Technical Assistance on Selected Content of the 2009 *Mathematics Standards of Learning*

This document is based on comments provided to frequently asked questions received by the Virginia Department of Education regarding the 2009 *Mathematics Standards of Learning*. The comments are organized by content strand or course. In support of the implementation of the standards, teachers are encouraged to review comments not only from their specific grade level or course standards, but rather review the document in its entirety to gain information that can directly impact instruction and provide connections to previous and future instruction. This document is to be used in conjunction with, not in place of, the Mathematics Curriculum Framework.

Virginia Department of Education
Revised January 2014

Change Log

Date	Change
November 20, 2013	**Page 16, deletion of characters** Examples include, but are not limited to: • $\{x\mid\ 0 \leq x < 3\}$ or $\cancel{x}\mid 0 \leq x < 3$ • $\{y\colon\ y \geq 3\}$ or $\cancel{y}\colon y \geq 3$
January 7, 2014	**Page 11, language was edited to provide clarification on SOL 6.13** **Page 12, language was edited to provide clarification in the second bullet under SOL 6.14**

Standards of Learning 1.5, 2.5, 2.6, and 2.7 – Development of Fact Fluency

- To achieve the goal of fact fluency, students should have instructional experiences that develop relational understanding between addition and subtraction. Instructional experiences should facilitate the development of mental strategies for computation found in the Curriculum Framework. Manipulatives should be utilized when developing both relational understanding and strategies.
- Students would benefit from the use of the number line model as they develop their understanding of addition and subtraction of whole numbers.

Fractions, Fraction Models, and Ratios

Fractions represent a part-to-whole relationship and are used to name a part of a whole or a part of a collection. They can be represented with numerical symbols and with models. Fractions are used to name a part of a defined whole. Fraction models include area/region models, length/measurement models, or set models. Models can include pattern blocks, fraction bars, rulers, number lines, etc.

- In each area/region and length/measurement model, each part of the whole must have equal size and shape (congruent).
- In set models, the whole needs to be defined, but members of the set may have different sizes and shapes. For instance, if a whole is defined as a set of 10 animals the animals within the set may be different. Further, students may be asked to write a fraction that represents the number of monkeys. In the primary grades, students may benefit from experiences with sets that are comprised of congruent figures (i.e., 12 eggs in a carton) before working with sets that have noncongruent parts.

Ratios are introduced to students in the grade 6 standards. A ratio shows a relationship between two or more quantities that can be expressed as a fraction, decimal, or percent, depending on the situation. Fractions, decimals, and percents represent a part-to-whole relationship. Ratios expressed as fractions, decimals, or percents should represent only a part-to-whole relationship.

> Example: Given 3 red cars and 9 blue cars in a parking lot, the ratio of the number of red cars to the number of blue cars can be written as 3 to 9, 3:9, 1 to 3, or 1:3. The ratio of the number of red cars to the total number of cars can be written as 3:12 or 3 to 12 or $\frac{3}{12}$ or $\frac{1}{4}$ or 0.25 or 25%.

Standard of Learning 3.1

The student will

a) **read and write six-digit numerals and identify the place value and value of each digit;**
b) round whole numbers, 9,999 or less, to the nearest ten, hundred, and thousand; and
c) compare two whole numbers between 0 and 9,999, using symbols (>, <, or =) and words (*greater than, less than*, or *equal to*).

Students need to understand that whole numbers can be expressed in several formats, including written, standard, and expanded forms. In addition to the expanded form notation listed in the *Understanding the Standard* column of the Grade 3 Curriculum Framework that emphasizes the importance of place value, students may also benefit from experiences with the expanded form notation that expresses the number 123,456 as 100,000 + 20,000 + 3,000 + 400 + 50 + 6.

Standard of Learning 3.3

The student will

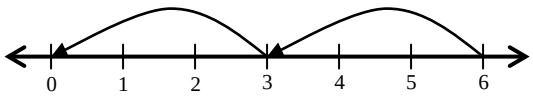
a) **name and write fractions (including mixed numbers) represented by a model;**
b) **model fractions (including mixed numbers) and write the fractions' names; and**
c) **compare fractions having like and unlike denominators, using words and symbols (>, <, or =).**

- Instruction for this standard includes use of all denominators of 12 or less.
- When comparing fractions using words and symbols, students should be asked to compare improper fractions.
- Students should be asked to rename an improper fraction as a mixed number (i.e., $\frac{5}{4} = 1\frac{1}{4}$, and vice versa), using a model.
- Models (length/measurement, region/area, and set) should be used when students compare fractions.

Standard of Learning 3.6

The student will represent multiplication and division, using area, set, and number line models, and create and solve problems that involve multiplication of two whole numbers, one factor 99 or less and the second factor 5 or less.

The number line model for division represents the division equation with the quotient as the number of sets needed to get to zero. In 6 ÷ 3, the number line model for division represents how many jumps of 3 are between 6 and 0.



For example, the number line model for the expression 6 ÷ 3 shows two jumps of three between 6 and 0, therefore, 6 ÷ 3 = 2.

Standard of Learning 3.7

The student will add and subtract proper fractions having like denominators of 12 or less.

Students should have experiences with addition problems having sums greater than 1, using models. The sums should be written as an improper fraction or mixed number. For example, $\frac{3}{5} + \frac{4}{5} = \frac{7}{5} = 1\frac{2}{5}$. Students should recognize both the improper fraction and the equivalent mixed number as correct answers.

Standards of Learning 4.4, 5.4 – Multiplication Symbols

Use of the • (middle dot, interpunct, or interpoint) as a multiplication symbol is not included until the grade 6 standards. While not required by the standard, teachers may choose to show students varied representations of the multiplication symbol.

Standard of Learning 4.5

The student will

a) determine common multiples and factors, including least common multiple and greatest common factor;
b) add and subtract fractions having like and unlike denominators that are limited to 2, 3, 4, 5, 6, 8, 10, and 12, and simplify the resulting fractions, using common multiples and factors;
c) add and subtract with decimals; and
d) solve single-step and multistep practical problems involving addition and subtraction with fractions and with decimals.

- While this standard requires instruction in solving problems with denominators of 2, 3, 4, 5, 6, 8, 10, and 12, students would benefit from experiences with other denominators. When students find common denominators to add or subtract fractions with unlike denominators, their answers may result in denominators greater than 12.
- In SOL 3.3 and 4.2, students have experiences working with improper fractions and mixed numbers. In this standard, instruction on addition and subtraction of fractions should include experiences with improper fractions and mixed numbers as addends, minuends, subtrahends, sums, and differences.

Standard of Learning 5.1

The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.

- Students would benefit from experiences that use the number line to develop the concept of rounding.
- One strategy for rounding decimal numbers to the nearest tenth and hundredth is as follows:
  - Look one place to the right of the digit you want to round to.
  - If the digit is 5 or greater, add 1 to the digit in the rounding place, and drop the digits to the right of the rounding place.
  - If the digit is less than 5, leave the digit in the rounding place as it is, and drop the digits to the right of the rounding place.

Standard of Learning 5.2

The student will

a) **recognize and name fractions in their equivalent decimal form and vice versa; and**
b) compare and order fractions and decimals in a given set from least to greatest and greatest to least.

- For fractions that deal with thirds, ninths, or twelfths with a repeating decimal equivalent, students should be able to determine which fraction is closest to a given terminating decimal. For instance, "$\frac{1}{3}$ is closest to which decimal?" Answers to consider may include 0.25, 0.3, 0.333, 0.4 – with the correct answer being 0.333.

The information below, from the Grade 5 Curriculum Framework, was included in the *Understanding the Standard* column for the purpose of providing mathematics content for teachers. Students will have experiences with these representations of repeating decimals when receiving instruction on the grade 6 standards.

> "In this standard, students should have experiences with fractions such as $\frac{1}{8}$, whose decimal representation is a terminating decimal (e. g., $\frac{1}{8}$ = 0.125) and with fractions such as $\frac{2}{9}$, whose decimal representation does not end but continues to repeat (e. g., $\frac{2}{9}$ = 0.222…). The repeating decimal can be written with ellipses (three dots) as in 0.222… or denoted with a bar above the digits that repeat as in $0.\overline{2}$."

Standard of Learning 5.5

The student will

a) **find the sum, difference, product, and quotient of two numbers expressed as decimals through thousandths (divisors with only one nonzero digit); and**
b) create and solve single-step and multistep practical problems involving decimals.

- Students are expected to find quotients with dividends expressed as decimals through thousandths and using a single-digit, whole number divisor (1 through 9).
- The VDOE format for writing decimals includes a leading zero (e.g., 0.5) prior to the decimal point.

Kindergarten – Grade 5: Measurement and Geometry

Standards of Learning 3.11, 4.9, and 5.10 – Elapsed Time

In elapsed time problems, there are three common elements: a beginning time, an ending time, and the amount of time that has elapsed. If given any two of these three elements, the students should be able to find the missing element.

- Grade 3 – Times should not cross between a.m. and p.m.
- Grade 4 – Times can cross between a.m. and p.m.

Standard of Learning 3.14

The student will identify, describe, compare, and contrast characteristics of plane and solid geometric figures (circle, square, rectangle, triangle, cube, rectangular prism, square pyramid, sphere, cone, and cylinder) by identifying relevant characteristics, including the number of angles, vertices, and edges, and the number and shape of faces, using concrete models.

- The curved surface of a cone or cylinder is not considered a face.
- The following chart defines the characteristics of solid geometric figures:

Solid Geometric Figure	# of Faces	Shape of Faces	# of Edges	# of Vertices
Cube	6	Squares	12	8
Rectangular Prism	6	Rectangles	12	8
Square Pyramid	5	Square/Triangles	8	5
Sphere	0	N/A	0	0
Cone	0	**	0	0*
Cylinder	0	**	0	0

* Since vertices of three-dimensional figures are defined by the Curriculum Framework as the point where three or more faces intersect, a cone has only a point (defined as an "apex" in formal geometry).
**Cones and cylinders do not have faces. They have bases that are circles.

Standard of Learning 4.12

The student will

a) **define polygon; and**
b) **identify polygons with 10 or fewer sides.**

Students should have experiences defining polygons by their properties as listed in the *Understanding the Standard* column of the Grade 4 Curriculum Framework. These figures include:

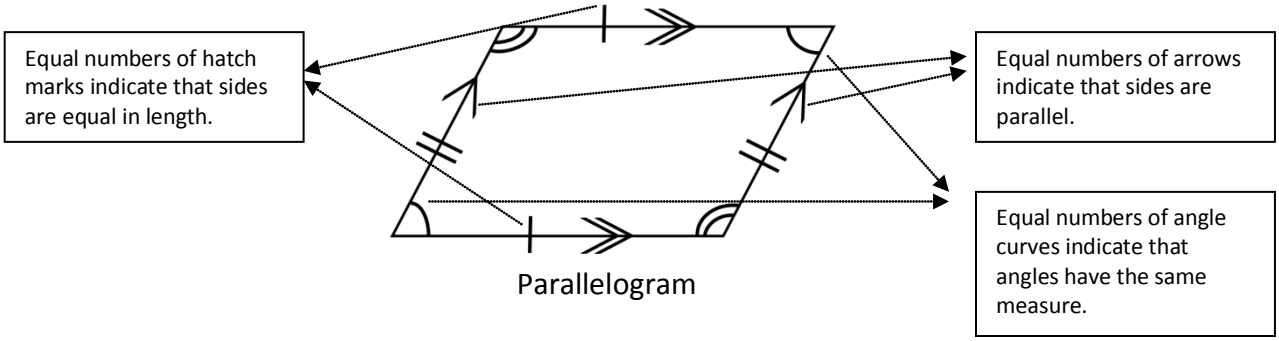
- triangle (specific types of triangles are included in instruction with SOL 5.12b);
- quadrilateral (including rectangle, square, trapezoid, parallelogram, and rhombus);
- pentagon;
- hexagon;
- heptagon;
- octagon;
- nonagon; and
- decagon.

Standards of Learning 5.12 and 5.13a – Measuring and Marking Figures

While learning the grade 5 standards, students should have experiences measuring sides and angles in order to classify and develop definitions of triangles and quadrilaterals.

The grade 6 standards require the use of geometric markings in figures to indicate congruence of sides and angles and to indicate parallel sides. Geometric markings used in grade 6 are shown in the parallelogram.

While not required by the grade 5 standards, students may benefit from experiences with marking and interpreting markings on figures.



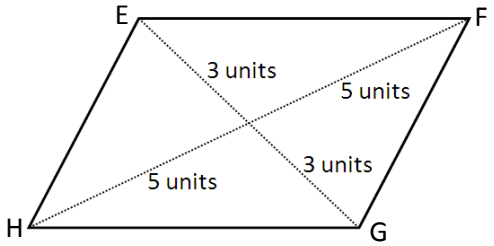
Parallelogram

Standard of Learning 5.13

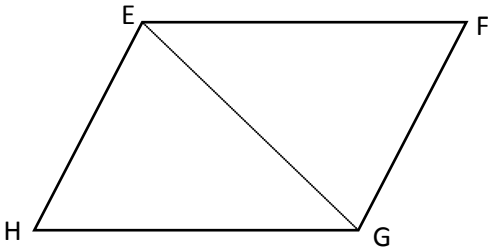
The student, using plane figures (square, rectangle, triangle, parallelogram, rhombus, and trapezoid), will

a) **develop definitions of these plane figures;** and
b) investigate and describe the results of combining and subdividing plane figures.

The diagonals of a parallelogram bisect each other. An example is seen below on the left. To bisect means to cut a geometric figure into two congruent halves. A bisector is a line segment, line, or plane that divides a geometric figure into two congruent halves. A sample of a bisected parallelogram is below on the right.



Parallelogram EFGH



Segment EG bisects parallelogram EFGH.
Triangle EFG is congruent to triangle GHE.

Kindergarten – Grade 5: Probability and Statistics

Standard of Learning K.14

The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.

Gathered data can be displayed in graphs vertically or horizontally. During instruction and assessment, it is important to vary the orientation of graphs.

Standard of Learning 2.17

The student will use data from experiments to construct picture graphs, pictographs, and bar graphs.

Picture graphs are graphs that use pictures to show and compare information. Pictures used in picture graphs represent one object. Pictographs are a form of picture graph that uses symbols to represent one or more objects to show and compare information. A key should be provided for the symbol in a pictograph (e.g.,  represents five people in a graph).

Kindergarten – Grade 5: Patterns, Functions, and Algebra

Standards of Learning 3.20, 4.16, and 5.19 – Algebraic Properties

A listing of the algebraic properties included in Virginia's 2009 *Mathematics Standards of Learning* in grade 3 through Algebra II has been posted on the Virginia Department of Education's Mathematics Instructional Resources Web site under the "General" resources tab.

Standards of Learning 6.1 and 6.2 – Expressing Ratios as Fractions

A ratio shows a relationship between two or more quantities that can be expressed as a fraction, decimal, or percent, depending on the situation. Fractions, decimals, and percents represent a part-to-whole relationship. Ratios expressed as fractions, decimals, or percents should represent only a part-to-whole relationship.

> Example: Given 3 red cars and 9 blue cars in a parking lot, the ratio of the number of red cars to the number of blue cars can be written as 3 to 9, 3:9, 1 to 3, or 1:3. The ratio of the number of red cars to the total number of cars can be written as 3:12 or 3 to 12 or $\frac{3}{12}$ or $\frac{1}{4}$ or 0.25 or 25%.

Standard of Learning 6.5

The student will investigate and describe concepts of positive exponents and perfect squares.

Zero (a whole number) is a perfect square.

Standard of Learning 7.4

The student will solve single-step and multistep practical problems, using proportional reasoning.

- The third bullet under the *Essential Knowledge and Skills* column of the Grade 7 Curriculum Framework states that students should apply proportions to convert units of measurement between the U.S. Customary System and the metric system.
  - Students are expected to learn the ballpark conversions in SOL 6.9, so they are considered prior knowledge that students are expected to know in the seventh grade. The emphasis of SOL 7.4 is on the application of proportional reasoning. When deciding whether or not to include conversions on instructional or assessment tasks, teachers should consider the context of the problem and ensure that the item is assessing proportional reasoning and not conversion skills.
- The sixth bullet under the *Essential Knowledge and Skills* column of the Grade 7 Curriculum Framework states "students should be able to solve problems involving tips, tax, and discounts. Limit problems to only one percent computation per problem." While the bullet limits instruction to only one percent computation per practical problem, students would benefit from problems requiring two or more percent computations.

Standard of Learning 6.9

The student will make ballpark comparisons between measurements in the U.S. Customary System of measurement and measurements in the metric system.

This standard does not limit the conversion estimations to be between two similar measures such as liters and quarts or kilometers and miles. Students should have experiences with questions that ask about other comparisons, such as "Approximately how many liters are in a gallon?"

Standard of Learning 6.10

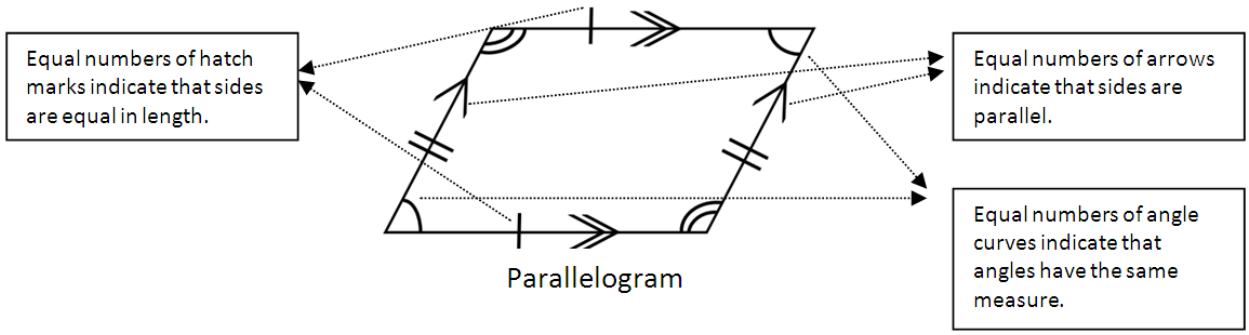
The student will

a) **define pi (π) as the ratio of the circumference of a circle to its diameter;**
b) **solve practical problems involving circumference and area of a circle, given the diameter or radius;**
c) solve practical problems involving area and perimeter; and
d) describe and determine the volume and surface area of a rectangular prism.

When assessing this standard, teachers need to provide specific instructions on which approximation of pi students should use, or they should ensure that answer choices accommodate the use of either approximation of pi ($\frac{22}{7}$ or 3.14) or the π button on the calculator.

Standards of Learning 6.12 and 6.13

Students should have experiences using geometric markings in figures to indicate congruence of sides and angles and to indicate parallel sides. Geometric markings used are shown in the parallelogram.



Standard of Learning 6.13

The student will describe and identify properties of quadrilaterals.

The Grade 6 Curriculum Framework states that a kite is a quadrilateral with two pairs of adjacent, congruent sides and one pair of opposite angles congruent. The Curriculum Framework does not restrict the rhombus from being considered a special case of a kite.

- If all 4 sides of a kite have the same length, then it must be a rhombus with two pairs of opposite angles congruent; and
- If all 4 angles of the kite are equal, then it must also be a square.

Standard of Learning 7.8

The student, given a polygon in the coordinate plane, will represent transformations (reflections, dilations, rotations, and translations) by graphing in the coordinate plane.

Students should have experiences with rotations of right triangles or rectangles about the origin in the clockwise or counterclockwise direction.

Standard of Learning 8.7

The student will

a) **investigate and solve practical problems involving volume and surface area of prisms, cylinders, cones, and pyramids; and**
b) describe how changing one measured attribute of a figure affects the volume and surface area.

For instruction on pyramids, the intent of the standard is to focus on two types of regular pyramids (those with bases that are squares or those with bases that are equilateral triangles). The grade 8 mathematics formula sheet includes a diagram and formulas (volume and surface area) for the square-based pyramid. These formulas can be used to find the volume and surface area of any regular pyramid.

Grades 6 – 8: Probability and Statistics

Standard of Learning 6.14

The student, given a problem situation, will

a) **construct circle graphs;**
b) draw conclusions and make predictions, using circle graphs; and
c) compare and contrast graphs that present information from the same data set.

- The Curriculum Framework for SOL 6.2 states that students should be working with fractions that have denominators of 12 or less (when comparing fractions) or denominators that are factors of 100 (when describing equivalent relationships between fractions, decimals, and percents). For SOL 6.14, students should work with fractions having denominators of 12 or less or those that are factors of 100, when they are asked to collect, organize, and display data in circle graphs by depicting information as fractional. While not required by the standard, teachers may choose to give students experiences with fractions outside of the parameters of the standard.
- Students are not expected to construct circle graphs by multiplying the percentage of data in a category by 360° in order to determine the central angle measure. Adhering to fraction parameters noted above will assist students in estimating the central angle measures needed to construct circle graphs.

Standard of Learning 7.10

The student will determine the probability of compound events, using the Fundamental (Basic) Counting Principle.

Probability of events is included in SOL 6.16, 7.10, and 8.12. For SOL 7.10, students need to be able to determine the probability of compound events of two independent or two dependent events. Replacement and nonreplacement are included in the grade 6 standards (SOL 6.16); therefore, they should be included in the instruction for this standard.

Grades 6 – 8: Patterns, Functions, and Algebra

Standards of Learning 6.19, 7.16, and 8.15 – Algebraic Properties

A listing of the algebraic properties included in Virginia's 2009 *Mathematics Standards of Learning* in grade 3 through Algebra II has been posted on the Virginia Department of Education's Mathematics Instructional Resources Web site under the "General" resources tab.

Standard of Learning 6.18

The student will solve one-step linear equations in one variable involving whole number coefficients and positive rational solutions.

Instruction for this standard should be limited to solving one-step equations that students can check without using operations with integers, since operations with negative integers are not included until the grade 7 standards. If a division-level curriculum or individual teacher decides to include examples that go beyond the standard, students should receive instruction on the inverse property of addition and operations with negative integers.

Included in Grade 6 Standards	Not included until Grade 7 Standards
$5 = x + 3$	$3 = x + 5$
$n - 6.3 = 2.1$	$-6.3 + n = 2.1$
$2x = 7$	$-2x = 7$
$\frac{n}{6} = 36$	$\frac{n}{-6} = 36$

Standard of Learning 8.15

The student will
a) solve multistep linear equations in one variable on one and two sides of the equation;
b) solve two-step linear inequalities and graph the results on a number line; and
c) identify properties of operations used to solve an equation.

Students should have experiences with identification of properties of operations used to solve each step of equations that contain variables on one and both sides.

Standard of Learning 8.16

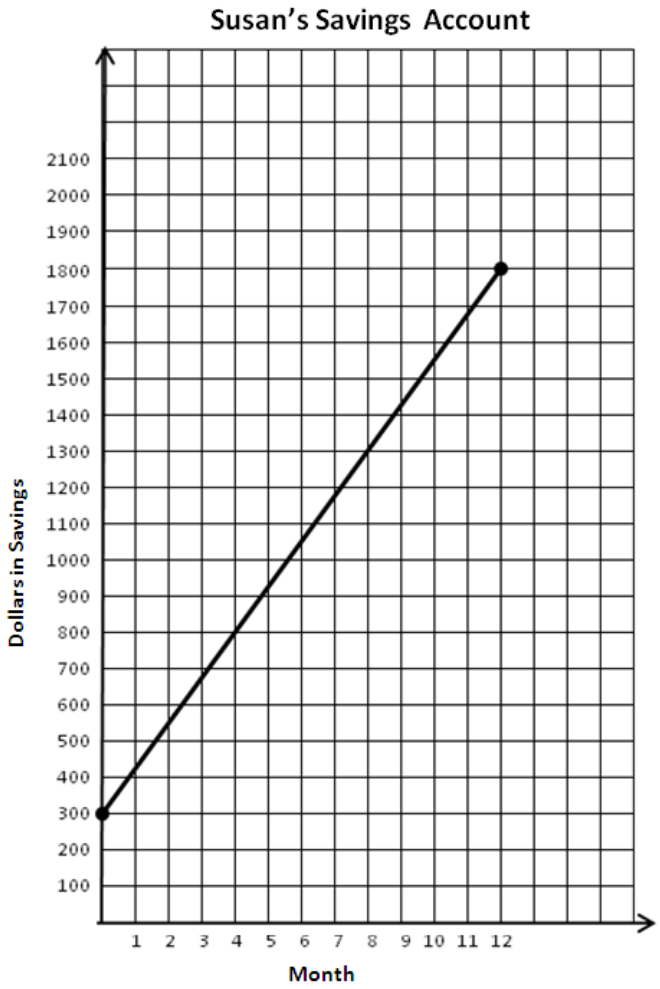
The student will graph a linear equation in two variables.

From the *Essential Knowledge and Skills* column of the Grade 8 Curriculum Framework:

- **"Interpret the unit rate of the proportional relationship graphed as the slope of the graph, and compare two different proportional relationships represented in different ways."**

The intent of the fourth bullet of the *Essential Knowledge and Skills* column of the Grade 8 Curriculum Framework requires teachers to include discussions about slope of a line as a rate of change while graphing linear relationships. Students should have experiences comparing the relative steepness of lines, as indicated by the unit rate of change for each. These experiences should come through student analysis of graphs on a coordinate grid, in conjunction with the function's explicit rule and tables of values.

For example, the graph below shows how Susan's savings account balance has changed over the course of one year. Susan would like to find out how much she saved per month for the year. One way to determine this is by finding the monthly rate of change (slope).



Algebra I and Algebra II: Expressions and Operations

Standard of Learning A.1

The student will represent verbal quantitative situations algebraically and evaluate these expressions for given replacement values of the variables.

The Algebra I Curriculum Framework states that "Evaluating expressions should include expressions containing absolute value, square roots, and cube roots." The inclusion of square roots should require students to add, subtract, multiply, and divide radicals.

Standard of Learning A.2

The student will perform operations on polynomials, including

a) applying the laws of exponents to perform operations on expressions;
b) adding, subtracting, multiplying, and dividing polynomials; and
c) factoring completely first- and second-degree binomials and trinomials in one or two variables. Graphing calculators will be used as a tool for factoring and for confirming algebraic factorizations.

- For division of polynomials in this standard, instruction on the use of long or synthetic division is not required, but students may benefit from experiences with these methods, which become more useful and prevalent in the study of advanced levels of algebra.
- Prime polynomials cannot be factored, such that each factor is a lower-degree polynomial. Linear polynomials are always prime polynomials over the real numbers. Quadratic polynomials are prime over the real numbers if and only if the polynomial function does not have any real zeros (i.e., the polynomial function's graph does not cross the x-axis).

Standard of Learning AII.1

The student, given rational, radical, or polynomial expressions, will

a) add, subtract, multiply, divide, and simplify rational algebraic expressions;
b) add, subtract, multiply, divide, and simplify radical expressions containing rational numbers and variables, and expressions containing rational exponents;
c) write radical expressions as expressions containing rational exponents and vice versa; and
d) factor polynomials completely.

While the standard does not require students to rationalize denominators while simplifying radical expressions containing numbers and variables, students would benefit from experiences in rationalizing denominators.

Algebra I and Algebra II: Equations and Inequalities

Standards of Learning A.4, A.5, and AII.3 (Expressions and Operations) – Algebraic Properties

A listing of the algebraic properties included in Virginia's 2009 *Mathematics Standards of Learning* in grade 3 through Algebra II has been posted on the Virginia Department of Education's Mathematics Instructional Resources Web site under the "General" resources tab.

Notation in Algebra

The Curriculum Frameworks for Algebra I and Algebra II state that set builder notation may be used to represent the domain, range, and solution set for a given equation or inequality, which allows for other notations to be used. Students will benefit from experiences using multiple notations of domain, range, or solution sets.

Examples include, but are not limited to:

- $\{x|\ 0 \leq x < 3\}$ or $0 \leq x < 3$
- $\{y:\ y \geq 3\}$ or $y \geq 3$
- Empty (null) set as $\emptyset$ or { }

Interval notation is introduced explicitly in Algebra, Functions, and Data Analysis, and if not included in a local curriculum for Algebra II, it should be included in mathematics courses above the level of Algebra II.

Standard of Learning A.4

The student will solve multistep linear and quadratic equations in two variables, including

a) solving literal equations (formulas) for a given variable;
b) justifying steps used in simplifying expressions and solving equations, using field properties and axioms of equality that are valid for the set of real numbers and its subsets;
c) solving quadratic equations algebraically and graphically;
d) solving multistep linear equations algebraically and graphically;
e) solving systems of two linear equations in two variables algebraically and graphically;
f) and
g) solving real-world problems involving equations and systems of equations.

Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.

- Students should have experiences solving quadratic equations by graphing, factoring, and using the quadratic formula. Solutions may be irrational.

Standard of Learning AII.4

The student will solve, algebraically and graphically,

a) absolute value equations and inequalities;
b) quadratic equations over the set of complex numbers;
c) equations containing rational algebraic expressions; and
d) equations containing radical expressions.

Graphing calculators will be used for solving and for confirming the algebraic solutions.

- The *Essential Knowledge and Skills* column of the Algebra II Curriculum Framework states, **"**Recognize that the quadratic formula can be derived by applying the completion of squares to any quadratic equation in standard form.[†]" This bullet provides guidance that asks teachers to expose students to the relationship between completing the square and the derivation of the quadratic formula. Completing the square is included in this standard as one strategy for solving quadratic equations.
- Quadratic equations with exactly one real root can be referred to as having one real root with a multiplicity of two. For instance, the quadratic equation $x^2 - 4x + 4 = 0$ has two identical factors, giving one real root with a multiplicity of two.

Standard of Learning AII.5

The student will solve nonlinear systems of equations, including linear-quadratic and quadratic-quadratic, algebraically and graphically. Graphing calculators will be used as a tool to visualize graphs and predict the number of solutions.

Nonlinear systems of equations would be limited to linear and quadratic equations. While not included in the standard, students will benefit from experiences with systems of any equations to which they have been exposed in previous courses or Algebra II, including circles if students have taken Geometry prior to Algebra II.

Algebra I and Algebra II: Functions

Standard of Learning AII.6

The student will recognize the general shape of function (absolute value, square root, cube root, rational, polynomial, exponential, and logarithmic) families and will convert between graphic and symbolic forms of functions. A transformational approach to graphing will be employed. Graphing calculators will be used as a tool to investigate the shapes and behaviors of these functions.

Transformations of functions in the standard include translations, reflections, and dilations. For some transformations, the domain may need to be restricted.

Standard of Learning AII.7

The student will investigate and analyze functions algebraically and graphically. Key concepts include

a) **domain and range, including limited and discontinuous domains and ranges;**
b) zeros;
c) *x*- and *y*-intercepts;
d) intervals in which a function is increasing or decreasing;
e) **asymptotes;**
f) end behavior;
g) inverse of a function; and
h) composition of multiple functions.

Graphing calculators will be used as a tool to assist in investigation of functions.

- Students will benefit from instruction that provides connections between the procedures of algebraic analysis and other representations, including graphs and tables of data.
- Discontinuous domains and ranges include those with removable (holes) and nonremovable (asymptotes) discontinuities. Students should be expected to find the domain and range of any provided graph.
- Slant asymptotes are not included in the standard, but students would benefit from experiences including slant asymptotes.

Algebra I and Algebra II: Statistics

Standards of Learning A.9 and AII.11 – Measures of Spread and the Normal Curve

Technical assistance documents for SOL A.9 and SOL AII.11 have been posted on the Virginia Department of Education's Mathematics Instructional Resources Web site under the "Middle and High School" resources tab.

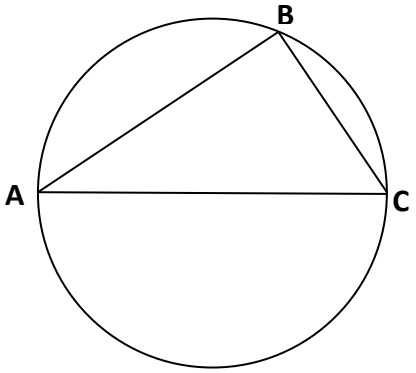
Standard of Learning G.4

The student will construct and justify the constructions of

a) a line segment congruent to a given line segment;
b) the perpendicular bisector of a line segment;
c) a perpendicular to a given line from a point not on the line;
d) a perpendicular to a given line at a given point on the line;
e) the bisector of a given angle;
f) an angle congruent to a given angle; and
g) a line parallel to a given line through a point not on the given line.

- Students should have experiences justifying individual steps of and determining the validity of both partial and complete constructions.
- Students should have experiences with completing constructions within the context of a more complex figure.

Example:



Given inscribed ΔABC with diameter $\overline{AC}$, complete a construction to identify the center of the circle.

- The Geometry Curriculum Framework for this standard was revised in March 2011 to include the addition of the following constructions:
  - Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle;
  - Construct the inscribed and circumscribed circles of a triangle; and
  - Construct a tangent line from a point outside a given circle to the circle.

Standard of Learning G.8

The student will solve real-world problems involving right triangles by using the Pythagorean Theorem and its converse, properties of special right triangles, and right triangle trigonometry.

- "Right triangle trigonometry" in this standard requires that students have experiences finding missing side lengths or angle measurements.
- Students should be required to rationalize denominators in real-world problems associated with special right triangles.

Standard of Learning G.11

The student will use angles, arcs, chords, tangents, and secants to

a) investigate, verify, and apply properties of circles;
b) solve real-world problems involving properties of circles; and
c) find arc lengths and areas of sectors in circles.

Arcs can be measured in degrees or in units of length.

Standard of Learning G.12

The student, given the coordinates of the center of a circle and a point on the circle, will write the equation of the circle.

Students should have experiences that require them to determine any of the following from given information:

- the coordinates of the center;
- the length of a radius;
- coordinate endpoints of a radius;
- the length of a diameter;
- coordinate endpoints of a diameter;
- the coordinates of a point on the circle; and/or
- the equation of a circle.