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

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
	1.7a										recognize and describe with fluency part-whole relationships for numbers up to 10
	1.7b										demonstrate fluency with addition and subtraction within 10
	ES	**2.5b**									demonstrate fluency with addition and subtraction within 20
	ES	ES	**3.4c**								demonstrate fluency with multiplication facts of 0, 1, 2, 5 and 10
	ES	ES	ES	**4.4a**							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.

K-8 Cross-Strand Connections – Fluency – Whole Number Operations

Number and Number Sense

K.4 The student will
a) recognize and describe with fluency part-whole relationships for numbers up to 5; and
b) investigate and describe part-whole relationships for numbers up to 10.

7.1 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
		2.5a									recognize and use the relationships between addition and subtraction to solve single-step practical problems, with whole numbers to 20
		2.6a									estimate sums and differences
		2.6b									determine sums and differences, using various methods
			3.3a								estimate and determine the sum or difference of two whole numbers
			3.4a								represent multiplication and division through 10 x 10, using a variety of approaches and models
				4.4b							estimate and determine sums, differences, and products of whole numbers*
				4.4c							estimate and determine quotients of whole numbers, with and without remainders*
					5.7						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 The student will
c) simplify numerical expressions involving integers.

Patterns, Functions, and Algebra

7.11 The student will evaluate algebraic expressions for given replacement values of the variables.
8.14a 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
				4.5a							determine common multiples and factors, including least common multiple and greatest common factor
				4.5b							add and subtract fractions and mixed numbers having like and unlike denominators*
				4.6a							add and subtract with decimals*
					5.5a						estimate and determine the product and quotient of two numbers involving decimals*
						6.5a					multiply and divide fractions and mixed numbers*
						6.6a					add, subtract, multiply and divide integers*
						6.6c					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 The student will
c) identify the division statement that represents a fraction, with models and in context.

6.4 The student will recognize and represent patterns with whole number exponents and perfect squares.

7.1 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											model and solve single-step story and picture problems with sums to 10 and differences within 10, using concrete objects
	1.6										create and solve single-step story and picture problems using addition and subtraction within 20
		2.6c									create and solve single-step and two-step practical problems involving addition and subtraction
			3.3b								create and solve single-step and multistep practical problems involving sums or differences of two whole numbers, each 9,999 or less
			3.4b								create and solve single-step practical problems that involve multiplication and division through 10 x 10
			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
				4.4d							create and solve single-step and multistep practical problems involving addition, subtraction, and multiplication, and single-step practical problems involving division with whole numbers

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K-8 Cross-Strand Connections – Practical Applications - Whole Numbers

Measurement and Geometry Connections

1.8 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 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 The student will
a) determine the value of a collection of bills and coins whose total value is $5.00 or less;

3.9 The student will
b) solve practical problems related to elapsed time in one-hour increments within a 12- hour period;

4.7 The student will solve practical problems that involve determining perimeter and area in U.S. Customary and metric units.

4.9 The student will solve practical problems related to elapsed time in hours and minutes within a 12-hour period.

5.8 The student will
a) solve practical problems that involve perimeter, area, and volume in standard units of measure;

5.9 The student will
b) solve practical problems involving length, mass, and liquid volume using metric units.

5.11 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 The student will determine the probability of an outcome by constructing a sample space or using the Fundamental (Basic) Counting Principle.

5.17 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**
			3.5								solve practical problems that involve addition and subtraction with proper fractions having like denominators of 12 or less
				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*
						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
						6.6b					solve practical problems involving operations with integers
							7.2				solve practical problems involving operations with rational numbers
							7.3				solve single-step and multistep practical problems, using proportional reasoning
								8.4			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 The student will
a) represent and solve practical problems involving equal sharing with two or four sharers;

6.1 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 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 The student will
b) solve practical problems involving length, mass, and liquid volume using metric units.

7.5 The student will solve problems, including practical problems, involving the relationship between corresponding sides and corresponding angles of similar quadrilaterals and triangles.

8.6 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 The student will
a) determine the theoretical and experimental probabilities of an event;

8.11 The student will
b) determine probabilities for independent and dependent events.

Patterns, Functions, and Algebra Connections

6.12 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 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 The student will
a) 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;
b) 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 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 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 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 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 Numbers[1] – Computation and Estimation Strand

Standard of Learning and Curriculum Framework Description	Sum or Difference of Two Whole Numbers/Practical Problems **3.3a,b**	Multiplication and Division through 10 x 10//Fluency/ Practical Problems **3.4a,b,c,d**	Multiplication and Division through 12 x 12 Sum/Difference/Product/ Quotient of Whole Numbers/Practical Problems **4.4a, b, c, d**	Practical Problems involving Sum/Difference/Product/ Quotient of Whole Numbers **5.4**	Practical Problems involving Multiplication of a Whole Number and a Proper Fraction **5.6b**
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 $a \cdot 0 = 0 = 0 \cdot a$		✓	✓	✓	

[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.

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Middle School Mathematics *2016 Mathematics Standards of Learning*
Application of Properties of Real Numbers[1] – Computation and Estimation Strand

Standard of Learning Description	Simplify Numerical Expressions Involving Integers **6.6c**
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 $a \left(\frac{1}{a}\right) = 1 = \left(\frac{1}{a}\right) a, a \neq 0$	
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	✓

[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.