, 5, 6$ ….

Benchmark Clarifications

Clarification 1: Rules are limited to one or two operations using whole numbers.

Related Benchmark/Horizontal Alignment

- MA.5.AR.2.1
- MA.5.AR.2.4

Vertical Alignment

Previous Benchmarks	Next Benchmarks
MA.5.AR.3.2	MA.6.AR.3.3

Terms from the K-12 Glossary

- Coefficient

Purpose and Instructional Strategies

The purpose of this benchmark is for students to identify and write an expression that shows the rule for a given pattern. Students have been identifying and generating patterns since Grade 3. In Grade 5, the expectation extends to students writing a rule as an expression that may have 1 or 2 operations. In Grade 6, the focus is on patterns involving ratios (MA.6.AR.3.3).

- The rules for given patterns are limited to one or two operations using whole numbers.
- Vocabulary (e.g., coefficient, terms, variables) should be interwoven into instruction of this benchmark. These terms are introduced in Grade 5, but not expected to be mastered until Grade 6.
- Students should understand that determining a rule for patterns helps them determine the value of future terms in the pattern (MTR.2.1, MTR.5.1).
- During instruction, teachers can have students compare their rules and justify them using properties of operations. For example, have students determine why the rule for the pattern in the benchmark example could be 6 + 2x or 2x + 6 (MTR.5.1, MTR.6.1).
- Instruction of this benchmark should be paired with MA.5.AR.3.2. The combination of determining rules and completing tables is important for students to begin understanding ratios and functions in the middle grades (MTR.5.1).
- Instruction includes recognizing patterns that arise from geometrical figures with

different lengths and their perimeter or area.

- For example, a pattern can arise from the following sequence of rectangles: 1 unit by 1 unit, 1 unit by 2 units, 1 unit by 3 units, 1 unit by 4 units. Students can describe the pattern of the perimeter or of the area.

Common Misconceptions or Errors

- A common mistake that students make is to determine a rule based on the change in only the first two terms. During instruction, teachers should emphasize that a rule must work for the change in any two terms in a pattern.

Strategies to Support Tiered Instruction

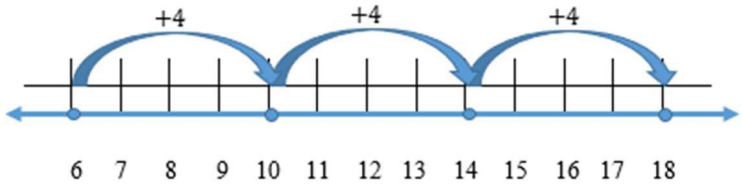
- Instruction includes opportunities to determine a rule given a numerical expression. After determining the rule, teachers provide guidance to support students as they work to describe the pattern as an expression. Special attention should be given to ensure that the rule is based on changes in all terms within the pattern (not just the first two terms).
  - For example, the teacher provides students with the first four terms of a pattern:

    3, 8, 13, 18 …

    The teacher guides students to notice what pattern they see between the four terms (each number is five greater than the previous number). If students have difficulty, a number line or hundreds chart may be used to support finding the pattern. Students should identify that the rule is to add five. Based on this rule, the teacher guides students to represent the pattern as an expression (e.g., $3 + 5x$, where $x = 0, 1, 2, 3$ …) having students use the expression to check for accuracy with each of the terms in the pattern and identify the next two terms in the pattern (… 23, 28 …).
  - For example, the teacher provides students with the first four terms of a pattern.

    6, 10, 14, 18 …

    The teacher guides students to notice what patterns they see between the four terms (each number is five greater than the previous number). A number line or hundreds chart is used to support finding the pattern. Students identify that the rule is to add four. Based on this rule, the teacher guides students to represent the pattern as an expression (e.g., $6 + 4x$, where $x = 0, 1, 2, 3$ …) having students use the expression to check for accuracy with each of the terms in the pattern and identify the next two terms in the pattern (… 22, 26 …).



Questions to ask students:

How does the rule help you to determine the values of future terms in the pattern?

Sample answer that indicates understanding: Rules help us to understand patterns and the sequence they follow. They help to provide structure to the pattern and an understandable format for finding the next number in the sequence.

Do both expressions represent the same rule? 6 + 2x or 2x + 6
Sample answer that indicates understanding: Both of these expressions represent the same rule. First, because of order of operations, we know to multiply the variable x first no matter where it is within the expression. Then, because of the commutative property of addition, we know we can switch the order of the addends and the sum will be the same. Both expressions represent the same rule.

What is the rule for the pattern 2, 5, 8, 11, 14?
Sample answer that indicates understanding: The rule is 3p -1, where p is 1,2,3,4..

Instructional Tasks
Instructional Task 1

The first four terms of a pattern are below.

9, 13, 17, 21, ...

Part A. Write a mathematical description for a rule that matches these terms.
Part B. Write an expression that describes your rule.
Part C. Use your answer from Part B to determine the value of the 16th term.

Instructional Items
Instructional Item 1

Write an expression that can be a rule for the terms shown below.

2, 7, 12, 17, ...

Achievement Level Descriptors

Benchmark	Context	Assessment Limits
MA.5.AR.3.1 Given a numerical pattern, identify and write a rule that can describe the pattern as an expression. Example: The given pattern 6, 8, 10, 12 ... can be describe using the expression 4 + 2x, where x = 1, 2, 3, 4 ...; the expression 6 + 2x, where x = 0, 1, 2, 3 ... or the expression 2x, where x = 3, 4, 5, 6 .... Clarification 1: Rules are limited to one or two operations using whole numbers,	Mathematical	Items may use coefficients to represent multiplication.

ALD 2	ALD 3	ALD 4	ALD 5
N/A	Given a numerical pattern, identifies a rule, using one procedural step involving any of the four operations,	Given a numerical pattern, identifies and writes a rule that can describe the pattern as an expression.	Given a numerical pattern, identifies and writes multiple rules that describe the pattern as an expression.

	that describes the pattern as an expression.		

Additional Resources:
CPALMS Resources

Khan Academy: Finding Patterns in Numbers

Khan Academy: Math Patterns

YouTube: Rules for Number Patterns

Resources/Tasks to Support Your Child at Home:

Given the numerical pattern 20, 25, 30, 35…where x=1, 2, 3, 4, create a rule that can describe the pattern as an expression.

Example Rule: 15 + 5x