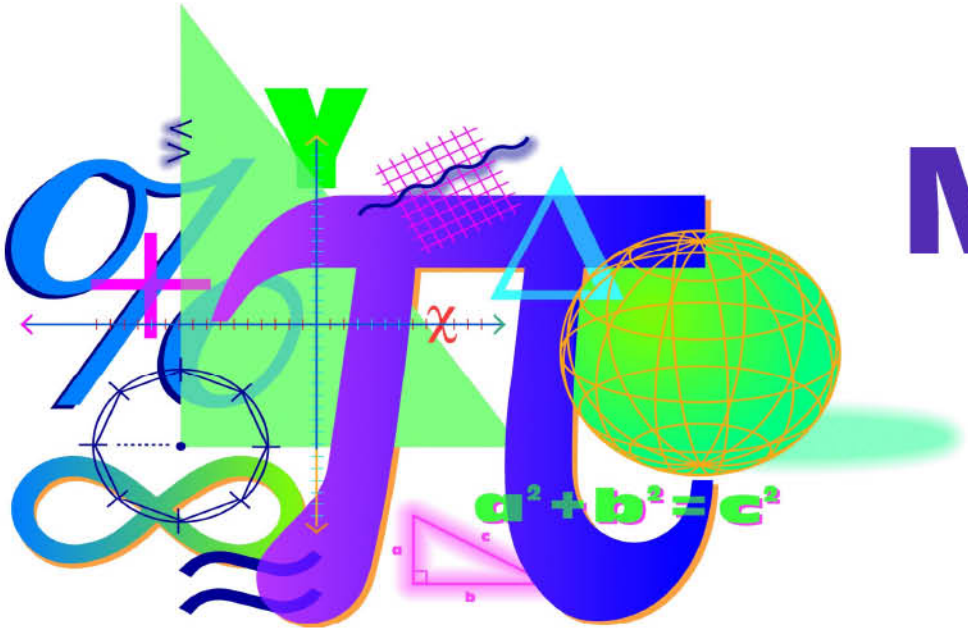

Mathematics
Standards of Learning

Curriculum Framework 2009

Supplement to the Curriculum Framework for the 2009 *Mathematics Standards of Learning*

January 13, 2011

Board of Education
Commonwealth of Virginia

Introduction

To ensure alignment of the 2009 *Mathematics Standards of Learning* and Curriculum Framework with the Common Core State Standards for Mathematics, Department of Education staff conducted a preliminary analysis of the content from the two sets of standards, and presented a comparison report to the Board of Education on September 23, 2010. In October 2010, the Department convened a committee of mathematics educators to further review and refine the analysis. The review committee identified several concepts in Virginia's Curriculum Framework for the 2009 *Mathematics Standards of Learning* that need to be added or strengthened to ensure that Virginia's standards are equal to or more rigorous in content and scope than the Common Core State Standards for Mathematics.

There are no changes proposed to the 2009 *Mathematics Standards of Learning*. Supplemental content is proposed only to the Curriculum Framework. The proposed changes to the Curriculum Framework for the 2009 *Mathematics Standards of Learning* have been noted with underlines (additions) and strikethroughs (deletions).

CCSS for Mathematics	Supplemental Information to Virginia's Mathematics SOL Curriculum Framework to Align with the Mathematics Common Core State Standards
Measurement and Data 4.MD	
Geometric measurement: understand concepts of angle and measure angles.	
7. Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real-world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.	**5.11 The student will measure right, acute, obtuse, and straight angles.** **5.11 CF** • **Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts.** • **Solve addition and subtraction problems to find unknown angle measures on a diagram in practical and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.**
Measurement and Data 5.MD	
Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.	
5. Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.	
a. Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.	**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.** **6.10 CF** • **Experiences in deriving the formulas for area, perimeter, and volume using manipulatives such as tiles, one inch cubes, adding machine tape, graph**

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	paper, geoboards, or tracing paper, promote an understanding of the formulas and facility in their use.
The Number System 6.NS	
Apply and extend previous understandings of numbers to the system of rational numbers.	
8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.	**6.11 The student will** **a) identify the coordinates of a point in a coordinate plane; and** **b) graph ordered pairs in a coordinate plane.** **6.11 CF** • **Relate the coordinate of a point to the distance from each axis and relate the coordinates of a single point to another point on the same horizontal or vertical line.**
Geometry 6.G	
Solve real-world and mathematical problems involving area, surface area, and volume.	
3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.	**6.12 The student will determine congruence of segments, angles, and polygons.** **6.12 CF** • **Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving practical and mathematical problems.**
Statistics and Probability 6.SP	
Develop understanding of statistical variability.	
3. Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a	**5.16 The student will** **a) describe mean, median, and mode as measures of center;** **b) describe mean as fair share;** **c) find the mean, median, mode, and range of a set of data; and**

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single number.	**d) describe the range of a set of data as a measure of variation.** **5.16 CF** • **Describe the impact on measures of center when a single value of a data set is added, removed, or changed.**
The Number System 7.NS	
Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.	
1. Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.	
c. Understand subtraction of rational numbers as adding the additive inverse, $p - q = p + (-q)$. Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.	**7.1 The student will** **a) investigate and describe the concept of negative exponents for powers of ten;** **b) determine scientific notation for numbers greater than zero;** **c) compare and order fractions, decimals, percents and numbers written in scientific notation;** **d) determine square roots; and** **e) identify and describe absolute value for rational numbers.** **7.1 CF** • **Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle to solve practical problems.**
Geometry 7.G	
Draw, construct, and describe geometrical figures and describe the relationships between	

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them.	
3. Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.	**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.** **8.7 CF** • **Describe the two-dimensional figures that result from slicing three-dimensional figures parallel to the base (e.g., as in plane sections of right rectangular prisms and right rectangular pyramids).**
Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.	
5. Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.	**8.6 The student will** **a) verify by measuring and describe the relationships among vertical angles, adjacent angles, supplementary angles, and complementary angles; and** **b) measure angles of less than 360°.** **8.6 CF** • **Use the relationships among supplementary, complementary, vertical, and adjacent angles to solve practical problems.**
Expressions and Equations 8.EE	
Understand the connections between proportional relationships, lines, and linear equations.	
5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example,*	**8.16 The student will graph a linear equation in two variables.** **8.16 CF** • **Interpret the unit rate of the proportional relationship graphed as the slope of the graph, and compare two different proportional relationships**

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compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.	**represented in different ways.**
Expressions and Equations 8.EE	
Analyze and solve linear equations and pairs of simultaneous linear equations.	
7. Solve linear equations in one variable.	
a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form x = a, a = a, or a = b results (where a and b are different numbers).	**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; and** **f) 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.** **A.4 CF** • **Determine if a linear equation in one variable has one, an infinite number, or no solutions.**
The Real Number System N-RN	
Use properties of rational and irrational numbers.	
3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational	**8.2 The student will describe orally and in writing the relationships between the subsets of the real number system.**

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number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.	**8.2 CF** • **Recognize that the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.**
Arithmetic with Polynomials and Rational Expressions A-APR	
Use polynomial identities to solve problems	
4. Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity* $(x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.*	**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.** **AII.1 CF** • **Verify polynomial identities including the difference of squares, sum and difference of cubes, and perfect square trinomials.**
Reasoning with Equations and Inequalities A-REI	
Solve equations and inequalities in one variable	
4. Solve quadratic equations in one variable.	
a. Use the method of completing the square to transform any quadratic equation in *x* into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.	**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**

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	solutions. **AII.4 CF** • **Recognize that the quadratic formula can be derived by applying the completion of squares to any quadratic equation in standard form.**
Trigonometric Functions F-TF	
Prove and apply trigonometric identities	
9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.	**T.9 The student will identify, create, and solve real-world problems involving triangles. Techniques will include using the trigonometric functions, the Pythagorean Theorem, the Law of Sines, and the Law of Cosines.** **T.9 CF** • **Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.**
Congruence G-CO	
Make geometric constructions	
13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.	**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.** **G.4 CF** • **Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.**
Similarity, Right Triangles, and Trigonometry G-SRT	
Define trigonometric ratios and solve problems	

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involving right triangles	
7. Explain and use the relationship between the sine and cosine of complementary angles.	**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.** **G.8 CF** • **Explain and use the relationship between the sine and cosine of complementary angles.**
Circles G-C	
Understand and apply theorems about circles	
3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.	**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.** **G.4 CF** • **Construct the inscribed and circumscribed circles of a triangle.** **G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.** **G.9 CF** • **Prove properties of angles for a quadrilateral inscribed in a circle.**
4. (+) Construct a tangent line from a point outside a given circle to the circle.	**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;**

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	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.** **G.4 CF** • **Construct a tangent line from a point outside a given circle to the circle.**
Expressing Geometric Properties with Equations G-GPE	
Translate between the geometric description and the equation for a conic section	
1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.	**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.** **G.12 CF** • **Recognize that the equation of a circle of given center and radius is derived using the Pythagorean Theorem.**