# MATHEMATICS VERTICAL ARTICULATION TOOL (MVAT)

# 2016 *Mathematics Standards of Learning* – Computation and Estimation

# Kindergarten-Algebra II Progression

**All K-8 Mathematics SOL for the Computation and Estimation strand are represented in this document. All End-of-Course Mathematics SOL are NOT represented.**

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

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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** | **Fluency – Whole Number Operations** |
| N/A | [**1.7a**](https://www.doe.virginia.gov/home/showpublisheddocument/2936#page=19) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | recognize and describe with fluency part-whole relationships for numbers up to 10 |
| N/A | [**1.7b**](https://www.doe.virginia.gov/home/showpublisheddocument/2936#page=19) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | demonstrate fluency with addition and subtraction within 10 |
| N/A | ES | [**2.5b**](https://www.doe.virginia.gov/home/showpublisheddocument/2950#page=16) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | demonstrate fluency with addition and subtraction within 20 |
| N/A | ES | ES | [**3.4c**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | demonstrate fluency with multiplication facts of 0, 1, 2, 5 and 10 |
| N/A | ES | ES | ES | [**4.4a**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=14) | N/A | N/A | N/A | N/A | N/A | N/A | demonstrate fluency with multiplication facts through 12 x 12, and the corresponding division facts\* |

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\*On the state assessment, items measuring this objective are assessed without the use of a calculator.

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| **K-8 Cross-Strand Connections – Fluency – Whole Number Operations** |
| **Number and Number Sense**  [**K.4**](https://www.doe.virginia.gov/home/showpublisheddocument/3036#page=12)  The student will   1. recognize and describe with fluency part-whole relationships for numbers up to 5; and 2. investigate and describe part-whole relationships for numbers up to 10.   [**7.1**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=8) The student will  d) determine square roots of perfect squares |

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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** | **Whole Number - Estimation and Operations** |
| N/A | N/A | [**2.5a**](https://www.doe.virginia.gov/home/showpublisheddocument/2950#page=16) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | recognize and use the relationships between addition and subtraction to solve single-step practical problems, with whole numbers to 20 |
| N/A | N/A | [**2.6a**](https://www.doe.virginia.gov/home/showpublisheddocument/2950#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | estimate sums and differences |
| N/A | N/A | [**2.6b**](https://www.doe.virginia.gov/home/showpublisheddocument/2950#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | determine sums and differences, using various methods |
| N/A | N/A | ES | [**3.3a**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=14) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | estimate and determine the sum or difference of two whole numbers |
| N/A | N/A | ES | [**3.4a**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | represent multiplication and division through 10 x 10, using a variety of approaches and models |
| N/A | N/A | ES | ES | [**4.4b**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=14) | N/A | N/A | N/A | N/A | N/A | N/A | estimate and determine sums, differences, and products of whole numbers\* |
| N/A | N/A | ES | ES | [**4.4c**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=14) | N/A | N/A | N/A | N/A | N/A | N/A | estimate and determine quotients of whole numbers, with and without remainders\* |
| N/A | N/A | ES | ES | ES | [**5.7**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=23) | N/A | N/A | N/A | N/A | N/A | simplify whole number numerical expressions using the order of operations\* |

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| **K-8 Cross-Strand Connections – Whole Number - Estimation and Operations** |
| **Computation and Estimation**  [**6.6c**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=19) The student will  c) simplify numerical expressions involving integers.  **Patterns, Functions, and Algebra**  [**7.11**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=39) The student will evaluate algebraic expressions for given replacement values of the variables.  [**8.14a**](https://www.doe.virginia.gov/home/showpublisheddocument/3020#page=30) The student will  b) evaluate an algebraic expression for given replacement values of the variables |

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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** | **Rational Number - Estimation and Operations** |
| N/A | N/A | N/A | N/A | [**4.5a**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=22) | N/A | N/A | N/A | N/A | N/A | N/A | determine common multiples and factors, including least common multiple and greatest common factor |
| N/A | N/A | N/A | N/A | [**4.5b**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=22) | N/A | N/A | N/A | N/A | N/A | N/A | add and subtract fractions and mixed numbers having like and unlike denominators\* |
| N/A | N/A | N/A | N/A | [**4.6a**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=24) | N/A | N/A | N/A | N/A | N/A | N/A | add and subtract with decimals\* |
| N/A | N/A | N/A | N/A | ES | [**5.5a**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=18) | N/A | N/A | N/A | N/A | N/A | estimate and determine the product and quotient of two numbers involving decimals\* |
| N/A | N/A | N/A | N/A | ES | ES | [**6.5a**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=17) | N/A | N/A | N/A | N/A | multiply and divide fractions and mixed numbers\* |
| N/A | N/A | N/A | N/A | ES | ES | [**6.6a**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=19) | N/A | N/A | N/A | N/A | add, subtract, multiply and divide integers\* |
| N/A | N/A | N/A | N/A | ES | ES | [**6.6c**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=19) | N/A | N/A | N/A | N/A | simplify numerical expressions involving integers\* |

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| **K-8 Cross-Strand Connections – Rational Number - Estimation and Operations** |
| **Number and Number Sense**  [**4.2**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=9) The student will  c) identify the division statement that represents a fraction, with models and in context.  [**6.4**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=15) The student will recognize and represent patterns with whole number exponents and perfect squares.  [**7.1**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=8) The student will  d) determine square roots of perfect squares |

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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** | **Practical Applications - Whole Numbers** |
| [**K.6**](https://www.doe.virginia.gov/home/showpublisheddocument/3036#page=16) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | model and solve single-step story and picture problems with sums to 10 and differences within 10, using concrete objects |
| ES | [**1.6**](https://www.doe.virginia.gov/home/showpublisheddocument/2936#page=16) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | create and solve single-step story and picture problems using addition and subtraction within 20 |
| ES | ES | [**2.6c**](https://www.doe.virginia.gov/home/showpublisheddocument/2950#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | create and solve single-step and two-step practical problems involving addition and subtraction |
| ES | ES | ES | [**3.3b**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=14) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | create and solve single-step and multistep practical problems involving sums or differences of two whole numbers, each 9,999 or less |
| ES | ES | ES | [**3.4b**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | create and solve single-step practical problems that involve multiplication and division through 10 x 10 |
| ES | ES | ES | [**3.4d**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=18) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 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 |
| ES | ES | ES | ES | [**4.4d**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=14) | N/A | N/A | N/A | N/A | N/A | N/A | create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers |

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| **K-8 Cross-Strand Connections – Practical Applications - Whole Numbers** |
| **Measurement and Geometry Connections**  [**1.8**](https://www.doe.virginia.gov/home/showpublisheddocument/2936#page=23) The student will determine the value of a collection of like coins (pennies, nickels, or dimes) whose total value is 100 cents or less.  [**2.7**](https://www.doe.virginia.gov/home/showpublisheddocument/2950#page=24) The student will  a) count and compare a collection of pennies, nickels, dimes, and quarters whose total value is $2.00 or less;  [**3.6**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=26) The student will  a) determine the value of a collection of bills and coins whose total value is $5.00 or less;  [**3.9**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=29) The student will  b) solve practical problems related to elapsed time in one-hour increments within a 12- hour period;  [**4.7**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=27) The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.  [**4.9**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=30) The student will solve practical problems related to elapsed time in hours and minutes within a 12-hour period.  [**5.8**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=26) The student will  a) solve practical problems that involve perimeter, area, and volume in standard units of measure;  [**5.9**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=28) The student will  b) solve practical problems involving length, mass, and liquid volume using metric units.  [**5.11**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=30) The student will solve practical problems related to elapsed time in hours and minutes within a 24-hour period.  **Probability and Statistics Connections**  [**5.15**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=36)  The student will determine the probability of an outcome by constructing a sample space or using the Fundamental (Basic) Counting Principle.  [**5.17**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=41)  The student, given a practical context, will  b) describe mean as fair share; |

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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** | **Practical Applications –**  **Rational Numbers and Proportional Reasoning** |
| N/A | N/A | N/A | [**3.5**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=23) |  | N/A | N/A | N/A | N/A | N/A | N/A | solve practical problems that involve addition and subtraction with proper fractions having like denominators of 12 or less |
| N/A | N/A | N/A | ES | [**4.5c**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=22) |  | N/A | N/A | N/A | N/A | N/A | solve single-step practical problems involving addition and subtraction with fractions and mixed numbers |
| N/A | N/A | N/A | ES | [**4.6b**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=24) |  | N/A | N/A | N/A | N/A | N/A | solve single-step and multistep practical problems involving addition and subtraction with decimals |
| N/A | N/A | N/A | ES | ES | [**5.4**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=13) | N/A | N/A | N/A | N/A | N/A | create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of whole numbers |
| N/A | N/A | N/A | ES | ES | [**5.5b**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=18) | N/A | N/A | N/A | N/A | N/A | 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 |
| N/A | N/A | N/A | ES | ES | [**5.6a**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=20) | N/A | N/A | N/A | N/A | N/A | solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers |
| N/A | N/A | N/A | ES | ES | [**5.6b**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=20) | N/A | N/A | N/A | N/A | N/A | solve single-step practical problems involving multiplication of a whole number, limited to 12 or less, and a proper fraction, with models\* |
| N/A | N/A | N/A | ES | ES | ES | [**6.5b**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=17) | N/A | N/A | N/A | N/A | solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions and mixed numbers |
| N/A | N/A | N/A | ES | ES | ES | [**6.5c**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=17) | N/A | N/A | N/A | N/A | solve multistep practical problems involving addition, subtraction, multiplication, and division of decimals |
| N/A | N/A | N/A | ES | ES | ES | [**6.6b**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=19) | N/A | N/A | N/A | N/A | solve practical problems involving operations with integers |
| N/A | N/A | N/A | ES | ES | ES | MS | [**7.2**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=12) | N/A | N/A | N/A | solve practical problems involving operations with rational numbers |
| N/A | N/A | N/A | ES | ES | ES | MS | [**7.3**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=13) | N/A | N/A | N/A | solve single-step and multistep practical problems, using proportional reasoning |
| N/A | N/A | N/A | ES | ES | ES | MS | MS | [**8.4**](https://www.doe.virginia.gov/home/showpublisheddocument/3020#page=12) | N/A | N/A | solve practical problems involving consumer applications |

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| **K-8 Cross-Strand Connections – Practical Applications - Rational Numbers and Proportional Reasoning** |
| **Number and Number Sense Connections**  [**1.4**](https://www.doe.virginia.gov/home/showpublisheddocument/2936#page=12) The student will  a) represent and solve practical problems involving equal sharing with two or four sharers;  [**6.1**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=8) The student will represent relationships between quantities using ratios, and will use appropriate notations, such as *a* to *b*, and *a*:*b*.  **Measurement and Geometry Connections**  [**3.6**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=26) The student will  a) determine the value of a collection of bills and coins whose total value is $5.00 or less; and  c) make change from $5.00 or less  [**5.9**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=28) The student will  b) solve practical problems involving length, mass, and liquid volume using metric units.  [**7.5**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=18) The student will solve problems, including practical problems, involving the relationship between corresponding sides and corresponding angles of similar quadrilaterals and triangles.  [**8.6**](https://www.doe.virginia.gov/home/showpublisheddocument/3020#page=15) The student will  b) describe how changing one measured attribute of a rectangular prism affects the volume and surface area.  **Probability and Statistics**  [**7.8**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=25) The student will  a) determine the theoretical and experimental probabilities of an event;  [**8.11**](https://www.doe.virginia.gov/home/showpublisheddocument/3020#page=23) The student will  b) determine probabilities for independent and dependent events.  **Patterns, Functions, and Algebra Connections**  [**6.12**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=33) The student will  a) represent a proportional relationship between two quantities, including those arising from practical situations;  b) determine the unit rate of a proportional relationship and use it to find a missing value in a ratio table;  [**6.13**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=42) The student will solve one-step linear equations in one variable, including practical problems that require the solution of a one-step linear equation in one variable.    [**7.10**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=31) The student will   1. 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; 2. 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   [**7.12**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=41) The student will solve two-step linear equations in one variable, including practical problems that require the solution of a two-step linear equation in one variable.  [**7.13**](https://www.doe.virginia.gov/home/showpublisheddocument/3008#page=43) The student will solve one- and two-step linear inequalities in one variable, including practical problems, involving addition, subtraction, multiplication, and division, and graph the solution on a number line.  **Algebra I**  [**A.6**](https://www.doe.virginia.gov/home/showpublisheddocument/2868#page=15) The student will a) determine the slope of a line when given an equation of the line, the graph of the line, or two points on the line;  **Geometry**  [**G.7**](https://www.doe.virginia.gov/home/showpublisheddocument/2924#page=17) The student, given information in the form of a figure or statement, will prove two triangles are similar. |

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**Elementary School Mathematics *2016 Mathematics Standards of Learning***

**Application of the Properties of Real Numbers1 – Computation and Estimation Strand**

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| **Standard of Learning and Curriculum Framework Description** | Sum or Difference of Two Whole Numbers/Practical Problems  [**3.3a,b**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=14) | Multiplication and Division through  10 x 10//Fluency/ Practical Problems  [**3.4a,b,c,d**](https://www.doe.virginia.gov/home/showpublisheddocument/2960#page=18) | Multiplication and Division through 12 x 12  Sum/Difference/Product/ Quotient of Whole Numbers/Practical Problems  [**4.4a, b, c, d**](https://www.doe.virginia.gov/home/showpublisheddocument/2972#page=14) | Practical Problems involving Sum/Difference/Product/ Quotient of Whole Numbers  [**5.4**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=13) | Practical Problems involving Multiplication of a Whole Number and a Proper Fraction  [**5.6b**](https://www.doe.virginia.gov/home/showpublisheddocument/2984#page=20) |
| **Commutative Property of Addition**  *a* + *b* = *b* +a |  |  |  |  |  |
| **Commutative Property of Multiplication**  *ab* = *b*a |  |  |  |  |  |
| **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*· 1 = *a* = 1·*a* |  |  |  |  |  |
| **Inverse Property of Addition**  *a* + (-*a*) = 0 = (-*a*) + *a* |  |  |  |  |  |
| **Inverse Property of Multiplication** |  |  |  |  |  |
| **Multiplicative Property of Zero**  *a* · 0 = 0 = 0 ∙ *a* |  |  |  |  |  |

**1** The 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., 1-step equations) that may prevent situations in which a property could be applied.

**Middle School Mathematics *2016 Mathematics Standards of Learning***

**Application of Properties of Real Numbers1 – Computation and Estimation Strand**

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| **Standard of Learning Description** | Simplify Numerical Expressions Involving Integers  [**6.6c**](https://www.doe.virginia.gov/home/showpublisheddocument/2996#page=19) |
| **Commutative Property of Addition**  *a* + *b* = *b* +a |  |
| **Commutative Property of Multiplication**  *ab* = *b*a |  |
| **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*· 1 = *a* = 1·*a* |  |
| **Inverse Property of Addition**  *a* + (-*a*) = 0 = (-*a*) + *a* |  |
| **Inverse Property of Multiplication** |  |
| **Multiplicative Property of Zero**  *a* · 0 = 0 ∙ *a* |  |
| **Substitution Property†**  If *a* = *b*, then *b* can be substituted for *a* in any expression, equation or inequality |  |

**1** The 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. **†**Substitution Property is also a property of equality/inequality.