

MATHEMATICS VERTICAL ARTICULATION TOOL (MVAT)
2016 Mathematics Standards of Learning - Patterns, Functions and Algebra
Kindergarten-Algebra II Progression

KEY TO COLORED BOXES: **ES** = K-5 Prior Knowledge Concepts; **MS** = 6-8 Prior Knowledge Concepts; **HS** = 9-12 Prior Knowledge Concepts; N/A = No Concepts Listed

| Grade K | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6 | Grade 7 | Grade 8 | Related to Algebra 1 | Related to Algebra 2 | EQUALITY/SOLVING EQUATIONS |
|---------|----------------------|----------------------|----------------------|----------------------|-----------------------|----------------------|----------------------|----------------------|----------------------|------------------------|--|
| | 1.15 | | | | | | | | | | demonstrate an understanding of equality through the use of the equal symbol |
| | | 2.17 | | | | | | | | | demonstrate an understanding of equality through the use of the equal symbol = and the use of the not equal symbol |
| | | | 3.17 | | | | | | | | create equations to represent equivalent mathematical relationships |
| | | | | 4.16 | | | | | | | recognize and demonstrate the meaning of equality in an equation |
| | | | | | 5.19b | | | | | | write an equation to represent a given mathematical relationship, using a variable |
| | | | | | 5.19d | | | | | | create a problem situation based on a given equation, using a single variable |
| | | | | | | 6.13 | | | | | solve one-step linear equations in one variable, including practical problems |
| | | | | | | | 7.12 | | | | solve two-step linear equations in one variable, including practical problems |
| | | | | | | | | 8.17 | | | solve multistep linear equations in one variable with the variable on one and both sides of the equation, including practical problems |
| | | | | | | | | | A.4a | | solve multistep linear equations in one variable algebraically |
| | | | | | | | | | A.4b | | solve quadratic equations in one variable algebraically |
| | | | | | | | | | A.4c | | solve literal equations for a specified variable |
| | | | | | | | | | A.4d | | solve systems of two linear equations in two variables algebraically and graphically |
| | | | | | | | | | A.4e | | solve practical problems involving equations and systems of equations |
| | | | | | | | | | | AII.3a | solve absolute value linear equations |

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|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------------------|------------------------|--|
| | | | | | | | | | | AII.3b | solve algebraically and graphically, quadratic equations over the set of complex numbers |
| | | | | | | | | | | AII.3c | solve algebraically and graphically, equations containing rational algebraic expressions |
| | | | | | | | | | | AII.3d | solve algebraically and graphically, equations containing radical expressions |
| | | | | | | | | | | AII.4 | solve systems of linear-quadratic and quadratic-quadratic equations, algebraically and graphically |

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K-8 Cross-Strand Connections – Equality/Solving Equations

Number and Number Sense Connections

- [6.3c](#) - identify and describe absolute value of integers
- [7.1d](#) - determine square roots of perfect squares
- [7.1e](#) - identify and describe absolute value of rational numbers
- [8.2](#) - describe the relationships between the subsets of the real number system
- [8.3b](#) - determine both the positive and negative square roots of a given perfect square

Computation and Estimation Connections

- [K.6](#) – single step story and picture problems – addition/subtraction
- [1.6 & 1.7](#) – single step story and picture problems – addition/subtraction
- [2.5 & 2.6](#) – practical problems with addition/subtraction with whole numbers
- [3.3, 3.4, 3.5](#) – practical problems with whole numbers; practical problems add/sub fractions
- [4.4, 4.5, 4.6](#) – computation with fractions and mixed numbers, whole numbers, decimals and practical problems
- [5.4, 5.5, 5.6, 5.7](#) – solve practical problems using operations with whole numbers, fractions, mixed numbers, decimals; apply order of operations
- [6.5 & 6.6](#) – solve practical problems using operations with rational numbers; operations with integers; solve practical problems using operations with integers
- [7.2](#) – solve practical problems using operations with rational numbers
- [8.4](#) – solve practical problems involving consumer applications

Measurement and Geometry Connections

Probability and Statistics Connections

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| Grade K | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6 | Grade 7 | Grade 8 | Related to Algebra 1 | Related to Algebra 2 | SOLVING INEQUALITIES |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------------------|----------------------|--|
| | | | | | | 6.14a | | | | | represent a practical situation with a linear inequality in one variable; and |
| | | | | | | 6.14b | | | | | solve one-step linear inequalities in one variable and graph the solution on a number line |
| | | | | | | | 7.13 | | | | solve one- and two-step linear inequalities in one variable, including practical problems, and graph the solution on a number line |
| | | | | | | | | 8.18 | | | solve multistep linear inequalities in one variable with the variable on one and both sides of the inequality symbol, including practical problems, and graph on a number line |
| | | | | | | | | | A.5a | | solve multi-step linear inequalities in one variable algebraically and represent the solution graphically |
| | | | | | | | | | A.5b | | represent the solution of linear inequalities in two variables algebraically and graphically |
| | | | | | | | | | A.5c | | solve practical problems involving inequalities; and |
| | | | | | | | | | A.5d | | solve systems of inequalities algebraically and graphically |
| | | | | | | | | | | AII.3a | solve absolute value linear inequalities |

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K-8 Cross-Strand Connections – Solving Inequalities

Number and Number Sense Connections

K.2a - compare and describe one set as having more, fewer, or the same number of objects as the other set(s)

1.2b - compare two numbers between 0 and 110 represented pictorially or with concrete objects, using the words greater than, less than or equal to

3.2c - compare fractions having like and unlike denominators, using words and symbols ($>$, $<$, $=$, or \neq), with models

Computation and Estimation Connections

Measurement and Geometry Connections

6.8a - identify the components of the coordinate plane

Probability and Statistics Connections

1.12b - read and interpret data displayed in tables, picture graphs, and object graphs, using the vocabulary more, less, fewer, greater than, less than, and equal to

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| Grade K | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6 | Grade 7 | Grade 8 | Related to Algebra 1 | Related to Algebra 2 | ALGEBRAIC EXPRESSIONS |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------------------|----------------------|---|
| | | | | | 5.19a | | | | | | investigate/describe the concept of variable |
| | | | | | 5.19c | | | | | | use a variable expression to represent a verbal quantitative expression involving one operation |
| | | | | | | | 7.11 | | | | evaluate algebraic expressions for given replacement values of the variables |
| | | | | | | | | 8.14a | | | evaluate an algebraic expression for given replacement values of the variables |
| | | | | | | | | 8.14b | | | simplify expressions in one variable |
| | | | | | | | | | A.1a | | represent verbal quantitative situations algebraically |
| | | | | | | | | | A.1b | | evaluate algebraic expressions for given replacement values of the variables |
| | | | | | | | | | A.2a | | perform operations on polynomials, including applying laws of exponents to perform operations on expressions |
| | | | | | | | | | A.2b | | perform operations on polynomials, including adding, subtract, multiply, and divide polynomials |
| | | | | | | | | | A.2c | | perform operations on polynomials, including factoring first- and second-degree binomials and trinomials in one variable |
| | | | | | | | | | A.3a | | simplify square roots of non-negative rational numbers and monomial algebraic expressions; |
| | | | | | | | | | | AII.1a | add, subtract, multiply, divide and simplify rational algebraic expressions |
| | | | | | | | | | | AII.1b | add, subtract, multiply, divide and simplify radical expressions containing rational numbers and variable, and expressions contain rational exponents |
| | | | | | | | | | | AII.1c | factor polynomials completely in one or two variables |
| | | | | | | | | | | AII.2 | perform operations on complex numbers, express the results in simplest form using patterns of i |

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K-8 Cross-Strand Connections – Algebraic Expressions

Number and Number Sense Connections

7.1d - determine square roots of perfect squares

8.3a - estimate and determine the two consecutive integers between which a square root lies

8.3b - determine both the positive and negative square roots of a given perfect square

Computation and Estimation Connections

3.4d - solve single-step practical problems involving multiplication of whole numbers, where one factor is 99 or less and the second factor is 5 or less

4.5a - determine common multiples and factors, including least common multiple and greatest common factor

1.6 - create and solve single-step story and picture problems using addition and subtraction within 20

2.5a - recognize and use the relationships between addition and subtraction to solve single-step practical problems, with whole numbers to 20

2.6c - create and solve single-step and two-step practical problems involving addition and subtraction

3.5 - solve practical problems that involve addition and subtraction with proper fractions having like denominators of 12 or less

4.4d - create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers

4.5c - solve single-step practical problems involving addition and subtraction with fractions and mixed numbers

4.6b - solve single-step and multistep practical problems involving addition and subtraction with decimals

5.4 - create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers

5.5b - create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication of decimals, and create and solve single-step practical problems involving division of decimals

5.6a - solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers

5.6b - solve single-step practical problems involving multiplication of a whole number, limited to 12 or less, and a proper fraction, with models

5.7 - simplify whole number numerical expressions using the order of operations

6.5a - multiply and divide fractions and mixed numbers

6.5b - solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions and mixed numbers

6.5c - solve multistep practical problems involving addition, subtraction, multiplication, and division of decimals

6.6a - add, subtract, multiply, and divide integers

6.6b - solve practical problems involving operations with integers

6.6c - simplify numerical expressions involving integers

Measurement and Geometry Connections

Probability and Statistics Connections

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| Grade K | Grade 1 | Grade 2 | Grade 3 | Grade 4 | Grade 5 | Grade 6 | Grade 7 | Grade 8 | Related to Algebra 1 | Related to Algebra 2 | PROPORTIONAL AND ADDITIVE RELATIONSHIPS; SLOPE; LINEAR FUNCTIONS |
|---------|---------|---------|---------|---------|---------|--------------|--------------|--------------|----------------------|----------------------|---|
| | | | | | | <u>6.12a</u> | | | | | represent a proportional relationship between two quantities, including those arising from practical situations; |
| | | | | | | <u>6.12b</u> | | | | | determine the unit rate of a proportional relationship and use it to find a missing value in a ratio table; |
| | | | | | | <u>6.12c</u> | | | | | determine whether a proportional relationship exists between two quantities; |
| | | | | | | <u>6.12d</u> | | | | | make connections between and among representations of a proportional relationship between two quantities using verbal descriptions, ratio tables, and graphs. |
| | | | | | | | <u>7.10a</u> | | | | determine the slope, m , as rate of change in a proportional relationship between two quantities and write an equation in the form $y=mx$ to represent the relationship |
| | | | | | | | <u>7.10b</u> | | | | graph a line representing a proportional relationship between two quantities given the slope and an ordered pair, or given the equation in $y=mx$ form where m represents the slope as rate of change; |
| | | | | | | | <u>7.10c</u> | | | | determine the y -intercept, b , in an additive relationship between two quantities and write an equation in the form $y = x + b$ to represent the relationship; |
| | | | | | | | <u>7.10d</u> | | | | graph a line representing an additive relationship between two quantities given the y -intercept and an ordered pair, or given the equation in the form $y = x + b$, where b represents the y -intercepts; |
| | | | | | | | <u>7.10e</u> | | | | make connections between and among representations of proportional or additive relationships between two quantities using verbal descriptions, tables, equations, and graphs |
| | | | | | | | | <u>8.16a</u> | | | recognize and describe the graph of a linear function with a slope that is positive, negative, or zero |
| | | | | | | | | <u>8.16b</u> | | | identify the slope and y -intercept of a linear function given a table of values, a graph, or an equation in $y = mx + b$ form; |
| | | | | | | | | <u>8.16c</u> | | | determine the independent and dependent variable, given a practical situation modeled by a linear function; |
| | | | | | | | | <u>8.16d</u> | | | graph a linear function given the equation in $y = mx + b$ form; and |
| | | | | | | | | <u>8.16e</u> | | | make connections between and among representations of a linear function using verbal descriptions, tables, equations, and graphs. |
| | | | | | | | | | <u>A.6a</u> | | determine the slope of a line when given an equation of the line, the graph of the line, or two points on the line; |

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|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----------------------------|--|---|
| | | | | | | | | | <u>A.6b</u> | | write the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line; and |
| | | | | | | | | | <u>A.6c</u> | | graph linear equations in two variables |
| | | | | | | | | | <u>A.8</u> | | given a data set or practical situation, students will analyze a relation to determine whether a direct-variation exists, and represent a direct variation algebraically and graphically |
| | | | | | | | | | | <u>AII.5</u> | investigate and apply the properties of arithmetic and geometric sequences and series to solve practical problems, including writing the first n terms, determining the n th term and evaluating summation formulas. |
| | | | | | | | | | | <u>AII.6</u> <u>b</u> | For absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic functions, the student will use knowledge of transformations to convert between equations and the corresponding graphs of functions. |

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K-8 Cross-Strand Connections – Proportional and Additive Relationships; Slope; Linear Functions

Number and Number Sense Connections

K.4a - recognize and describe with fluency part-whole relationships for numbers up to 5

K.4b - investigate and describe part-whole relationships for numbers up to 10

1.7a - recognize and describe with fluency part-whole relationships for numbers up to 10

2.2a - count forward by twos, fives, and tens to 120, starting at various multiples of 2, 5, or 10

2.5 - recognize and use the relationships between addition and subtraction to solve single-step practical problems, with whole numbers to 20

4.2b - represent equivalent fractions

4.5a - determine common multiples

6.1 - represent relationships between quantities using ratios, and will use appropriate notations, such as ab , a to b , and $a:b$

Computation and Estimation Connections

Measurement and Geometry Connections

6.8a - identify the components of the coordinate plane

Probability and Statistics Connections

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|-------------|-------------|-------------|-------------|-------------|-------------|---------|---------|--------------|----------------------|----------------------|--|
| <u>K.12</u> | | | | | | | | | | | sort and classify objects according to attributes. |
| <u>K.13</u> | | | | | | | | | | | identify, describe, extend, create and transfer repeating patterns. |
| | <u>1.13</u> | | | | | | | | | | sort and classify objects according to one or more attributes |
| | <u>1.14</u> | | | | | | | | | | identify, recognize, describe, extend, and transfer growing and repeating patterns. |
| | | <u>2.16</u> | | | | | | | | | identify, describe, create, extend, and transfer patterns found in objects, pictures, and numbers |
| | | | <u>3.16</u> | | | | | | | | identify, describe, create, extend, and transfer patterns found in objects, pictures, numbers, and tables. |
| | | | | <u>4.15</u> | | | | | | | identify, describe, create, and extend patterns found in objects, pictures, numbers, and tables. |
| | | | | | <u>5.18</u> | | | | | | describe and express the relationship of number patterns found in objects, pictures, numbers, and tables |
| | | | | | | | | <u>8.15a</u> | | | determine whether a given relation is a function |
| | | | | | | | | <u>8.15b</u> | | | determine domain and range of a function |
| | | | | | | | | | <u>A.7a</u> | | Investigate and analyze function families and their characteristics both algebraically and graphically, including determining whether a relation is a function |
| | | | | | | | | | <u>A.7b</u> | | domain and range |
| | | | | | | | | | <u>A.7c</u> | | zeros |
| | | | | | | | | | <u>A.7d</u> | | intercepts |
| | | | | | | | | | <u>A.7e</u> | | values of a function for elements in its domain |
| | | | | | | | | | <u>A.7f</u> | | connections between any two representations of functions, including concrete/verbal/numeric/graphic/algebraic |

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|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------------------|-------------------------------|---|
| | | | | | | | | | | <u>AII.6a</u> | For absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic functions recognize the general shape of function families |
| | | | | | | | | | | <u>AII.6b</u> | use knowledge of transformations to convert between graphic and symbolic forms of functions |
| | | | | | | | | | | <u>AII.7a</u> | The student will investigate and analyze linear, quadratic, absolute value, square root, cube root, rational, polynomial, exponential and logarithmic function families algebraically and graphically. Key concepts include: domain and range, and continuity |
| | | | | | | | | | | <u>AII.7b</u> | intervals in which a function is increasing or decreasing |
| | | | | | | | | | | <u>AII.7c</u> | maxima and minima |
| | | | | | | | | | | <u>AII.7d</u> | investigate and analyze linear, quadratic, absolute value, square root, cube root, rational, polynomial, exponential and logarithmic function families algebraically and graphically. Key concepts include: zeros |
| | | | | | | | | | | <u>AII.7e</u> | intercepts |
| | | | | | | | | | | <u>AII.7f</u> | values of a function for elements in its domain |
| | | | | | | | | | | <u>AII.7g</u> | connections between any two representations of function including concrete, verbal, numeric, graphic, and algebraic; |
| | | | | | | | | | | <u>AII.7h</u> | end behavior; |
| | | | | | | | | | | <u>AII.7i</u> | vertical and horizontal asymptotes; |
| | | | | | | | | | | <u>AII.7j</u> | inverse of a function; and |
| | | | | | | | | | | <u>AII.7k</u> | composition of functions algebraically |
| | | | | | | | | | | <u>AII.8</u> | Investigate and describe the relationships among solutions of an equation, zeros of a function, x -intercepts of a graph, and factors of a polynomial expression. |

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Cross-Strand Connections – Relations and Functions

6.1 – represents relationships between quantities using ratios

Number and Number Sense Connections

Computation and Estimation Connections

6.4 - recognize and represent patterns with whole number exponents and perfect squares

Measurement and Geometry Connections

Probability and Statistics Connections

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Middle School Mathematics 2016 Mathematics Standards of Learning

Application of Properties of Real Numbers¹ - Patterns, Functions, and Algebra Strand

✓ = property can be applied in this standard; N/A = not applicable

| Standard of Learning Description | Solve One-Step Linear Equations 6.13 | Solve One-Step Linear Inequalities (addition/subtraction only) 6.14b | Evaluate Algebraic Expressions 7.11 | Solve Two-Step Linear Equations 7.12 | Solve One- and Two-Step Linear Inequalities 7.13 | Evaluate/Simplify Algebraic Expressions 8.14a,b | Solve Multistep Linear Equations 8.17 | Solve Multistep Linear Inequalities 8.18 |
|--|--|--|---|--|--|---|---|--|
| Commutative Property of Addition $a + b = b + a$ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Commutative Property of Multiplication $ab = ba$ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Associative Property of Addition $(a + b) + c = a + (b + c)$ | | | ✓ | | | ✓ | ✓ | ✓ |
| Associative Property of Multiplication $(ab)c = a(bc)$ | | | ✓ | | | ✓ | ✓ | ✓ |
| Distributive Property (over addition/subtraction) $a(b + c) = ab + ac$ and $a(b - c) = ab - ac$ | | | ✓ | | | ✓ | ✓ | ✓ |
| Identity Property of Addition $a + 0 = a = 0 + a$ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Identity Property of Multiplication $a \cdot 1 = a = 1 \cdot a$ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Inverse Property of Addition $a + (-a) = 0 = (-a) + a$ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Inverse Property of Multiplication $a \cdot \frac{1}{a} = 1 = \frac{1}{a} \cdot a, a \neq 0$ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Multiplicative Property of Zero[†] $a \cdot 0 = 0 \cdot a$ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Substitution Property[†] If $a = b$, then b can be substituted for a in any expression, equation or inequality | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

¹The properties of real numbers listed apply given a , b , and c are real numbers. In some standards, limitations may exist on the values of a , b , or c (e.g., integers only or rational numbers only), or impose other parameters (e.g., one-step equations) that may prevent situations in which a property could be applied. [†]Multiplicative Property of Zero and the Substitution Property may also be considered properties of equality/inequality.

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Application of Properties of Equality/Inequality² - Patterns, Functions, and Algebra Strand

✓ = property can be applied in this standard; N/A = not applicable

| Standard of Learning Description | Solve One-Step Linear Equations 6.13 | Solve One-Step Linear Inequalities (addition/subtraction only) 6.14b | Solve Two-Step Linear Equations 7.12 | Solve One- and Two-Step Linear Inequalities 7.13 | Solve Multistep Linear Equations 8.17 | Solve Multistep Linear Inequalities 8.18 |
|--|--|--|--|--|---|--|
| Addition Property of Equality If $a = b$, then $a + c = b + c$ | ✓ | | ✓ | | ✓ | |
| Subtraction Property of Equality If $a = b$, then $a - c = b - c$ | ✓ | | ✓ | | ✓ | |
| Multiplication Property of Equality If $a = b$, then $ac = bc$ | ✓ | | ✓ | | ✓ | |
| Division Property of Equality If $a = b$ and $c \neq 0$, then $\frac{a}{c} = \frac{b}{c}$ | ✓ | | ✓ | | ✓ | |
| Addition Property of Inequality If $a < b$, then $a + c < b + c$; If $a > b$, then $a + c > b + c$ | | ✓ | | ✓ | | ✓ |
| Subtraction Property of Inequality If $a < b$, then $a - c < b - c$; If $a > b$, then $a - c > b - c$ | | ✓ | | ✓ | | ✓ |
| Multiplication Property of Inequality If $a < b$ and $c > 0$, then $ac < bc$; If $a > b$ and $c > 0$, then $ac > bc$; If $a < b$ and $c < 0$, then $ac > bc$; If $a > b$ and $c < 0$, then $ac < bc$ | | | | ✓ | | ✓ |
| Division Property of Inequality If $a < b$ and $c > 0$, then $\frac{a}{c} < \frac{b}{c}$; If $a < b$ and $c < 0$, then $\frac{a}{c} > \frac{b}{c}$; If $a > b$ and $c > 0$, then $\frac{a}{c} > \frac{b}{c}$; If $a > b$ and $c < 0$, then $\frac{a}{c} < \frac{b}{c}$ | | | | ✓ | | ✓ |
| Substitution Property If $a = b$, then b can be substituted for a in any expression, equation or inequality | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

²The properties of equality and inequality listed apply given a , b , and c are real numbers. In some standards, limitations may exist on the values of a , b , or c (e.g., integers only or rational numbers only), or impose other parameters (e.g., 1-step equations) that may prevent situations in which a property could be applied.

MATHEMATICS VERTICAL ARTICULATION TOOL (MVAT)
2016 Mathematics Standards of Learning - Patterns, Functions and Algebra
Kindergarten-Algebra II Progression
High School Mathematics 2016 Mathematics Standards of Learning

Application of Properties of Real Numbers¹ - Related to Patterns, Functions, and Algebra Strand

✓ = property can be applied in this standard; N/A = not applicable

| Standard of Learning Description | Solve Multistep Linear Equations; Literal Equations; Systems of Linear Equations A.4 | Solve Multistep Linear Inequalities; Systems of Linear Inequalities A.5 |
|--|--|---|
| Commutative Property of Addition $a + b = b + a$ | ✓ | ✓ |
| Commutative Property of Multiplication $ab = ba$ | ✓ | ✓ |
| Associative Property of Addition $(a + b) + c = a + (b + c)$ | ✓ | ✓ |
| Associative Property of Multiplication $(ab)c = a(bc)$ | ✓ | ✓ |
| Distributive Property (over addition/subtraction) $a(b + c) = ab + ac$ and $a(b - c) = ab - ac$ | ✓ | ✓ |
| Identity Property of Addition $a + 0 = a = 0 + a$ | ✓ | ✓ |
| Identity Property of Multiplication $a \cdot 1 = a = 1 \cdot a$ | ✓ | ✓ |
| Inverse Property of Addition $a + (-a) = 0 = (-a) + a$ | ✓ | ✓ |
| Inverse Property of Multiplication $a \cdot \frac{1}{a} = 1 = \frac{1}{a} \cdot a, a \neq 0$ | ✓ | ✓ |
| Multiplicative Property of Zero[†] $a \cdot 0 = 0 \cdot a$ | ✓ | ✓ |
| Substitution Property[†] If $a = b$, then b can be substituted for a in any expression, equation or inequality | ✓ | ✓ |

¹The properties of real numbers listed apply given a , b , and c are real numbers. In some standards, limitations may exist on the values of a , b , or c (e.g., integers only or rational numbers only), or impose other parameters (e.g., one-step equations) that may prevent situations in which a property could be applied. [†]Multiplicative Property of Zero and the Substitution Property may also be considered properties of equality/inequality.

MATHEMATICS VERTICAL ARTICULATION TOOL (MVAT)
2016 Mathematics Standards of Learning - Patterns, Functions and Algebra
Kindergarten-Algebra II Progression

High School Mathematics 2016 Mathematics Standards of Learning

Application of Properties of Equality/Inequality² - Related to Patterns, Functions, and Algebra Strand

✓ = property can be applied in this standard; N/A = not applicable

| Standard of Learning Description | Solve Multistep Linear Equations; Literal Equations; Systems of Linear Equations A.4 | Solve Multistep Linear Inequalities; Systems of Linear Inequalities A.5 |
|--|--|---|
| Addition Property of Equality If $a = b$, then $a + c = b + c$ | ✓ | |
| Subtraction Property of Equality If $a = b$, then $a - c = b - c$ | ✓ | |
| Multiplication Property of Equality If $a = b$, then $ac = bc$ | ✓ | |
| Division Property of Equality If $a = b$ and $c \neq 0$, then $\frac{a}{c} = \frac{b}{c}$ | ✓ | |
| Addition Property of Inequality If $a < b$, then $a + c < b + c$; If $a > b$, then $a + c > b + c$ | | ✓ |
| Subtraction Property of Inequality If $a < b$, then $a - c < b - c$; If $a > b$, then $a - c > b - c$ | | ✓ |
| Multiplication Property of Inequality If $a < b$ and $c > 0$, then $ac < bc$; If $a > b$ and $c > 0$, then $ac > bc$; If $a < b$ and $c < 0$, then $ac > bc$; If $a > b$ and $c < 0$, then $ac < bc$ | | ✓ |
| Division Property of Inequality If $a < b$ and $c > 0$, then $\frac{a}{c} < \frac{b}{c}$; If $a < b$ and $c < 0$, then $\frac{a}{c} > \frac{b}{c}$; If $a > b$ and $c > 0$, then $\frac{a}{c} > \frac{b}{c}$; If $a > b$ and $c < 0$, then $\frac{a}{c} < \frac{b}{c}$ | | ✓ |
| Substitution Property If $a = b$, then b can be substituted for a in any expression, equation or inequality. | ✓ | ✓ |
| Zero Product Property If $ab = 0$, then $a = 0$ or $b = 0$. | ✓ | |
| Reflexive Property $a = a$ | ✓ | |
| Symmetric Property If $a = b$, then $b = a$. | ✓ | |
| Transitive Property If $a = b$ and $b = c$, then $a = c$. | ✓ | ✓ |

²The properties of equality and inequality listed apply given a , b , and c are real numbers. In some standards, limitations may exist on the values of a , b , or c (e.g., integers only or rational numbers only), or impose other parameters (e.g., 1-step equations) that may prevent situations in which a property could be applied.