Virginia Department of Education

Comparison of Virginia's 2009 Mathematics Standards of Learning with the Common Core State Standards for Mathematics

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Introduction

This first draft of the *Comparison of Virginia's 2009 Mathematics Standards of Learning (SOL) with the Common Core State Standards (CCSS) for Mathematics* provides a side-by-side overview demonstrating how the 2009 Mathematics SOL are aligned to the CCSS. The comparison was made using Virginia's complete standards program for supporting teaching and learning in the Commonwealth's public schools and school divisions, including both the 2009 *Mathematics Standards of Learning* and the *Curriculum Framework for 2009 Mathematics Standards of Learning*. The Curriculum Framework is essential to any comparison conducted between the CCSS and the Mathematics SOL since it "unpacks" the SOL, providing detail that complements the standards.

Organization of the *Comparison of Virginia's 2009 Mathematics SOL with the CCSS*

The CCSS are presented in the left column of the table and are organized using the CCSS format. Headings and subheadings are those used in the CCSS. Using the format provided in the CCSS, the comparison is completed by individual grade levels in kindergarten through grade 8 and by conceptual categories in grades 9-12. As the SOL and Curriculum Framework components were reviewed and aligned to the CCSS, they were placed in the right column of the table adjacent to the similar standard in the CCSS. SOL bullets correlated to the CCSS are indicated with bold print. SOL listed as correlated to CCSS content may include correlations from the *Curriculum Framework for 2009 Mathematics Standards of Learning* and are denoted with "CF" following the SOL number (e.g., 7.4 CF). The CCSS conceptual categories for high school specify content that all students should learn in order to be college and career ready. In addition, the CCSS include content, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics. A subset of the CCSS considered modeling standards are marked with a star symbol "⋆".

Summary of Similarities and Differences Between the CCSS and the 2009 Mathematics SOL

Both the CCSS for Mathematics and Virginia's Mathematics SOL are rigorous and provide a detailed account of mathematics expectations for student learning and understanding. The content topics covered in both documents are clearly defined and sequential. By the time students have progressed into high school mathematics content through the CCSS or SOL, they have received at least the same mathematical content delivered through different learning progressions. Virginia's SOL are equal to or in some instances more rigorous in content and scope than the CCSS. While learning progressions may not completely mirror one another, the content from both is aligned.

Virginia's teachers value content standards that do not dictate methodology, as reflected in the public comment provided during the 2009 Mathematics SOL revision process. The CCSS include "content" standards that dictate methodology and/or applications and extensions of content that teacher professionals should determine based on the learning needs of their students.

Kindergarten – Grade 8 Mathematics

- The SOL strands (Number and Number Sense, Computation and Estimation, Measurement, Geometry, Probability and Statistics, and Patterns, Functions, and Algebra) remain constant throughout kindergarten – grade 8. In the CCSS document, the strand (domain) titles vary based on the content focus of that particular grade level. This flexibility in the strand content facilitates connections across the mathematics topics. The *Mathematics Curriculum Framework*, as the companion document of the SOL, rather than the SOL document itself, also makes mathematics connections, across mathematics topics.
- In an effort to minimize the number of topics included within a given grade level, the CCSS introduce some topics later and accelerate their progression faster than the SOL. For instance, fraction content is not introduced in the CCSS until grade 3, while the SOL begin development of fractional concepts in kindergarten. The learning progressions of the SOL provide ample time for concept development and application of content skills.
- The SOL and CCSS utilize different organizational strands. Although the SOL strand titles are different, all concepts included mirror those of the CCSS.
- The timeline for the introduction of specific content in the CCSS when compared to the SOL is not an exact match. Examples are listed below.
    - Fractions are not introduced to students in the CCSS until grade 3. The SOL introduce the concept of fractions in kindergarten.
    - Data collection does not begin in the CCSS until grade 3. The topic of data collection begins at the kindergarten level in the SOL.
    - Patterning is a fundamental topic that develops across the K-3 grade span in the SOL but does not begin in the CCSS until grade 3. The CCSS view the importance of connecting algebraic thinking with operations such as working with equal groups of objects to gain foundations for multiplication. The SOL also connect algebraic thinking with operations, but emphasize the use of patterning to build the basic foundations for multiplication as noted in both the *Curriculum Framework* and the *Sample Enhanced Scope and Sequence*.

- Probability is a topic that is introduced in grade 6 in the CCSS but begins at grade 3 in the SOL.

- While the CCSS K-4 content and learning progressions closely mirror the SOL, the learning progressions between grade 5 and Algebra I in the CCSS differ from the SOL progressions.
- Overall, the SOL for mathematics in kindergarten through grade 8 mirror the mathematics topics, content, and understandings identified in the CCSS document. The levels of rigor and cross-content connectedness in the *Standards of Learning*, *Curriculum Framework*, and the *Sample Enhanced Scope and Sequence* documents also mirror that of the CCSS document.

High School Mathematics

- By the time students complete high school mathematics SOL, they will have received the at least the same mathematical content found in the CCSS, but delivered through different learning progressions.
- The Common Core State Standards in high school mathematics are not presented in a format for each course, such as Algebra I, Geometry, Algebra II, etc. Rather, they are organized in the conceptual categories of:
  - Number and Quantity;
  - Algebra;
  - Functions;
  - Modeling (embedded within content and indicated with ⋆);
  - Geometry; and
  - Statistics and Probability.
- Model course sequences in a "traditional" sequence (Algebra I, Geometry, and Algebra II) and in a "integrated" sequence (Integrated 1, Integrated 2, Integrated 3) have been made available as an addendum to the CCSS.
- The CCSS specify mathematics standards that all students should study in order to be college and career ready. In addition, the CCSS include additional standards, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics. These CCSS standards are intended for students pursuing a career in science, technology, engineering, and mathematics (STEM) fields of study. Virginia embeds similar mathematics standards, those above the common core expectations for all students, within the *2009 Mathematics Standards of Learning* approved by the Virginia Board of Education.

- The *Mathematics Standards of Learning* have been externally validated by Achieve's American Diploma Project (ADP), The College Board, and ACT. A letter to the Virginia Department of Education from Laura Slover, vice president for content and policy research for Achieve, contained the following analysis: "The Virginia proposed revised *Mathematics Standards of Learning (SOL)* present student learning expectations that are intellectually demanding and generally well aligned with the ADP Benchmarks. If Virginia's students master the state standards, they will likely be well prepared for both workplace and college success." In the *Report on the Rigor and Alignment to College Readiness of the Virginia Mathematics Standards of Learning* (2007), the College Board says that "Virginia students who successfully complete a program of study aligned to the Virginia Standards will be prepared for the intellectual rigors they will encounter in college and in the workplace."

Kindergarten

CCSS for Mathematics – Kindergarten	Mathematics SOL
Counting and Cardinality K.CC	
Know number names and the count sequence.	
1. Count to 100 by ones and by tens.	**K.4 The student will** **a) count forward to 100 and backward from 10;** b) identify one more than a number and one less than a number; and **c) count by fives and tens to 100.**
2. Count forward beginning from a given number within the known sequence (instead of having to begin at 1).	**K.4 The student will** **a) count forward to 100 and backward from 10;** **b) identify one more than a number and one less than a number;** and c) count by fives and tens to 100.
3. Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).	**K.2 The student, given a set containing 15 or fewer concrete objects, will** **a) tell how many are in the set by counting the number of objects orally;** **b) write the numeral to tell how many are in the set; and** **c) select the corresponding numeral from a given set of numerals.** **1.1 The student will** a) count from 0 to 100 and write the corresponding numerals; and **b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.**
Count to tell the number of objects.	
4. Understand the relationship between numbers and quantities; connect counting to cardinality.	
a. When counting objects, say the number names in the standard	**K.1 The student, given two sets, each containing 10 or fewer concrete objects, will identify and describe one set as having**

CCSS for Mathematics – Kindergarten	Mathematics SOL
order, pairing each object with one and only one number name and each number name with one and only one object.	**more, fewer, or the same number of members as the other set, using the concept of one-to-one correspondence.** **K.1 CF** **• Match each member of one set with each member of another set, using the concept of one-to-one correspondence to compare the number of members between sets, where each set contains 10 or fewer objects.** **K.2 The student, given a set containing 15 or fewer concrete objects, will** **a) tell how many are in the set by counting the number of objects orally;** b) write the numeral to tell how many are in the set**;** and c) select the corresponding numeral from a given set of numerals.
b. Understand that the last number name said tells the number of objects counted. The number of objects is the same regardless of their arrangement or the order in which they were counted.	**K.2 The student, given a set containing 15 or fewer concrete objects, will** **a) tell how many are in the set by counting the number of objects orally;** b) write the numeral to tell how many are in the set; and c) select the corresponding numeral from a given set of numerals. **K.2 CF** **• *Conservation of number* and *cardinality principle* are two important milestones in development to attaching meaning to counting.** **• The cardinality principle refers to the concept that the last counted number describes the total amount of the counted set. It is an extension of one-to-one correspondence.**
c. Understand that each successive number name refers to a	**K.4 The student will**

CCSS for Mathematics – Kindergarten	Mathematics SOL
quantity that is one larger.	a) count forward to 100 and backward from 10; **b) identify one more than a number and one less than a number;** and c) count by fives and tens to 100.
5. Count to answer "how many?" questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1–20, count out that many objects.	**K.2 The student, given a set containing 15 or fewer concrete objects, will** **a) tell how many are in the set by counting the number of objects orally;** **b) write the numeral to tell how many are in the set; and** **c) select the corresponding numeral from a given set of numerals.**
Compare numbers.	
6. Identify whether the number of objects in one group is greater than, less than, or equal to the number of objects in another group, e.g., by using matching and counting strategies.	**K.1 The student, given two sets, each containing 10 or fewer concrete objects, will identify and describe one set as having more, fewer, or the same number of members as the other set, using the concept of one-to-one correspondence.**
7. Compare two numbers between 1 and 10 presented as written numerals.	**K.2 The student, given a set containing 15 or fewer concrete objects, will** **a) tell how many are in the set by counting the number of objects orally;** **b) write the numeral to tell how many are in the set; and** **c) select the corresponding numeral from a given set of numerals.**
Operations and Algebraic Thinking K.OA	
Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.	
1. Represent addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.	**K.6 The student will model adding and subtracting whole numbers, using up to 10 concrete objects.**

CCSS for Mathematics – Kindergarten	Mathematics SOL
2. Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem.	**K.6 The student will model adding and subtracting whole numbers, using up to 10 concrete objects.** **1.6 The student will create and solve one-step story and picture problems using basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
3. Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g., 5 = 2 + 3 and 5 = 4 + 1).	**K.6 The student will model adding and subtracting whole numbers, using up to 10 concrete objects.** **1.18 The student will demonstrate an understanding of equality through the use of the equal sign.** **1.18 CF** **• Model an equation that represents the relationship of two expressions of equal value.**
4. For any number from 1 to 9, find the number that makes 10 when added to the given number, e.g., by using objects or drawings, and record the answer with a drawing or equation.	**K.6 The student will model adding and subtracting whole numbers, using up to 10 concrete objects.** **1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
5. Fluently add and subtract within 5.	**1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
Number and Operations in Base Ten K.NBT	
Work with numbers 11–19 to gain foundations for place value.	
1. Compose and decompose numbers from 11 to 19 into ten ones and some further ones, e.g., by using objects or drawings, and record each composition or decomposition by a drawing or equation (e.g., 18 = 10 + 8); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.	**1.1 The student will** a) count from 0 to 100 and write the corresponding numerals; and **b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.** **1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
Measurement and Data K.MD	

CCSS for Mathematics – Kindergarten	Mathematics SOL
Describe and compare measurable attributes.	
1. Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.	**K.8 The student will identify the instruments used to measure length (ruler), weight (scale), time (clock: digital and analog; calendar: day, month, and season), and temperature (thermometer).** **K.10 The student will compare two objects or events, using direct comparisons or nonstandard units of measure, according to one or more of the following attributes: length (shorter, longer), height (taller, shorter), weight (heavier, lighter), temperature (hotter, colder). Examples of nonstandard units include foot length, hand span, new pencil, paper clip, and block.**
2. Directly compare two objects with a measurable attribute in common, to see which object has "more of"/"less of" the attribute, and describe the difference. *For example, directly compare the heights of two children and describe one child as taller/shorter.*	**K.10 The student will compare two objects or events, using direct comparisons or nonstandard units of measure, according to one or more of the following attributes: length (shorter, longer), height (taller, shorter), weight (heavier, lighter), temperature (hotter, colder). Examples of nonstandard units include foot length, hand span, new pencil, paper clip, and block.**
Classify objects and count the number of objects in each category.	
3. Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.	**K.15 The student will sort and classify objects according to attributes.**
Geometry K.G	
Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).	
1. Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as *above*, *below*, *beside*, *in front of*, *behind*, and *next to*.	**K.12 The student will describe the location of one object relative to another (above, below, next to) and identify representations of plane geometric figures (circle, triangle,**

CCSS for Mathematics – Kindergarten	Mathematics SOL
	square, and rectangle) regardless of their positions and orientations in space.
2. Correctly name shapes regardless of their orientations or overall size.	**K.11 The student will** **a) identify, describe, and trace plane geometric figures (circle, triangle, square, and rectangle); and** b) compare the size (larger, smaller) and shape of plane geometric figures (circle, triangle, square, and rectangle).
3. Identify shapes as two-dimensional (lying in a plane, "flat") or three dimensional ("solid").	**K.11 The student will** **a) identify, describe, and trace plane geometric figures (circle, triangle, square, and rectangle**); and b) compare the size (larger, smaller) and shape of plane geometric figures (circle, triangle, square, and rectangle). **2.16 The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).**
Analyze, compare, create, and compose shapes.	
4. Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length).	**K.15 The student will sort and classify objects according to attributes.** **K.11 The student will** **a) identify, describe, and trace plane geometric figures (circle, triangle, square, and rectangle); and** **b) compare the size (larger, smaller) and shape of plane geometric figures (circle, triangle, square, and rectangle).** **1.12 The student will identify and trace, describe, and sort plane geometric figures (triangle, square, rectangle, and circle) according to number of sides, vertices, and right angles.** 2.16 The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).

CCSS for Mathematics – Kindergarten	Mathematics SOL
5. Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.	**1.13 The student will construct, model, and describe objects in the environment as geometric shapes (triangle, rectangle, square, and circle) and explain the reasonableness of each choice.**
6. Compose simple shapes to form larger shapes. *For example, "Can you join these two triangles with full sides touching to make a rectangle?"*	**1.13 The student will construct, model, and describe objects in the environment as geometric shapes (triangle, rectangle, square, and circle) and explain the reasonableness of each choice.**

Mathematics SOL for kindergarten aligned with the CCSS at other grade levels	
Grade 2 – Measurement and Data 8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. *Example: If you have 2 dimes and 3 pennies, how many cents do you have?*	**K.7 The student will recognize a penny, nickel, dime, and quarter and will determine the value of a collection of pennies and/or nickels whose total value is 10 cents or less.**
Grade 1 – Measurement and Data 3. Tell and write time in hours and half-hours using analog and digital clocks.	**K.9 The student will tell time to the hour, using analog and digital clocks.**
Grade 2 – Measurement and Data 10. Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put together, take-apart, and compare problems using information presented in a bar graph. Grade 3 – Measurement and Data 3. Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a*	**K.14 The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.**

Mathematics SOL for kindergarten aligned with the CCSS at other grade levels	
bar graph in which each square in the bar graph might represent 5 pets.	
Grade 3 – Operations and Algebraic Thinking 9. Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. *For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.* Grade 4 – Operations and Algebraic Thinking 5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. *For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.*	**K.16 The student will identify, describe, and extend repeating patterns.**

Mathematics SOL for kindergarten not explicitly stated in the CCSS at any grade level	
	K.3 The student, given an ordered set of ten objects and/or pictures, will indicate the ordinal position of each object, first through tenth, and the ordered position of each object.
	K.5 The student will identify the parts of a set and/or region that represent fractions for halves and fourths.
	K.13 The student will gather data by counting and tallying.

Grade 1

CCSS for Mathematics – Grade 1	Mathematics SOL
Operations and Algebraic Thinking 1.OA	
Represent and solve problems involving addition and subtraction.	
1. Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.	**1.6 The student will create and solve one-step story and picture problems using basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
2. Solve word problems that call for addition of three whole numbers whose sum is less than or equal to 20, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.	**1.6 The student will create and solve one-step story and picture problems using basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
Understand and apply properties of operations and the relationship between addition and subtraction.	
3. Apply properties of operations as strategies to add and subtract. *Examples: If 8 + 3 = 11 is known, then 3 + 8 = 11 is also known. (Commutative property of addition.) To add 2 + 6 + 4, the second two numbers can be added to make a ten, so 2 + 6 + 4 = 2 + 10 = 12. (Associative property of addition.)*	**1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
4. Understand subtraction as an unknown-addend problem. *For example, subtract 10 – 8 by finding the number that makes 10 when added to 8.*	**1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
Add and subtract within 20.	
5. Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).	**1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**
6. Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., 8 + 6 = 8 + 2 + 4 = 10 + 4 = 14); decomposing a number leading to a ten (e.g., 13 – 4 = 13 – 3 – 1	**1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.**

CCSS for Mathematics – Grade 1	Mathematics SOL
= 10 – 1 = 9); using the relationship between addition and subtraction (e.g., knowing that 8 + 4 = 12, one knows 12 – 8 = 4); and creating equivalent but easier or known sums (e.g., adding 6 + 7 by creating the known equivalent 6 + 6 + 1 = 12 + 1 = 13).	
Work with addition and subtraction equations.	
7. Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. *For example, which of the following equations are true and which are false? 6 = 6, 7 = 8 – 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2.*	**1.18 The student will demonstrate an understanding of equality through the use of the equal sign.** **2.22 The student will demonstrate an understanding of equality by recognizing that the symbol = in an equation indicates equivalent quantities and the symbol ≠ indicates that quantities are not equivalent.**
8. Determine the unknown whole number in an addition or subtraction equation relating to three whole numbers. *For example, determine the unknown number that makes the equation true in each of the equations 8 + ? = 11, 5 = □ – 3, 6 + 6 = □.*	**1.5 The student will recall basic addition facts with sums to 18 or less and the corresponding subtraction facts.** **1.18 The student will demonstrate an understanding of equality through the use of the equal sign.**
Number and Operations in Base Ten 1.NBT	
Extend the counting sequence.	
1. Count to 120, starting at any number less than 120. In this range, read and write numerals and represent a number of objects with a written numeral.	**1.1 The student will** **a) count from 0 to 100 and write the corresponding numerals**; and b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.
Understand place value.	

CCSS for Mathematics – Grade 1	Mathematics SOL
2. Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases: a. 10 can be thought of as a bundle of ten ones — called a "ten." b. The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones. c. The numbers 10, 20, 30, 40, 50, 60, 70, 80, 90 refer to one, two, three, four, five, six, seven, eight, or nine tens (and 0 ones).	**K.4 The student will** a) count forward to 100 and backward from 10; b) identify one more than a number and one less than a number; and **c) count by fives and tens to 100.** **1.1 The student will** a) count from 0 to 100 and write the corresponding numerals; and **b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.**
3. Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols >, =, and <.	**2.1 The student will** a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models; b) round two-digit numbers to the nearest ten; and **c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).**
Use place value understanding and properties of operations to add and subtract.	
4. Add within 100, including adding a two-digit number and a one-digit number, and adding a two-digit number and a multiple of 10, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. Understand that in adding two-digit numbers, one adds tens and tens, ones and ones; and sometimes it is necessary to compose a ten.	**2.6 The student, given two whole numbers whose sum is 99 or less, will** **a) estimate the sum; and** **b) find the sum, using various methods of calculation.**
5. Given a two-digit number, mentally find 10 more or 10 less	**1.1 The student will**

CCSS for Mathematics – Grade 1	Mathematics SOL
than the number, without having to count; explain the reasoning used.	**a) count from 0 to 100 and write the corresponding numerals; and** **b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.** **1.2 The student will count forward by ones, twos, fives, and tens to 100 and backward by ones from 30.**
6. Subtract multiples of 10 in the range 10-90 from multiples of 10 in the range 10-90 (positive or zero differences), using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.	**1.1 The student will** **a) count from 0 to 100 and write the corresponding numerals; and** **b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value.** **1.2 The student will count forward by ones, twos, fives, and tens to 100 and backward by ones from 30.**
Measurement and Data 1.MD	
Measure lengths indirectly and by iterating length units.	
1. Order three objects by length; compare the lengths of two objects indirectly by using a third object.	**K.10 The student will compare two objects or events, using direct comparisons or nonstandard units of measure, according to one or more of the following attributes: length (shorter, longer), height (taller, shorter), weight (heavier, lighter), temperature (hotter, colder). Examples of nonstandard units include foot length, hand span, new pencil, paper clip, and block.** **1.9 The student will use nonstandard units to measure length, weight/mass, and volume.**
2. Express the length of an object as a whole number of length units, by laying multiple copies of a shorter object (the length unit) end to end; understand that the length measurement of an	**1.9 The student will use nonstandard units to measure length, weight/mass, and volume.**

CCSS for Mathematics – Grade 1	Mathematics SOL
object is the number of same-size length units that span it with no gaps or overlaps. *Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.*	
Tell and write time.	
3. Tell and write time in hours and half-hours using analog and digital clocks.	**K.9 The student will tell time to the hour, using analog and digital clocks.** **1.8 The student will tell time to the half-hour, using analog and digital clocks.**
Represent and interpret data.	
4. Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.	**K.14 The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.** **1.15 The student will interpret information displayed in a picture or object graph, using the vocabulary *more, less, fewer, greater than, less than,* and *equal to*.**
Geometry 1.G	
Reason with shapes and their attributes.	
1. Distinguish between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size) ; build and draw shapes to possess defining attributes.	**K.15 The student will sort and classify objects according to attributes.** **1.12 The student will identify and trace, describe, and sort plane geometric figures (triangle, square, rectangle, and circle) according to number of sides, vertices, and right angles.** **1.16 The student will sort and classify concrete objects according to one or more attributes, including color, size, shape, and thickness.**
2. Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right	**5.13 The student, using plane figures (square, rectangle, triangle, parallelogram, rhombus, and trapezoid), will** **a) develop definitions of these plane figures; and**

CCSS for Mathematics – Grade 1	Mathematics SOL
circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.	**b) investigate and describe the results of combining and subdividing plane figures.**
3. Partition circles and rectangles into two and four equal shares, describe the shares using the words *halves*, *fourths*, and *quarters*, and use the phrases *half of*, *fourth of*, and *quarter of*. Describe the whole as two of, or four of the shares. Understand for these examples that decomposing into more equal shares creates smaller shares.	**K.5 The student will identify the parts of a set and/or region that represent fractions for halves and fourths.** **1.3 The student will identify the parts of a set and/or region that represent fractions for halves, thirds, and fourths and write the fractions.**

Mathematics SOL for grade 1 aligned with the CCSS at other grade levels	
Grade 2 – Measurement and Data 8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. *Example: If you have 2 dimes and 3 pennies, how many cents do you have?*	**1.7 The student will** **a) identify the number of pennies equivalent to a nickel, a dime, and a quarter; and** **b) determine the value of a collection of pennies, nickels, and dimes whose total value is 100 cents or less.**
Grade 3 – Measurement and Data 2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	**1.10 The student will compare, using the concepts of more, less, and equivalent,** **a) the volumes of two given containers; and** **b) the weight/mass of two objects, using a balance scale.**
Kindergarten – Geometry 4. Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/"corners") and other attributes (e.g., having sides of equal length).	**1.12 The student will identify and trace, describe, and sort plane geometric figures (triangle, square, rectangle, and circle) according to number of sides, vertices, and right angles.**
Kindergarten – Geometry	**1.13 The student will construct, model, and describe objects in**

Mathematics SOL for grade 1 aligned with the CCSS at other grade levels	
5. Model shapes in the world by building shapes from components (e.g. sticks and clay balls) and drawing shapes. 6. Compose simple shapes to form larger shapes. *For example, "Can you join these two triangles with full sides touching to make a rectangle?"*	**the environment as geometric shapes (triangle, rectangle, square, and circle) and explain the reasonableness of each choice.**
Grade 2 – Measurement and Data 10. Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put together, take-apart, and compare problems using information presented in a bar graph. Grade 3 – Measurement and Data 3. Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*	**1.14 The student will investigate, identify, and describe various forms of data collection (e.g., recording daily temperature, lunch count, attendance, favorite ice cream), using tables, picture graphs, and object graphs.**
Grade 3 – Operations and Algebraic Thinking 9. Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. *For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.* Grade 4 – Operations and Algebraic Thinking 5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. *For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and*	**1.17 The student will recognize, describe, extend, and create a wide variety of growing and repeating patterns.**

Mathematics SOL for grade 1 aligned with the CCSS at other grade levels	
even numbers. Explain informally why the numbers will continue to alternate in this way.	

Mathematics SOL for grade 1 not explicitly stated in the CCSS at any grade level	
	1.4 The student, given a familiar problem situation involving magnitude, will **a) select a reasonable order of magnitude from three given quantities: a one-digit numeral, a two-digit numeral, and a three-digit numeral (e.g., 5, 50, 500); and** **b) explain the reasonableness of the choice.**
	1.11 The student will use calendar language appropriately (e.g., names of the months, *today, yesterday, next week, last week*).

Grade 2

CCSS for Mathematics – Grade 2	Mathematics SOL
Operations and Algebraic Thinking 2.OA	
Represent and solve problems involving addition and subtraction.	
1. Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.	**2.6 The student, given two whole numbers whose sum is 99 or less, will** a) estimate the sum; and **b) find the sum, using various methods of calculation.** **2.7 The student, given two whole numbers, each of which is 99 or less, will** a) estimate the difference; and **b) find the difference, using various methods of calculation.** **2.8 The student will create and solve one- and two-step addition and subtraction problems, using data from simple tables, picture graphs, and bar graphs.**
Add and subtract within 20.	
2. Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.	**2.5 The student will recall addition facts with sums to 20 or less and the corresponding subtraction facts.**
Work with equal groups of objects to gain foundations for multiplication.	
3. Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.	**2.4 The student will** a) count forward by twos, fives, and tens to 100, starting at various multiples of 2, 5, or 10; b) count backward by tens from 100; and **c) recognize even and odd numbers.** **2.4 CF** • **Use objects to determine whether a number is odd or even.** **5.3 The student will** a) identify and describe the characteristics of prime and composite

CCSS for Mathematics – Grade 2	Mathematics SOL
	numbers; and **b) identify and describe the characteristics of even and odd numbers.** **5.17 The student will describe the relationship found in a number pattern and express the relationship.**
4. Use addition to find the total number of objects arranged in rectangular arrays with up to 5 rows and up to 5 columns; write an equation to express the total as a sum of equal addends.	**2.4 The student will** **a) count forward by twos, fives, and tens to 100, starting at various multiples of 2, 5, or 10;** b) count backward by tens from 100; and c) recognize even and odd numbers. **2.4 CF** • **Skip counting by fives lays the foundation for** reading a clock effectively and telling time to the nearest five minutes, counting money, and **developing the multiplication facts for five.** • **Skip counting by tens is a precursor for** use of place value, addition, counting money, and **multiplying by multiples of 10.** **3.5 The student will recall multiplication facts through the twelves table, and the corresponding division facts.** **3.5 CF** • **Understand that multiplication is repeated addition. The array model, consisting of rows and columns (e.g., 3 rows of 4 columns for a 3- by-4 array) helps build the commutative property.**
Number and Operations in Base Ten 2.NBT	
Understand place value.	
1. Understand that the three digits of a three-digit number represent amounts of hundreds, tens, and ones; e.g., 706 equals 7 hundreds, 0 tens, and 6 ones. Understand the following as special cases:	

CCSS for Mathematics – Grade 2	Mathematics SOL
a. 100 can be thought of as a bundle of ten tens — called a "hundred."	**2.1 The student will** **a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models;** b) round two-digit numbers to the nearest ten; and c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).
b. The numbers 100, 200, 300, 400, 500, 600, 700, 800, 900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones).	
2. Count within 1000; skip-count by 5s, 10s, and 100s.	**2.4 The student will** **a) count forward by twos, fives, and tens to 100, starting at various multiples of 2, 5, or 10;** **b) count backward by tens from 100**; and c) recognize even and odd numbers.
3. Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.	**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*).
4. Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using >, =, and < symbols to record the results of comparisons.	**2.1 The student will** a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models; b) round two-digit numbers to the nearest ten; and **c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).**
Use place value understanding and properties of operations to add and subtract.	
5. Fluently add and subtract within 100 using strategies based	**2.6 The student, given two whole numbers whose sum is 99 or**

CCSS for Mathematics – Grade 2	Mathematics SOL
on place value, properties of operations, and/or the relationship between addition and subtraction.	**less, will** a) estimate the sum; and **b) find the sum, using various methods of calculation.** **2.7 The student, given two whole numbers, each of which is 99 or less, will** a) estimate the difference; and **b) find the difference, using various methods of calculation.** **2.9 The student will recognize and describe the related facts that represent and describe the inverse relationship between addition and subtraction.**
6. Add up to four two-digit numbers using strategies based on place value and properties of operations.	**2.6 The student, given two whole numbers whose sum is 99 or less, will** a) estimate the sum; and **b) find the sum, using various methods of calculation.**
7. Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds.	**2.6 The student, given two whole numbers whose sum is 99 or less, will** a) estimate the sum; and **b) find the sum, using various methods of calculation.** **2.7 The student, given two whole numbers, each of which is 99 or less, will** a) estimate the difference; and **b) find the difference, using various methods of calculation.** **2.8 The student will create and solve one- and two-step addition and subtraction problems, using data from simple tables, picture graphs, and bar graphs.** **2.8 CF** • **Develop strategies for solving practical problems.**
8. Mentally add 10 or 100 to a given number 100–900, and mentally subtract 10 or 100 from a given number 100–900.	**1.1 The student will** **a) count from 0 to 100 and write the corresponding numerals; and**

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	b) group a collection of up to 100 objects into tens and ones and write the corresponding numeral to develop an understanding of place value. **2.4 The student will** **a) count forward by twos, fives, and tens to 100, starting at various multiples of 2, 5, or 10;** **b) count backward by tens from 100; and** **c) recognize even and odd numbers.** **Grades K-3 CF** **Although young children first compute using objects and manipulatives, they gradually shift to performing computations mentally or using paper and pencil to record their thinking. Therefore, computation and estimation instruction in the early grades revolves around modeling, discussing, and recording a variety of problem situations. This approach helps students transition from the concrete to the representation to the symbolic in order to develop meaning for the operations and how they relate to each other.** **2.4 CF** **• Skip count by twos, fives, and tens to 100, using manipulatives, a hundred chart, mental mathematics, a calculator, and/or paper and pencil.** **2.6 CF** **• Strategies for mentally adding two-digit numbers include student-invented strategies, making-ten, partial sums, and counting on, among others.** **– partial sums: 56 + 41 = __** **50 + 40 = 90** **6 + 1 = 7**

CCSS for Mathematics – Grade 2	Mathematics SOL
	90 + 7 = 97 **– counting on: 36 + 62 = __** **36 + 60 = 96** **96 + 2 = 98** **2.7 CF** **• Mental computational strategies for subtracting two-digit numbers might include** **– lead-digit or front-end strategy:** **56 – 21 = __** **50 – 20 = 30** **6 – 1 = 5** **30 + 5 = 35** **– counting up:** **87 – 25 = __** **20 + 60 = 80** **5 + 2 = 7** **60 + 2 = 62** **or** **87 – 25 = __** **25 + 60 = 85** **85 + 2 = 87** **60 + 2 = 62** **or** **87 – 25 = __** **25 + 2 = 27** **27 + 60 = 87** **2 + 60 = 62** **– partial differences:** **98 – 41 = __**

CCSS for Mathematics – Grade 2	Mathematics SOL
	90 – 40 = 50 **8 – 1 = 7** **50 + 7 = 57.**
9. Explain why addition and subtraction strategies work, using place value and the properties of operations.	**2.9 The student will recognize and describe the related facts that represent and describe the inverse relationship between addition and subtraction.** **2.21 The student will solve problems by completing numerical sentences involving the basic facts for addition and subtraction. The student will create story problems, using the numerical sentences.** **2.21 CF** **• Understand various meanings of addition and subtraction and the relationship between the two operations.**
Measurement and Data 2.MD	
Measure and estimate lengths in standard units.	
1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.	**2.11 The student will estimate and measure** **a) length to the nearest centimeter and inch;** b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and c) liquid volume in cups, pints, quarts, gallons, and liters.
2. Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.	**2.11 The student will estimate and measure** **a) length to the nearest centimeter and inch;** b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and c) liquid volume in cups, pints, quarts, gallons, and liters.
3. Estimate lengths using units of inches, feet, centimeters, and meters.	**2.11 The student will estimate and measure** **a) length to the nearest centimeter and inch;** b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and

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	c) liquid volume in cups, pints, quarts, gallons, and liters. **3.9 The student will estimate and use U.S. Customary and metric units to measure** **a) length to the nearest 12 inch, inch, foot, yard, centimeter, and meter;** b) liquid volume in cups, pints, quarts, gallons, and liters; c) weight/mass in ounces, pounds, grams, and kilograms; and d) area and perimeter.
4. Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.	**2.11 The student will estimate and measure** **a) length to the nearest centimeter and inch;** b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and c) liquid volume in cups, pints, quarts, gallons, and liters.
Relate addition and subtraction to length.	
5. Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem.	**2.6 The student, given two whole numbers whose sum is 99 or less, will** a) estimate the sum; and **b) find the sum, using various methods of calculation.** **2.7 The student, given two whole numbers, each of which is 99 or less, will** a) estimate the difference; and **b) find the difference, using various methods of calculation.** **2.8 The student will create and solve one- and two-step addition and subtraction problems, using data from simple tables, picture graphs, and bar graphs.**
6. Represent whole numbers as lengths from 0 on a number line diagram with equally spaced points corresponding to the numbers 0, 1, 2, ..., and represent whole-number sums and differences within 100 on a number line diagram.	**2.6 The student, given two whole numbers whose sum is 99 or less, will** a) estimate the sum; and **b) find the sum, using various methods of calculation.**

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	2.7 The student, given two whole numbers, each of which is 99 or less, will a) estimate the difference; and **b) find the difference, using various methods of calculation.**
Work with time and money.	
7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.	**2.12 The student will tell and write time to the nearest five minutes, using analog and digital clocks.**
8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately. *Example: If you have 2 dimes and 3 pennies, how many cents do you have?*	**K.7 The student will recognize a penny, nickel, dime, and quarter and will determine the value of a collection of pennies and/or nickels whose total value is 10 cents or less.** **1.7 The student will** **a) identify the number of pennies equivalent to a nickel, a dime, and a quarter; and** **b) determine the value of a collection of pennies, nickels, and dimes whose total value is 100 cents or less.** **2.10 The student will** **a) count and compare a collection of pennies, nickels, dimes, and quarters whose total value is $2.00 or less; and** **b) correctly use the cent symbol (¢), dollar symbol ($), and decimal point (.).**
Represent and interpret data.	
9. Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.	**3.17 The student will** a) collect and organize data, using observations, measurements, surveys, or experiments; **b) construct a line plot, a picture graph, or a bar graph to represent the data; and** **c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.**

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10. Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put together, take-apart, and compare problems using information presented in a bar graph.	**K.14 The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.** **1.14 The student will investigate, identify, and describe various forms of data collection (e.g., recording daily temperature, lunch count, attendance, favorite ice cream), using tables, picture graphs, and object graphs.** **1.15 The student will interpret information displayed in a picture or object graph, using the vocabulary *more, less, fewer, greater than, less than,* and *equal to*.** **2.17 The student will use data from experiments to construct picture graphs, pictographs, and bar graphs.** **2.19 The student will analyze data displayed in picture graphs, pictographs, and bar graphs.**
Geometry 2.G	
Reason with shapes and their attributes.	
1. Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.	**2.16 The student will identify, describe, compare, and contrast plane and solid geometric figures (circle/sphere, square/cube, and rectangle/rectangular prism).** **2.16 CF** **• Trace faces of solid figures (e.g., cube and rectangular solid) to create the set of plane figures related to the solid figure.** **• Identify and describe plane and solid figures (e.g., circle/sphere, square/cube, and rectangle/rectangular prism), according to the number and shape of their faces, edges, and vertices using models.** **• Compare and contrast plane and solid geometric figures (e.g., circle/sphere, square/cube, and rectangle/rectangular prism) according to the number and shape of their faces, edges,**

CCSS for Mathematics – Grade 2	Mathematics SOL
	vertices, and angles.
2. Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.	**2.3 The student will** **a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths;** b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths. **3.9 The student will estimate and use U.S. Customary and metric units to measure** a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter; b) liquid volume in cups, pints, quarts, gallons, and liters; c) weight/mass in ounces, pounds, grams, and kilograms; and **d) area and perimeter.** **3.10 The student will** a) measure the distance around a polygon in order to determine perimeter; and **b) count the number of square units needed to cover a given surface in order to determine area.**
3. Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words *halves*, *thirds*, *half of*, *a third of*, etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.	**2.3 The student will** **a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths;** b) write the fractions; and **c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.**

Mathematics SOL for grade 2 aligned with the CCSS at other grade levels	
Grade 3 – Operations and Algebraic Thinking 8. Solve two-step word problems using the four operations. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.	**2.1 The student will** a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models; **b) round two-digit numbers to the nearest ten; and** c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*).
Grade 3 – Measurement and Data 2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	**2.11 The student will estimate and measure** a) length to the nearest centimeter and inch; **b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and** **c) liquid volume in cups, pints, quarts, gallons, and liters.**
Grade 6 – Number System 5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.	**2.14 The student will read the temperature on a Celsius and/or Fahrenheit thermometer to the nearest 10 degrees.**
Grade 4 – Geometry 3. Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the line into matching parts. Identify line-symmetric figures and draw lines of symmetry.	**2.15 The student will** **a) draw a line of symmetry in a figure; and** **b) identify and create figures with at least one line of symmetry.**
Grade 3 – Operations and Algebraic Thinking 9. Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using	**2.20 The student will identify, create, and extend a wide variety of patterns.**

Mathematics SOL for grade 2 aligned with the CCSS at other grade levels	
properties of operations. *For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.* Grade 4 – Operations and Algebraic Thinking 5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. *For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.*	
Grade 1 – Operations and Algebraic Thinking 7. Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. *For example, which of the following equations are true and which are false? 6 = 6, 7 = 8 – 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2.*	**2.22 The student will demonstrate an understanding of equality by recognizing that the symbol = in an equation indicates equivalent quantities and the symbol ≠ indicates that quantities are not equivalent.**

Mathematics SOL for grade 2 not explicitly stated in the CCSS at any grade level	
	2.2 The student will **a) identify the ordinal positions first through twentieth, using an ordered set of objects; and** **b) write the ordinal numbers.**
	2.3 The student will a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths; **b) write the fractions; and** c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths.
	2.6 The student, given two whole numbers whose sum is 99 or

Mathematics SOL for grade 2 not explicitly stated in the CCSS at any grade level	
	less, will **a) estimate the sum; and** b) find the sum, using various methods of calculation.
	2.7 The student, given two whole numbers, each of which is 99 or less, will **a) estimate the difference; and** b) find the difference, using various methods of calculation.
	2.13 The student will **a) determine past and future days of the week; and** **b) identify specific days and dates on a given calendar.**
	2.18 The student will use data from experiments to predict outcomes when the experiment is repeated.

Grade 3

CCSS for Mathematics – Grade 3	Mathematics SOL
Operations and Algebraic Thinking 3.OA	
Represent and solve problems involving multiplication and division.	
1. Interpret products of whole numbers, e.g., interpret 5 × 7 as the total number of objects in 5 groups of 7 objects each. *For example, describe a context in which a total number of objects can be expressed as 5 × 7.*	**3.5 The student will recall multiplication facts through the twelves table, and the corresponding division facts.** **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.**
2. Interpret whole-number quotients of whole numbers, e.g., interpret 56 ÷ 8 as the number of objects in each share when 56 objects are partitioned equally into 8 shares, or as a number of shares when 56 objects are partitioned into equal shares of 8 objects each. *For example, describe a context in which a number of shares or a number of groups can be expressed as 56 ÷ 8.*	**3.5 The student will recall multiplication facts through the twelves table, and the corresponding division facts.** **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.**
3. Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.	**3.2 The student will recognize and use the inverse relationships between addition/subtraction and multiplication/division to complete basic fact sentences. The student will use these relationships to solve problems.** **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.**
4. Determine the unknown whole number in a multiplication or division equation relating three whole numbers. *For example, determine the unknown number that makes the equation true*	**3.2 The student will recognize and use the inverse relationships between addition/subtraction and multiplication/division to complete basic fact sentences.**

CCSS for Mathematics – Grade 3	Mathematics SOL
in each of the equations 8 × ? = 48, 5 = □÷ 3, 6 × 6 = ?.	**The student will use these relationships to solve problems.**
Understand properties of multiplication and the relationship between multiplication and division.	
5. Apply properties of operations as strategies to multiply and divide. *Examples: If 6 × 4 = 24 is known, then 4 × 6 = 24 is also known. (Commutative property of multiplication.) 3 × 5 × 2 can be found by 3 × 5 = 15, then 15 × 2 = 30, or by 5 × 2 = 10, then 3 × 10 = 30. (Associative property of multiplication.) Knowing that 8 × 5 = 40 and 8 × 2 = 16, one can find 8 × 7 as 8 × (5 + 2) = (8 × 5) + (8 × 2) = 40 + 16 = 56. (Distributive property.)*	**3.20 The student will** **a) investigate the identity and the commutative properties for addition and multiplication; and** **b) identify examples of the identity and commutative properties for addition and multiplication.** **4.16 The student will** a) recognize and demonstrate the meaning of equality in an equation; and **b) investigate and describe the associative property for addition and multiplication.** **5.19 The student will investigate and recognize the distributive property of multiplication over addition.**
6. Understand division as an unknown-factor problem. *For example, find 32 ÷ 8 by finding the number that makes 32 when multiplied by 8.*	**3.2 The student will recognize and use the inverse relationships between addition/subtraction and multiplication/division to complete basic fact sentences. The student will use these relationships to solve problems.**
Multiply and divide within 100.	
7. Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that 8 × 5 = 40, one knows 40 ÷ 5 = 8) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.	**3.2 The student will recognize and use the inverse relationships between addition/subtraction and multiplication/division to complete basic fact sentences. The student will use these relationships to solve problems.** **3.5 The student will recall multiplication facts through the twelves table, and the corresponding division facts.**
Solve problems involving the four operations, and identify and explain patterns in arithmetic.	
8. Solve two-step word problems using the four operations.	**2.1 The student will**

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Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.	a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models; **b) round two-digit numbers to the nearest ten; and** c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*). **3.4 The student will estimate solutions to and solve single-step and multistep problems involving the sum or difference of two whole numbers, each 9,999 or less, with or without regrouping.** **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.** **4.4 The student will** **a) estimate sums, differences, products, and quotients of whole numbers;** **b) add, subtract, and multiply whole numbers;** **c) divide whole numbers, finding quotients with and without remainders; and** **d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.** **5.18 The student will** a) investigate and describe the concept of variable; **b) write an open sentence to represent a given mathematical relationship, using a variable;** c) model one-step linear equations in one variable, using addition and subtraction; and d) create a problem situation based on a given open sentence, using a single variable.
9. Identify arithmetic patterns (including patterns in the	**K.16 The student will identify, describe, and extend repeating**

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addition table or multiplication table), and explain them using properties of operations. *For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.*	**patterns.** **1.17 The student will recognize, describe, extend, and create a wide variety of growing and repeating patterns.** **2.20 The student will identify, create, and extend a wide variety of patterns.** **3.19 The student will recognize and describe a variety of patterns formed using numbers, tables, and pictures, and extend the patterns, using the same or different forms.**
Number and Operations in Base Ten 3.NBT	
Use place value understanding and properties of operations to perform multi-digit arithmetic.	
1. Use place value understanding to round whole numbers to the nearest 10 or 100.	**2.1 The student will** a) read, write, and identify the place value of each digit in a three-digit numeral, using numeration models; **b) round two-digit numbers to the nearest ten**; and c) compare two whole numbers between 0 and 999, using symbols (>, <, or =) and words (*greater than, less than,* or *equal to*). **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*).
2. Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.	**3.4 The student will estimate solutions to and solve single-step and multistep problems involving the sum or difference of two whole numbers, each 9,999 or less, with or without regrouping.**
3. Multiply one-digit whole numbers by multiples of 10 in the	**3.5 The student will recall multiplication facts through the**

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range 10–90 (e.g., 9 × 80, 5 × 60) using strategies based on place value an properties of operations.	**twelves table, and the corresponding division facts.** **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.** **3.19 The student will recognize and describe a variety of patterns formed using numbers, tables, and pictures, and extend the patterns, using the same or different forms.**
Number and Operations—Fractions 3.NF	
Develop understanding of fractions as numbers.	
1. Understand a fraction 1/*b* as the quantity formed by 1 part when a whole is partitioned into *b* equal parts; understand a fraction *a*/*b* as the quantity formed by *a* parts of size 1/*b*.	**K.5 The student will identify the parts of a set and/or region that represent fractions for halves and fourths.** **1.3 The student will identify the parts of a set and/or region that represent fractions for halves, thirds, and fourths and write the fractions.** **2.3 The student will** **a) identify the parts of a set and/or region that represent fractions for halves, thirds, fourths, sixths, eighths, and tenths;** b) write the fractions; and c) compare the unit fractions for halves, thirds, fourths, sixths, eighths, and tenths. **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 =).
2. Understand a fraction as a number on the number line;	

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represent fractions on a number line diagram.	
a. Represent a fraction 1/*b* on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into *b* equal parts. Recognize that each part has size 1/*b* and that the endpoint of the part based at 0 locates the number 1/*b* on the number line.	**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 =). **3.3 CF** **• A fraction is a way of representing part of a whole (as in a region/area model or a length/measurement model) or part of a group (as in a set model). Fractions are used to name a part of one thing or a part of a collection of things. Models can include pattern blocks, fraction bars, rulers, number line, etc.**
b. Represent a fraction *a*/*b* on a number line diagram by marking off *a* lengths 1/*b* from 0. Recognize that the resulting interval has size *a*/*b* and that its endpoint locates the number *a*/*b* on the number line.	**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 =). **3.3 CF** **• A fraction is a way of representing part of a whole (as in a region/area model or a length/measurement model) or part of a group (as in a set model). Fractions are used to name a part of one thing or a part of a collection of things. Models can include pattern blocks, fraction bars, rulers, number line, etc.**
3. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.	

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a. Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line.	**4.2 The student will** a) compare and order fractions and mixed numbers; **b) represent equivalent fractions**; and c) identify the division statement that represents a fraction.
b. Recognize and generate simple equivalent fractions, e.g., 1/2 = 2/4, 4/6 = 2/3). Explain why the fractions are equivalent, e.g., by using a visual fraction model.	**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 =).** **3.3 CF** **• Compare fractions using the terms greater than, less than, or equal to and the symbols (<, >, and =). Comparisons are made between fractions with both like and unlike denominators, using models, concrete materials and pictures.** **4.2 The student will** a) compare and order fractions and mixed numbers; **b) represent equivalent fractions**; and c) identify the division statement that represents a fraction.
c. Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers. *Examples: Express 3 in the form 3 = 3/1; recognize that 6/1 = 6; locate 4/4 and 1 at the same point of a number line diagram.*	**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 =).**
d. Compare two fractions with the same numerator or the same denominator by reasoning about their size. Recognize	**3.3 The student will** a) name and write fractions (including mixed numbers)

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that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.	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 =).**
Measurement and Data 3.MD	
Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.	
1. Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.	**3.11 The student will** **a) tell time to the nearest minute, using analog and digital clocks; and** **b) determine elapsed time in one-hour increments over a 12-hour period.**
2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	**1.10 The student will compare, using the concepts of more, less, and equivalent,** **a) the volumes of two given containers; and** **b) the weight/mass of two objects, using a balance scale.** **2.11 The student will estimate and measure** a) length to the nearest centimeter and inch; **b) weight/mass of objects in pounds/ounces and kilograms/grams, using a scale; and** **c) liquid volume in cups, pints, quarts, gallons, and liters.** **3.9 The student will estimate and use U.S. Customary and metric units to measure** a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter; **b) liquid volume in cups, pints, quarts, gallons, and liters;** **c) weight/mass in ounces, pounds, grams, and kilograms; and**

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	d) area and perimeter. **4.6 The student will** **a) estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate; and** b) identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms). **4.8 The student will** **a) estimate and measure liquid volume and describe the results in U.S. Customary units; and** **b) identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons).**
Represent and interpret data.	
3. Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*	**K.14 The student will display gathered data in object graphs, picture graphs, and tables, and will answer questions related to the data.** **1.14 The student will investigate, identify, and describe various forms of data collection (e.g., recording daily temperature, lunch count, attendance, favorite ice cream), using tables, picture graphs, and object graphs.** **3.17 The student will** a) collect and organize data, using observations, measurements, surveys, or experiments; **b) construct a line plot, a picture graph, or a bar graph to represent the data**; and **c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.**
4. Generate measurement data by measuring lengths using	**3.17 The student will**

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rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.	a) collect and organize data, using observations, measurements, surveys, or experiments; **b) construct a line plot, a picture graph, or a bar graph to represent the data**; and c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data. **3.9 The student will estimate and use U.S. Customary and metric units to measure** **a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter;** b) liquid volume in cups, pints, quarts, gallons, and liters; c) weight/mass in ounces, pounds, grams, and kilograms; and d) area and perimeter.
Geometric measurement: understand concepts of area and relate area to multiplication and to addition.	
5. Recognize area as an attribute of plane figures and understand concepts of area measurement.	
a. A square with side length 1 unit, called "a unit square," is said to have "one square unit" of area, and can be used to measure area.	**3.10 The student will** a) measure the distance around a polygon in order to determine perimeter; and **b) count the number of square units needed to cover a given surface in order to determine area.**
b. A plane figure which can be covered without gaps or overlaps by *n* unit squares is said to have an area of *n* square units.	**3.9 The student will estimate and use U.S. Customary and metric units to measure** a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter; b) liquid volume in cups, pints, quarts, gallons, and liters;

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	c) weight/mass in ounces, pounds, grams, and kilograms; and **d) area and perimeter.** **3.10 The student will** a) measure the distance around a polygon in order to determine perimeter; and **b) count the number of square units needed to cover a given surface in order to determine area.**
6. Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).	**3.9 The student will estimate and use U.S. Customary and metric units to measure** a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter; b) liquid volume in cups, pints, quarts, gallons, and liters; c) weight/mass in ounces, pounds, grams, and kilograms; and **d) area and perimeter.** **3.10 The student will** a) measure the distance around a polygon in order to determine perimeter; and **b) count the number of square units needed to cover a given surface in order to determine area.**
7. Relate area to the operations of multiplication and addition.	
a. Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.	**3.5 The student will recall multiplication facts through the twelves table, and the corresponding division facts.** **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.** **3.10 The student will** a) measure the distance around a polygon in order to determine

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	perimeter; and **b) count the number of square units needed to cover a given surface in order to determine area.**
b. Multiply side lengths to find areas of rectangles with whole number side lengths in the context of solving real world and mathematical problems, and represent whole-number products as rectangular areas in mathematical reasoning.	**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.**
c. Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths a and $b + c$ is the sum of $a \times b$ and $a \times c$. Use area models to represent the distributive property in mathematical reasoning.	**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.**
d. Recognize area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.	**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.**
Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.	
8. Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.	**3.9 The student will estimate and use U.S. Customary and metric units to measure** a) length to the nearest $\frac{1}{2}$ inch, inch, foot, yard, centimeter, and meter; b) liquid volume in cups, pints, quarts, gallons, and liters; c) weight/mass in ounces, pounds, grams, and kilograms; and **d) area and perimeter.** **3.10 The student will** **a) measure the distance around a polygon in order to determine perimeter**; and

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	b) count the number of square units needed to cover a given surface in order to determine area.
Reason with shapes and their attributes.	
1. Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals). Recognize rhombuses, rectangles, and squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.	**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.**
2. Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. *For example, partition a shape into 4 parts with equal area, and describe the area of each part as 1/4 of the area of the shape.*	**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 =).

Mathematics SOL for grade 3 aligned with the CCSS at other grade levels	
Grade 2 – Number and Operations in Base Ten 3. Read and write numbers to 1000 using base-ten numerals, number names, and expanded form. Grade 4 – Number and Operations in Base Ten 2. Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits, using >, =, and < symbols to record the results of comparisons.	**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*).**
Grade 4 – Number and Operations - Fractions 3c. Add and subtract mixed numbers with like denominators,	**3.7 The student will add and subtract proper fractions having like denominators of 12 or less.**

Mathematics SOL for grade 3 aligned with the CCSS at other grade levels	
e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction.	
Grade 4 – Measurement and Data 2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.	**3.8 The student will determine, by counting, the value of a collection of bills and coins whose total value is $5.00 or less, compare the value of the bills and coins, and make change.**
Grade 4 – Geometry 1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.	**3.15 The student will identify and draw representations of points, line segments, rays, angles, and lines.**
Grade 8 – Geometry 2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.	**3.16 The student will identify and describe congruent and noncongruent plane figures.**
Grade 7 – Statistics and Probability 5. Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	**3.18 The student will investigate and describe the concept of probability as chance and list possible results of a given situation.**

Mathematics SOL for grade 3 not explicitly stated in the CCSS at any grade level	
	3.12 The student will identify equivalent periods of time, including relationships among days, months, and years, as well as minutes and hours.
	3.13 The student will read temperature to the nearest degree from a Celsius thermometer and a Fahrenheit thermometer. Real thermometers and physical models of thermometers will be used.
	3.17 The student will **a) collect and organize data, using observations, measurements, surveys, or experiments;** b) construct a line plot, a picture graph, or a bar graph to represent the data; and c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.

Grade 4

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Operations and Algebraic Thinking 4.OA	
Use the four operations with whole numbers to solve problems.	
1. Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.	**3.20 The student will** **a) investigate the identity and the commutative properties for addition and multiplication; and** **b) identify examples of the identity and commutative properties for addition and multiplication.**
2. Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison.	**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.** **4.4 The student will** **a) estimate sums, differences, products, and quotients of whole numbers;** **b) add, subtract, and multiply whole numbers;** **c) divide whole numbers, finding quotients with and without remainders; and** **d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.**
3. Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding.	**4.4 The student will** **a) estimate sums, differences, products, and quotients of whole numbers;** **b) add, subtract, and multiply whole numbers;** **c) divide whole numbers, finding quotients with and without remainders; and** **d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.** **5.18 The student will**

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	a) investigate and describe the concept of variable; **b) write an open sentence to represent a given mathematical relationship, using a variable;** **c) model one-step linear equations in one variable, using addition and subtraction; and** d) create a problem situation based on a given open sentence, using a single variable.
Gain familiarity with factors and multiples.	
4. Find the factor pairs for a whole number in the range 1-100. Recognize that a whole number is a multiple of each of its factors. Determine whether a given whole number in the range 1-100 is a multiple of a given one-digit number. Determine whether a given whole number in the range 1-100 is prime or composite.	**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. **5.3 The student will** **a) identify and describe the characteristics of prime and composite numbers; and** b) identify and describe the characteristics of even and odd numbers.
Generate and analyze patterns.	
5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. *For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and*	**K.16 The student will identify, describe, and extend repeating patterns.** **1.17 The student will recognize, describe, extend, and create a wide variety of growing and repeating patterns.** **2.20 The student will identify, create, and extend a wide variety**

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even numbers. Explain informally why the numbers will continue to alternate in this way.	**of patterns.** **4.15 The student will recognize, create, and extend numerical and geometric patterns.**
Number and Operations in Base Ten 4.NBT	
Generalize place value understanding for multi-digit whole numbers.	
1. Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. *For example, recognize that 700 ÷ 70 = 10 by applying concepts of place value and division.*	**4.1 The student will** **a) identify orally and in writing the place value for each digit in a whole number expressed through millions;** b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.
2. Read and write multi-digit whole numbers using base-ten numerals, number names, and expanded form. Compare two multi-digit numbers based on meanings of the digits, using >, =, and < symbols to record the results of comparisons.	**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*).** **4.1 The student will** **a) identify orally and in writing the place value for each digit in a whole number expressed through millions;** **b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and** c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.
3. Use place value understanding to round multi-digit whole	**4.1 The student will**

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numbers to any place.	a) identify orally and in writing the place value for each digit in a whole number expressed through millions; b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and **c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.**
Use place value understanding and properties of operations to perform multi-digit arithmetic.	
4. Fluently add and subtract multi-digit whole numbers using the standard algorithm.	**4.4 The student will** **a) estimate sums, differences, products, and quotients of whole numbers;** **b) add, subtract, and multiply whole numbers;** c) divide whole numbers, finding quotients with and without remainders; and d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.
5. Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	**4.4 The student will** a) estimate sums, differences, products, and quotients of whole numbers; **b) add, subtract, and multiply whole numbers;** c) divide whole numbers, finding quotients with and without remainders; and **d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.** **4.4 CF** **• A certain amount of practice is necessary to develop fluency with computational strategies for multidigit numbers; however, the practice must be meaningful, motivating, and systematic if students are to develop fluency in computation, whether**

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	mentally, with manipulative materials, or with paper and pencil.
6. Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	**4.4 The student will** a) estimate sums, differences, products, and quotients of whole numbers; b) add, subtract, and multiply whole numbers; **c) divide whole numbers, finding quotients with and without remainders; and** d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers. **4.4 CF** **• A certain amount of practice is necessary to develop fluency with computational strategies for multidigit numbers; however, the practice must be meaningful, motivating, and systematic if students are to develop fluency in computation, whether mentally, with manipulative materials, or with paper and pencil.**
Number and Operations—Fractions 4-NF	
Extend understanding of fraction equivalence and ordering.	
1. Explain why a fraction a/b is equivalent to a fraction $(n \times a)/(n \times b)$ by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.	**4.2 The student will** a) compare and order fractions and mixed numbers; **b) represent equivalent fractions; and** c) identify the division statement that represents a fraction. **4.2 CF** **• Represent equivalent fractions through twelfths, using region/area models, set models, and measurement models.**
2. Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as	**3.3 The student will** a) name and write fractions (including mixed numbers) represented by a model;

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½. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction 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 =).** **4.2 The student will** **a) compare and order fractions and mixed numbers;** b) represent equivalent fractions; and c) identify the division statement that represents a fraction. **4.2 CF** **• Strategies for comparing fractions having unlike denominators may include** **— comparing fractions to familiar benchmarks (e.g., 0, ½ , 1);** **— finding equivalent fractions, using manipulative models such as fraction strips, number lines, fraction circles, rods, pattern blocks, cubes, Base-10 blocks, tangrams, graph paper, or a multiplication chart and patterns.**
Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.	
3. Understand a fraction a/b with $a > 1$ as a sum of fractions $1/b$.	
a. Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.	**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**

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	addition and subtraction with fractions and with decimals. **4.5 CF** **• Students should investigate addition and subtraction with fractions, using a variety of models (e.g., fraction circles, fraction strips, rulers, linking cubes, pattern blocks).**
b. Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation (e.g., 3/8 = 1/8 + 1/8 + 1/8 and 3/8 = 1/8 + 2/8). Justify decompositions, e.g., by using a visual fraction model.	**Grades K-3 CF** **The focus of instruction in the number and number sense strand is to promote an understanding of counting, classification, whole numbers, place value, fractions, number relationships ("more than," "less than," and "equal to"), and the effects of single-step and multistep computations. These learning experiences should allow students to engage actively in a variety of problem solving situations and to model numbers (compose and decompose), using a variety of manipulatives. Additionally, students at this level should have opportunities to observe, to develop an understanding of the relationship they see between numbers, and to develop the skills to communicate these relationships in precise, unambiguous terms.**
c. Add and subtract mixed numbers with like denominators, e.g., by replacing each mixed number with an equivalent fraction, and/or by using properties of operations and the relationship between addition and subtraction.	**3.7 The student will add and subtract proper fractions having like denominators of 12 or less.** **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

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	d) solve single-step and multistep practical problems involving addition and subtraction with fractions and with decimals. **5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers and express answers in simplest form.** **5.6 CF** **To add or subtract with mixed numbers, students may use a number line, draw a picture, rewrite fractions with like denominators, or rewrite mixed numbers as fractions.**
d. Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.	**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.** **4.5 CF** **• Students should investigate addition and subtraction with fractions, using a variety of models (e.g., fraction circles, fraction strips, rulers, linking cubes, pattern blocks).**
4. Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.	**6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.
a. Understand a fraction *a*/*b* as a multiple of 1/*b*. *For example,*	**4.2 The student will**

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use a visual fraction model to represent 5/4 as the product 5 × (1/4), recording the conclusion by the equation 5/4 = 5 × (1/4).	**a) compare and order fractions and mixed numbers;** b) represent equivalent fractions; and c) identify the division statement that represents a fraction. **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions. **6.6 CF** **When multiplying a whole by a fraction such as 3 ½ , the meaning is the same as with multiplication of whole numbers: 3 groups the size of 1/2 of the whole.**
b. Understand a multiple of *a*/*b* as a multiple of 1/*b*, and use this understanding to multiply a fraction by a whole number. *For example, use a visual fraction model to express 3 × (2/5) as 6 × (1/5), recognizing this product as 6/5. (In general, n × (a/b) = (n × a)/b.)*	**4.2 The student will** **a) compare and order fractions and mixed numbers;** b) represent equivalent fractions; and c) identify the division statement that represents a fraction. **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions. **6.6 CF** **• When multiplying a whole by a fraction such as 3 ½ , the meaning is the same as with multiplication of whole numbers: 3 groups the size of 1/2 of the whole.**
c. Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. *For example: If each person at a party will eat 3/8 of a pound of roast beef, and there will be*	**6.6 The student will** a) multiply and divide fractions and mixed numbers; and **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction,**

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5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?	**multiplication, and division of fractions.**
Understand decimal notation for fractions, and compare decimal fractions.	
5. Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. *For example, express 3/10 as 30/100 and add 3/10 + 4/100 = 34/100.*	**4.2 The student will** a) compare and order fractions and mixed numbers; **b) represent equivalent fractions; and** c) identify the division statement that represents a fraction.
6. Use decimal notation for fractions with denominators 10 or 100. *For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram.*	**4.3 The student will** a) read, write, represent, and identify decimals expressed through thousandths; b) round decimals to the nearest whole number, tenth, and hundredth; c) compare and order decimals; and **d) given a model, write the decimal and fraction equivalents.** **4.3 CF** **• Decimals and fractions represent the same relationships; however, they are presented in two different formats. The decimal 0.25 is written as 1/4. Decimal numbers are another way of writing fractions. When presented with the fraction 3/5 , the division expression representing a fraction is written as 3 divided by 5. The Base-10 models concretely relate fractions to decimals (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money).** **• Provide a fraction model (halves, fourths, fifths), and ask students for its decimal equivalent.**
7. Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the	**4.3 The student will** **a) read, write, represent, and identify decimals expressed**

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two decimals refer to the same whole. Record the results of comparisons with the symbols >, =, or <, and justify the conclusions, e.g., by using a visual model.	**through thousandths;** b) round decimals to the nearest whole number, tenth, and hundredth; **c) compare and order decimals; and** d) given a model, write the decimal and fraction equivalents. **4.3 CF** **• Understand that models are used to show decimal and fraction equivalents.** **• Compare decimals, using the symbols >, <, =.**
Measurement and Data 4.MD	
Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.	
1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; *l*, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of smaller unit. Record measurement equivalents in a two-column table. *For example: Know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs* (*1, 12*), (*2, 24*), (*3, 36*), ….	**4.6 The student will** a) estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate; and **b) identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms).** **4.7 The student will** a) estimate and measure length, and describe the result in both metric and U.S. Customary units; and **b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters).** **4.8 The student will** a) estimate and measure liquid volume and describe the results in U.S. Customary units; and

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	b) identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons).
2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.	**3.8 The student will determine, by counting, the value of a collection of bills and coins whose total value is $5.00 or less, compare the value of the bills and coins, and make change.** **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.** **4.9 The student will determine elapsed time in hours and minutes within a 12-hour period.**
3. Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.*	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure;** b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation; c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **6.10 The student will**

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	a) define π (pi) 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 and perimeter, using manipulatives such as tiles, one inch cubes, adding machine tape, graph paper, geoboards, or tracing paper, promote an understanding of the formulas and facility in their use.**
Represent and interpret data.	
4. Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. *For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.*	**3.17 The student will** **a) collect and organize data, using observations, measurements, surveys, or experiments;** **b) construct a line plot, a picture graph, or a bar graph to represent the data; and** **c) read and interpret the data represented in line plots, bar graphs, and picture graphs and write a sentence analyzing the data.** **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;**

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	c) add and subtract with decimals; and **d) solve single-step and multistep practical problems involving addition and subtraction with fractions and with decimals.**
Geometric measurement: understand concepts of angle and measure angles.	
5. Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:	
a. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles.	**5.11 The student will measure right, acute, obtuse, and straight angles.** **5.11 CF** **• Angles are measured in degrees. There are up to 360 degrees in an angle. A degree is 1/360 of a complete rotation of a full circle. There are 360 degrees in a circle.**
b. An angle that turns through *n* one-degree angles is said to have an angle measure of *n* degrees.	**5.11 The student will measure right, acute, obtuse, and straight angles.** **5.11 CF** **• Angles are measured in degrees. There are up to 360 degrees in an angle. A degree is 1/360 of a complete rotation of a full circle. There are 360 degrees in a circle.**
6. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.	**5.11 The student will measure right, acute, obtuse, and straight angles.** **5.11 CF** **• Students should understand how to work with a protractor or angle ruler as well as available computer software to measure and draw angles and triangles.**
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	**5.11 The student will measure right, acute, obtuse, and straight angles.** **5.11 CF**

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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.	• **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.**
Geometry 4.G	
Draw and identify lines and angles, and classify shapes by properties of their lines and angles.	
1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.	**3.15 The student will identify and draw representations of points, line segments, rays, angles, and lines.** **4.10 The student will** **a) identify and describe representations of points, lines, line segments, rays, and angles, including endpoints and vertices; and** **b) identify representations of lines that illustrate intersection, parallelism, and perpendicularity.**
2. Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of specified size. Recognize right triangles as a category, and identify right triangles.	**5.12 The student will classify** a) angles as right, acute, obtuse, or straight; and **b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.** **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.
3. Recognize a line of symmetry for a two-dimensional figure as a line across the figure such that the figure can be folded along the	**2.15 The student will** **a) draw a line of symmetry in a figure; and**

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line into matching parts. Identify line-symmetric figures and draw lines of symmetry.	**b) identify and create figures with at least one line of symmetry.**

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Grade 5 – Number and Operations– Fractions 3. Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret 3/4 as the result of dividing 3 by 4, noting that 3/4 multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size 3/4. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*	**4.2 The student will** a) compare and order fractions and mixed numbers; b) represent equivalent fractions; and **c) identify the division statement that represents a fraction.**
Grade 5 – Number and Operations in Base Ten 4. Use place value understanding to round decimals to any place.	**4.3 The student will** a) read, write, represent, and identify decimals expressed through thousandths; **b) round decimals to the nearest whole number, tenth, and hundredth;** c) compare and order decimals; and d) given a model, write the decimal and fraction equivalents.
Grade 3 – Measurement and Data 2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a	**4.6 The student will** **a) estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate; and** b) identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms).

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measurement scale) to represent the problem.	
Grade 2 – Measurement and Data 1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes. Grade 3 –Measurement and Data 4. Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units—whole numbers, halves, or quarters.	**4.7 The student will** **a) estimate and measure length, and describe the result in both metric and U.S. Customary units; and** b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters).
Grade 3 – Measurement and Data 2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	**4.8 The student will** **a) estimate and measure liquid volume and describe the results in U.S. Customary units; and** b) identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons).
Grade 8 – Geometry 2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.	**4.11 The student will** **a) investigate congruence of plane figures after geometric transformations, such as reflection, translation, and rotation, using mirrors, paper folding, and tracing; and** **b) recognize the images of figures resulting from geometric transformations, such as translation, reflection, and rotation.**
Grade 7 – Statistics and Probability 5. Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely,	**4.13 The student will** **a) predict the likelihood of an outcome of a simple event; and** **b) represent probability as a number between 0 and 1, inclusive.**

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and a probability near 1 indicates a likely event.	
Grade 2 – Measurement and Data 10. Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories. Solve simple put together, take-apart, and compare problems using information presented in a bar graph. Grade 3 – Measurement and Data (picture and bar graphs) 3. Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step "how many more" and "how many less" problems using information presented in scaled bar graphs. *For example, draw a bar graph in which each square in the bar graph might represent 5 pets.*	**4.14 The student will collect, organize, display, and interpret data from a variety of graphs.**
Grade 1 –Operations and Algebraic Thinking 7. Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. *For example, which of the following equations are true and which are false? 6 = 6, 7 = 8 – 1, 5 + 2 = 2 + 5, 4 + 1 = 5 + 2.* Grade 1 – Operations and Algebraic Thinking 3. Apply properties of operations as strategies to add and subtract. *Examples: If 8 + 3 = 11 is known, then 3 + 8 = 11 is also known. (Commutative property of addition.) To add 2 + 6 + 4, the second two numbers can be added to make a ten, so 2 + 6 + 4 = 2 + 10 = 12. (Associative property of addition.)* Grade 3 – Operations and Algebraic Thinking 5. Apply properties of operations as strategies to multiply and divide. *Examples: If 6 × 4 = 24 is known, then 4 × 6 = 24 is also known. (Commutative property of multiplication.) 3 × 5 × 2 can be found by 3 × 5 = 15, then 15 × 2 = 30, or by 5 × 2 = 10, then 3 ×*	**4.16 The student will** **a) recognize and demonstrate the meaning of equality in an equation; and** **b) investigate and describe the associative property for addition and multiplication.**

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10 = 30. (Associative property of multiplication.) Knowing that 8 × 5 = 40 and 8 × 2 = 16, one can find 8 × 7 as 8 × (5 + 2) = (8 × 5) + (8 × 2) = 40 + 16 = 56. (Distributive property.)	

Grade 5

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Operations and Algebraic Thinking 5.OA	
Write and interpret numerical expressions.	
1. Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.	**5.7 The student will evaluate whole number numerical expressions, using the order of operations limited to parentheses, addition, subtraction, multiplication, and division.** **6.8 The student will evaluate whole number numerical expressions, using the order of operations.**
2. Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. *For example, express the calculation "add 8 and 7, then multiply by 2" as 2 × (8 + 7). Recognize that 3 × (18932 + 921) is three times as large as 18932 + 921, without having to calculate the indicated sum or product.*	**5.7 The student will evaluate whole number numerical expressions, using the order of operations limited to parentheses, addition, subtraction, multiplication, and division.**
Analyze patterns and relationships.	
3. Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. *For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.*	**5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.** **5.15 CF** **• Understand that line graphs show changes over time.** **5.17 The student will describe the relationship found in a number pattern and express the relationship.** **5.17 CF** **• Describe the relationship found in patterns, using words, tables, and symbols to express the relationship.**
Number and Operations in Base Ten 5.NBT	
Understand the place value system.	
1. Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.	**4.1 The student will** **a) identify orally and in writing the place value for each digit in a whole number expressed through millions;**

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	b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand. **5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.** **5.1 CF** • **The structure of the Base-10 number system is based upon a simple pattern of tens in which each place is ten times the value of the place to its right. This is known as a ten-to-one place value relationship.**
2. Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.	**5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.** **5.1 CF** • **The structure of the Base-10 number system is based upon a simple pattern of tens in which each place is ten times the value of the place to its right. This is known as a ten-to-one place value relationship.** **6.5 The student will investigate and describe concepts of positive exponents and perfect squares.** **6.5 CF** • **Recognize powers of ten by examining patterns in a place value chart: 10^4 = 10,000, 10^3 = 1000, 10^2 = 100, 10^1 = 10, 10^0 =1.**
3. Read, write, and compare decimals to thousandths.	
a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., 347.392 = 3 × 100 + 4 × 10 + 7 × 1 + 3 × (1/10) + 9 × (1/100) + 2 × (1/1000).	**4.3 The student will** **a) read, write, represent, and identify decimals expressed through thousandths;** b) round decimals to the nearest whole number, tenth, and

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	hundredth; c) compare and order decimals; and d) given a model, write the decimal and fraction equivalents. **5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.** **5.1 CF** • **Decimals may be written in a variety of forms:** — **Standard: 23.456** — **Written: Twenty-three and four hundred fifty-six thousandths** — **Expanded: (2 × 10) + (3 × 1) + (4 × 0.1) + (5 × 0.01) + (6 × 0.001)**
b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.	**4.3 The student will** a) read, write, represent, and identify decimals expressed through thousandths; b) round decimals to the nearest whole number, tenth, and hundredth; **c) compare and order decimals; and** d) given a model, write the decimal and fraction equivalents. **5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.** **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.**
4. Use place value understanding to round decimals to any place.	**4.3 The student will** a) read, write, represent, and identify decimals expressed through thousandths;

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	b) round decimals to the nearest whole number, tenth, and hundredth; c) compare and order decimals; and d) given a model, write the decimal and fraction equivalents. **5.1 The student, given a decimal through thousandths, will round to the nearest whole number, tenth, or hundredth.**
Perform operations with multi-digit whole numbers and with decimals to hundredths.	
5. Fluently multiply multi-digit whole numbers using the standard algorithm.	**4.4 The student will** a) estimate sums, differences, products, and quotients of whole numbers; **b) add, subtract, and multiply whole numbers;** c) divide whole numbers, finding quotients with and without remainders; and **d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.** **4.4 CF** • **A certain amount of practice is necessary to develop fluency with computational strategies for multidigit numbers; however, the practice must be meaningful, motivating, and systematic if students are to develop fluency in computation, whether mentally, with manipulative materials, or with paper and pencil.** **5.4 The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division with and without remainders of whole numbers.**

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6. Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.	**4.4 The student will** a) estimate sums, differences, products, and quotients of whole numbers; b) add, subtract, and multiply whole numbers; **c) divide whole numbers, finding quotients with and without remainders; and** **d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers.** **4.4 CF** • **Another model of multiplication is the "Partial Product" model.** **24** **× 3** **12 ← Multiply the ones: 3 × 4 = 12** **+ 60 ← Multiply the tens: 3 × 20 = 60** **72** • **Another model of multiplication is the "Area Model" (which also represents partial products) and should be modeled first with Base-10 blocks. (e.g., 23 x 68)** **5.4 CF** • **Solve single-step and multistep problems involving addition, subtraction, multiplication, and division with and without remainders of whole numbers, using paper and pencil, mental computation, and calculators in which** — **sums, differences, and products will not exceed five digits;** — **multipliers will not exceed two digits;** — **divisors will not exceed two digits; or** — **dividends will not exceed four digits.**
7. Add, subtract, multiply, and divide decimals to hundredths,	**5.5 The student will**

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using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.	**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.** **5.5 CF** • **Understand the various meanings of *division* and its effect on whole numbers.** **5.5 CF** • **Addition and subtraction of decimals may be investigated using a variety of models (e.g., 10-by-10 grids, number lines, money).** • **Division is the operation of making equal groups or shares. When the original amount and the number of shares are known, divide to find the size of each share. When the original amount and the size of each share are known, divide to find the number of shares. Both situations may be modeled with Base-10 manipulatives.**
Number and Operations—Fractions 5.NF	
Use equivalent fractions as a strategy to add and subtract fractions.	
1. Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, 2/3 + 5/4 = 8/12 + 15/12 = 23/12. (In general, a/b + c/d = (ad + bc)/bd.)*	**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

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	d) solve single-step and multistep practical problems involving addition and subtraction with fractions and with decimals. **5.4 The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division with and without remainders of whole numbers.** **5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers and express answers in simplest form.** **5.6 CF** • **To add or subtract with fractions that do not have the same denominator, first find equivalent fractions with the least common denominator. Then add or subtract and write the answer in simplest form.**
2. Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result 2/5 + 1/2 = 3/7, by observing that 3/7 < 1/2.*	**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.** **4.5 CF** • **Use visual models to add and subtract with fractions and decimals.** **5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and**

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	mixed numbers and express answers in simplest form. **5.6 CF** • **Addition and subtraction with fractions and mixed numbers can be modeled using a variety of concrete materials and pictorial representations as well as paper and pencil.** • **Develop and use strategies to estimate and compute addition and subtraction of fractions.**
Apply and extend previous understandings of multiplication and division to multiply and divide fractions.	
3. Interpret a fraction as division of the numerator by the denominator ($a/b = a \div b$). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret 3/4 as the result of dividing 3 by 4, noting that 3/4 multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size 3/4. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?*	**4.2 The student will** a) compare and order fractions and mixed numbers; b) represent equivalent fractions; and **c) identify the division statement that represents a fraction.** **4.2 CF** • **Identify the division statement that represents a fraction (e.g., $\frac{3}{5}$ means the same as 3 divided by 5).** • **A fraction is a way of representing part of a whole (as in a region/area model or a measurement model) or part of a group (as in a set model). A fraction is used to name a part of one thing or a part of a collection of things.** • **The denominator tells how many equal parts are in the whole or set. The numerator tells how many of those parts are being counted or described.**
4. Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **Using manipulatives to build conceptual understanding and using pictures and sketches to link concrete examples to the**

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	symbolic enhance students' understanding of operations with fractions and help students connect the meaning of whole number computation to fraction computation. • **Multiplication and division of fractions can be represented with arrays, paper folding, repeated addition, repeated subtraction, fraction strips, pattern blocks and area models.** • **When multiplying a whole by a fraction such as $3 \cdot \frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$, of the whole.** • **When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking for part of a part.** • **When multiplying a fraction by a whole number such as $\frac{1}{2} \times 6$, we are trying to find a part of the whole.** • **When multiplying fractions, what is the meaning of the operation? When multiplying a whole by a fraction such as $3 \cdot \frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$ of the whole. When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking for part of a part. When multiplying a fraction by a whole number such $\frac{1}{2} \times 6$, we are trying to find a part of the whole.** • **Demonstrate multiplication and division of fractions using multiple representations.** • **Model algorithms for multiplying and dividing with fractions using appropriate representations.** **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and**

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	b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.
a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show (2/3) × 4 = 8/3, and create a story context for this equation. Do the same with (2/3) × (4/5) = 8/15. (In general, (a/b) × (c/d) = ac/bd.)*	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **Using manipulatives to build conceptual understanding and using pictures and sketches to link concrete examples to the symbolic enhance students' understanding of operations with fractions and help students connect the meaning of whole number computation to fraction computation.** • **Multiplication and division of fractions can be represented with arrays, paper folding, repeated addition, repeated subtraction, fraction strips, pattern blocks and area models.** • **When multiplying a whole by a fraction such as $3 \cdot \frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$, of the whole.** • **When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking for part of a part.** • **When multiplying a fraction by a whole number such as $\frac{1}{2} \times 6$, we are trying to find a part of the whole.** • **When multiplying fractions, what is the meaning of the operation? When multiplying a whole by a fraction such as $3 \cdot \frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$ of the whole. When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking**

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	for part of a part. When multiplying a fraction by a whole number such $\frac{1}{2} \times 6$, we are trying to find a part of the whole. • **Demonstrate multiplication and division of fractions using multiple representations.** • **Model algorithms for multiplying and dividing with fractions using appropriate representations.** **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.
b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure;** **b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;** c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **5.8 CF** • **Find the sum, difference, and product of two numbers expressed as decimals through thousandths, using paper and pencil, estimation, mental computation, and calculators.** • **Determine the quotient, given a dividend expressed as a decimal through thousandths and a single-digit divisor. For example, 5.4 divided by 2 and 2.4 divided by 5.**

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	6.4 The student will demonstrate multiple representations of multiplication and division of fractions. **6.4 CF** • **Using manipulatives to build conceptual understanding and using pictures and sketches to link concrete examples to the symbolic enhance students' understanding of operations with fractions and help students connect the meaning of whole number computation to fraction computation.**
5. Interpret multiplication as scaling (resizing), by:	
a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **When multiplying a whole by a fraction such as 3 x 1/2, the meaning is the same as with multiplication of whole numbers: 3 groups the size of ½ of the whole.** • **When multiplying a fraction by a fraction such as 2/3 x 3/4 , we are asking for part of a part.** • **When multiplying a fraction by a whole number such as ½ x 6, we are trying to find a part of the whole.** **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.
b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller	**4.2 The student will** a) compare and order fractions and mixed numbers; **b) represent equivalent fractions**; and c) identify the division statement that represents a fraction. **6.4 The student will demonstrate multiple representations of**

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than the given number; and relating the principle of fraction equivalence $a/b = (n \times a)/(n \times b)$ to the effect of multiplying a/b by 1.	**multiplication and division of fractions.** **6.4 CF** • **When multiplying a whole by a fraction such as 3 x 1/2, the meaning is the same as with multiplication of whole numbers: 3 groups the size of ½ of the whole.** • **When multiplying a fraction by a fraction such as 2 /3 x 3/ 4 , we are asking for part of a part.** • **When multiplying a fraction by a whole number such as ½ x 6, we are trying to find a part of the whole.**
6. Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **Using manipulatives to build conceptual understanding and using pictures and sketches to link concrete examples to the symbolic enhance students' understanding of operations with fractions and help students connect the meaning of whole number computation to fraction computation.** • **Multiplication and division of fractions can be represented with arrays, paper folding, repeated addition, repeated subtraction, fraction strips, pattern blocks and area models.** • **When multiplying a whole by a fraction such as $3 \cdot \frac{1}{2}$, the meaning is the same as with multiplication of whole numbers: 3 groups the size of $\frac{1}{2}$, of the whole.** • **When multiplying a fraction by a fraction such as $\frac{2}{3} \cdot \frac{3}{4}$, we are asking for part of a part.** • **Demonstrate multiplication and division of fractions using multiple representations.** **6.6 The student will**

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	a) multiply and divide fractions and mixed numbers; and **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.**
7. Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.	
a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. *For example, create a story context for (1/3) ÷ 4, and use a visual fraction model to show the quotient.* *Use the relationship between multiplication and division to explain that (1/3) ÷ 4 = 1/12 because (1/12) × 4 = 1/3.*	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **For measurement division, the divisor is the number of groups. You want to know how many are in each of those groups. Division of fractions can be explained as how many of a given divisor are needed to equal the given dividend. In other words, for 1/4 ÷ 2/3 , the question is, "How many 2/3 make 1/4?"** • **For partition division, the divisor is the size of the group, so the quotient answers the question, "How much is the whole?" or "How much for one?"** **6.6 The student will** **a) multiply and divide fractions and mixed numbers**; and b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.
b. Interpret division of a whole number by a unit fraction, and compute such quotients. *For example, create a story context for 4 ÷ (1/5), and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that 4 ÷ (1/5) = 20 because 20 × (1/5) = 4.*	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **For measurement division, the divisor is the number of groups. You want to know how many are in each of those**

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	groups. Division of fractions can be explained as how many of a given divisor are needed to equal the given dividend. In other words, for 1/4 ÷ 2/3 , the question is, "How many 2/3 make 1/4?" • **For partition division, the divisor is the size of the group, so the quotient answers the question, "How much is the whole?" or "How much for one?"** **6.6 The student will** **a) multiply and divide fractions and mixed numbers**; and b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.
c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. *For example, how much chocolate will each person get if 3 people share 1/2 lb of chocolate equally? How many 1/3-cup servings are in 2 cups of raisins?*	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.4 CF** • **For measurement division, the divisor is the number of groups. You want to know how many are in each of those groups. Division of fractions can be explained as how many of a given divisor are needed to equal the given dividend. In other words, for 1/4 ÷ 2/3 , the question is, "How many 2/3 make 1/4?"** • **For partition division, the divisor is the size of the group, so the quotient answers the question, "How much is the whole?" or "How much for one?"** **6.6 The student will** **a) multiply and divide fractions and mixed numbers**; and b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.

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Measurement and Data 5.MD	
Convert like measurement units within a given measurement system.	
1. Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multistep, real world problems.	**4.6 The student will** a) estimate and measure weight/mass and describe the results in U.S. Customary and metric units as appropriate; and **b) identify equivalent measurements between units within the U.S. Customary system (ounces, pounds, and tons) and between units within the metric system (grams and kilograms).** **4.7 The student will** a) estimate and measure length, and describe the result in both metric and U.S. Customary units; and **b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards; yards and miles) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters).** **4.8 The student will** a) estimate and measure liquid volume and describe the results in U.S. Customary units; and **b) identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons).** **5.8 The student will** a) find perimeter, area, and volume in standard units of measure; b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation; **c) identify equivalent measurements within the metric system;** **d) estimate and then measure to solve problems, using U.S.**

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	Customary and metric units; and **e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units.**
Represent and interpret data.	
2. Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.*	**5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers and express answers in simplest form.** **6.6 The student will** a) multiply and divide fractions and mixed numbers; and **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.**
Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.	
3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement.	
a. A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure**; b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation; c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **5.8 CF** **• Develop a procedure for finding volume using manipulatives**

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	(e.g., cubes). **• Determine volume in standard units.**
b. A solid figure which can be packed without gaps or overlaps using *n* unit cubes is said to have a volume of *n* cubic units.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure**; b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation; c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **5.8 CF** **• Develop a procedure for finding volume using manipulatives (e.g., cubes).** **• Determine volume in standard units.**
4. Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure**; b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation; c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **5.8 CF**

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	• **Develop a procedure for finding volume using manipulatives (e.g., cubes).** • **Determine volume in standard units.**
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 paper, geoboards, or tracing paper, promote an understanding of the formulas and facility in their use.**
b. Apply the formulas $V = l \times w \times h$ and $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole number edge lengths in the context of solving real world and mathematical problems.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure;** **b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;** c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and

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	e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **5.8 CF** • **Determine the perimeter of a polygon, with or without diagrams, when** — **the lengths of all sides of a polygon that is not a rectangle or a square are given;** — **the length and width of a rectangle are given; or** — **the length of a side of a square is given.** • **Estimate and determine the perimeter of a polygon, and area of a square, rectangle, and right triangle following the parameters listed above, using only whole number measurements given in metric or U.S. Customary units, and record the solution with the appropriate unit of measure (e.g., 24 square inches).** • **Estimate and determine the area of a square, with or without diagrams, when the length of a side is given.** **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** • **The volume of a rectangular prism is computed by multiplying the area of the base, B, (length x width) by the height of the prism (*V* = *lwh* = *Bh*).**

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c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure;** **b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;** c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **5.8 CF** • **Estimate and determine the perimeter of a polygon, and area of a square, rectangle, and right triangle following the parameters listed above, using only whole number measurements given in metric or U.S. Customary units, and record the solution with the appropriate unit of measure (e.g., 24 square inches).** • **Estimate and determine the area of a square, with or without diagrams, when the length of a side is given.** **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.**
Geometry 5.G	

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Graph points on the coordinate plane to solve real-world and mathematical problems.	
1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., *x*-axis and *x*-coordinate, *y*-axis and *y* coordinate).	**5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.** **5.15 CF** • **Through experiences displaying data in a variety of graphical representations, students learn to select an appropriate representation.** • **Organize the data into a chart, table, stem-and-leaf plots, and line graphs.** • **Display data in line graphs and stem-and-leaf plots.** • **Construct line graphs, labeling the vertical axis with equal whole number, decimal, or fractional increments and the horizontal axis with continuous data commonly related to time (e.g., hours, days, months, years, and age). Line graphs will have no more than six identified points along a continuum for continuous data (e.g., the decades: 1950s, 1960s, 1970s, 1980s, 1990s, and 2000s).** **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** • **In a coordinate plane, the coordinates of a point are typically represented by the ordered pair (*x*, *y*), where *x* is the first coordinate and *y* is the second coordinate. However, any letters may be used to label the axes and the corresponding ordered pairs.** • **The quadrants of a coordinate plane are the four regions**

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	created by the two intersecting perpendicular number lines. Quadrants are named in counterclockwise order. The signs on the ordered pairs for quadrant I are (+,+); for quadrant II, (–,+); for quadrant III, (–, –); and for quadrant IV, (+,–).
2. Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.	**5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.** **5.15 CF** **• Through experiences displaying data in a variety of graphical representations, students learn to select an appropriate representation.** **• Organize the data into a chart, table, stem-and-leaf plots, and line graphs.** **• Display data in line graphs and stem-and-leaf plots.** **• Construct line graphs, labeling the vertical axis with equal whole number, decimal, or fractional increments and the horizontal axis with continuous data commonly related to time (e.g., hours, days, months, years, and age). Line graphs will have no more than six identified points along a continuum for continuous data (e.g., the decades: 1950s, 1960s, 1970s, 1980s, 1990s, and 2000s).** **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.**
Classify two-dimensional figures into categories based on their properties.	

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3. Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. *For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.*	**5.12 The student will classify** a) angles as right, acute, obtuse, or straight; and **b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.** **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. **5.13 CF** • **A rectangle is a parallelogram with four right angles. Since a rectangle is a parallelogram, a rectangle has the same properties as those of a parallelogram.** • **A square is a rectangle with four congruent sides. Since a square is a rectangle, a square has all the properties of a rectangle and of a parallelogram.** • **A rhombus is a parallelogram with four congruent sides. Opposite angles of a rhombus are congruent. Since a rhombus is a parallelogram, the rhombus has all the properties of a parallelogram.** • **A trapezoid is a quadrilateral with exactly one pair of parallel sides. The parallel sides are called *bases,* and the nonparallel sides are called *legs*. If the legs have the same length, then the trapezoid is an isosceles trapezoid.** **6.13 The student will describe and identify properties of quadrilaterals.** **6.13 CF** • **Sort and classify polygons as quadrilaterals, parallelograms, rectangles, trapezoids, kites, rhombi, and squares based on**

CCSS for Mathematics – Grade 5	Mathematics SOL
	their properties. Properties include number of parallel sides, angle measures and number of congruent sides.
4. Classify two-dimensional figures in a hierarchy based on properties.	**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. **5.13 CF** • **A rectangle is a parallelogram with four right angles. Since a rectangle is a parallelogram, a rectangle has the same properties as those of a parallelogram.** • **A square is a rectangle with four congruent sides. Since a square is a rectangle, a square has all the properties of a rectangle and of a parallelogram.** • **A rhombus is a parallelogram with four congruent sides. Opposite angles of a rhombus are congruent. Since a rhombus is a parallelogram,** • **the rhombus has all the properties of a parallelogram.** • **A trapezoid is a quadrilateral with exactly one pair of parallel sides. The parallel sides are called *bases,* and the nonparallel sides are called *legs*. If the legs have the same length, then the trapezoid is an isosceles trapezoid.** **6.13 The student will describe and identify properties of quadrilaterals.** **6.13 CF** • **Sort and classify polygons as quadrilaterals, parallelograms, rectangles, trapezoids, kites, rhombi, and squares based on**

CCSS for Mathematics – Grade 5	Mathematics SOL
	their properties. Properties include number of parallel sides, angle measures and number of congruent sides.

Mathematics SOL for grade 5 aligned with the CCSS at other grade levels	
Grade 4 – Operations and Algebraic Thinking 4. Find the factor pairs for a whole number in the range 1-100. Recognize that a whole number is a multiple of each of its factors. Determine whether a given whole number in the range 1-100 is a multiple of a given one-digit number. Determine whether a given whole number in the range 1-100 is prime or composite. Grade 2 – Operations and Algebraic Thinking 3. Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.	**5.3 The student will** **a) identify and describe the characteristics of prime and composite numbers; and** **b) identify and describe the characteristics of even and odd numbers.**
Grade 7 – Geometry 4. Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. Geometry [high school] – Circles 2. Identify and describe relationships among inscribed angles, radii, and chords. *Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.*	**5.9 The student will identify and describe the diameter, radius, chord, and circumference of a circle.**
Grade 3 – Measurement and Data 1. Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and	**5.10 The student will determine an amount of elapsed time in hours and minutes within a 24-hour period.**

Mathematics SOL for grade 5 aligned with the CCSS at other grade levels	
subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram. Grade 4 – Measurement and Data 2. Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.	
Grade 4 – Measurement and Data 5. Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement: a. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through 1/360 of a circle is called a "one-degree angle," and can be used to measure angles. b. An angle that turns through *n* one-degree angles is said to have an angle measure of *n* degrees. 6. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure. 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	**5.11 The student will measure right, acute, obtuse, and straight angles.**

Mathematics SOL for grade 5 aligned with the CCSS at other grade levels	
an equation with a symbol for the unknown angle measure.	
Grade 4 - Geometry 1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.	**5.12 The student will classify** **a) angles as right, acute, obtuse, or straight; and** b) triangles as right, acute, obtuse, equilateral, scalene, or isosceles.
Grade 4 – Geometry 2. Classify two-dimensional figures based on the presence or absence of parallel or perpendicular lines, or the presence or absence of angles of a specified size. Recognize right triangles as a category, and identify right triangles.	**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.**
Grade 7 – Statistics and Probability 8. Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation. b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.	**5.14 The student will make predictions and determine the probability of an outcome by constructing a sample space.**
Grade 6 – Statistics and Probability 1. Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. *For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.* 2. Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape. 3. Recognize that a measure of center for a numerical data set	**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** **d) describe the range of a set of data as a measure of variation.**

Mathematics SOL for grade 5 aligned with the CCSS at other grade levels	
summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number. 5. Summarize numerical data sets in relation to their context, such as by: c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.	
Grade 6 – Expressions and Equations 6. Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. Grade 6 – Expressions and Equations 6. Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set. 7. Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers. Grade 6 – Expressions and Equations	**5.18 The student will** **a) investigate and describe the concept of variable;** **b) write an open sentence to represent a given mathematical relationship, using a variable;** **c) model one-step linear equations in one variable, using addition and subtraction; and** **d) create a problem situation based on a given open sentence, using a single variable.**

Mathematics SOL for grade 5 aligned with the CCSS at other grade levels	
7. Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers.	
Grade 6 – The Number System 4. Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1–100 with a common factor as a multiple of a sum of two whole numbers with no common factor. *For example, express 36 + 8 as 4 (9 + 2).*	**5.19 The student will investigate and recognize the distributive property of multiplication over addition.**

Grade 6

CCSS for Mathematics – Grade 6	Mathematics SOL
Ratios and Proportional Relationships 6.RP	
Understand ratio concepts and use ratio reasoning to solve problems.	
1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. *For example, "The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."*	**6.1 The student will describe and compare data, using ratios, and will use appropriate notations, such as *a/b, a* to *b*, and *a*:*b*.** **CF 6.1** • **A ratio is a comparison of any two quantities. A ratio is used to represent relationships within and between sets.** • **A ratio can compare part of a set to the entire set (part-whole comparison).** • **A ratio can compare part of a set to another part of the same set (part-part comparison).** • **A ratio can compare part of a set to a corresponding part of another set (part-part comparison).** • **A ratio can compare all of a set to all of another set (whole-whole comparison).** **6.2 The student will** **a) investigate and describe fractions, decimals, and percents as ratios;** b) identify a given fraction, decimal, or percent from a representation; c) demonstrate equivalent relationships among fractions, decimals, and percents; and d) compare and order fractions, decimals, and percents. **7. 4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF**

CCSS for Mathematics – Grade 6	Mathematics SOL
	• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute.
2. Understand the concept of a unit rate *a*/*b* associated with a ratio *a*:*b* with *b* ≠ 0, and use rate language in the context of a ratio relationship. *For example, "This recipe has a ratio of 3 cups of flour to 4 cups of sugar, so there is 3/4 cup of flour for each cup of sugar." "We paid $75 for 15 hamburgers, which is a rate of $5 per hamburger."*	**6.1 The student will describe and compare data, using ratios, and will use appropriate notations, such as *a/b, a* to *b*, and *a*:*b*.** **7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.**
3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.	
a. Make tables of equivalent ratios relating quantities with whole number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.	**6.1 The student will describe and compare data, using ratios, and will use appropriate notations, such as *a/b, a* to *b*, and *a*:*b*.** **7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.12 The student will represent relationships with tables, graphs, rules, and words.**
b. Solve unit rate problems including those involving unit pricing and constant speed. *For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?*	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** **• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute.**
c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent.	**6.2 The student will** a) investigate and describe fractions, decimals, and percents as ratios; **b) identify a given fraction, decimal, or percent from a**

CCSS for Mathematics – Grade 6	Mathematics SOL
	representation; **c) demonstrate equivalent relationships among fractions, decimals, and percents; and** d) compare and order fractions, decimals, and percents. **7.4 CF** **• Using 10% as a benchmark, mentally compute 5%, 10%, 15%, or 20% in a practical situation such as tips, tax and discounts.** **• Solve problems involving tips, tax, and discounts. Limit problems to only one percent computation per problem.** **8.3 The student will** **a) solve practical problems involving rational numbers, percents, ratios, and proportions; and** b) determine the percent increase or decrease for a given situation.
d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.	**6.1 The student will describe and compare data, using ratios, and will use appropriate notations, such as *a/b, a* to *b*, and *a*:*b*.** **6.2 The student will** **a) investigate and describe fractions, decimals, and percents as ratios;** b) identify a given fraction, decimal, or percent from a representation; c) demonstrate equivalent relationships among fractions, decimals, and percents; and d) compare and order fractions, decimals, and percents. **7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.**
The Number System 6.NS	
Apply and extend previous understandings of multiplication and division to divide fractions by fractions.	

CCSS for Mathematics – Grade 6	Mathematics SOL
1. Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. *For example, create a story context for (2/3) ÷ (3/4) and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that (2/3) ÷ (3/4) = 8/9 because 3/4 of 8/9 is 2/3. (In general, (a/b) ÷ (c/d) = ad/bc.) How much chocolate will each person get if 3 people share 1/2 lb of chocolate equally? How many 3/4-cup servings are in 2/3 of a cup of yogurt? How wide is a rectangular strip of land with length 3/4 mi and area 1/2 square mi?*	**6.4 The student will demonstrate multiple representations of multiplication and division of fractions.** **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.**
Compute fluently with multi-digit numbers and find common factors and multiples.	
2. Fluently divide multi-digit numbers using the standard algorithm.	**4.4 The student will** a) estimate sums, differences, products, and quotients of whole numbers; b) add, subtract, and multiply whole numbers; **c) divide whole numbers, finding quotients with and without remainders; and** d) solve single-step and multistep addition, subtraction, and multiplication problems with whole numbers. **5.4 The student will create and solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division with and without remainders of whole numbers.**
3. Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.	**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

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	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. **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. **6.7 The student will solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of decimals.**
4. Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1–100 with a common factor as a multiple of a sum of two whole numbers with no common factor. *For example, express 36 + 8 as 4 (9 + 2).*	**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. **5.19 The student will investigate and recognize the distributive property of multiplication over addition.** **7.16 The student will apply the following properties of operations with real numbers:** a) the commutative and associative properties for addition and multiplication;

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	b) the distributive property; c) the additive and multiplicative identity properties; d) the additive and multiplicative inverse properties; and e) the multiplicative property of zero.
Apply and extend previous understandings of numbers to the system of rational numbers.	
5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.	**6.3 The student will** **a) identify and represent integers;** b) order and compare integers; and c) identify and describe absolute value of integers. **6.3 CF** • **Integers are the set of whole numbers, their opposites, and zero.** • **What role do negative integers play in practical situations? Some examples of the use of negative integers are found in temperature (below 0), finance (owing money), below sea level. There are many other examples.** **7.3 The student will** a) model addition, subtraction, multiplication and division of integers; and **b) add, subtract, multiply, and divide integers**. **7.3 CF** • **Integers are used in practical situations, such as temperature changes (above/below zero), balance in a checking account (deposits/withdrawals), and changes in altitude (above/below sea level).**
6. Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane	

CCSS for Mathematics – Grade 6	Mathematics SOL
with negative number coordinates.	
a. Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., –(–3) = 3, and that 0 is its own opposite.	**6.3 The student will** **a) identify and represent integers;** **b) order and compare integers; and** c) identify and describe absolute value of integers. **6.3 CF Understanding the Standard** • **Integers are the set of whole numbers, their opposites, and zero.** • **Positive integers are greater than zero.** • **Negative integers are less than zero.** • **Zero is an integer that is neither positive nor negative.** • **A negative integer is always less than a positive integer.** • **When comparing two negative integers, the negative integer that is closer to zero is greater.** • **An integer and its opposite are the same distance from zero on a number line. For example, the opposite of 3 is -3.** • **The absolute value of a number is the distance of a number from zero on the number line regardless of direction. Absolute value is represented as -6 = 6.**
b. Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.	**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.**
c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.	**6.2 The student will** a) investigate and describe fractions, decimals, and percents as ratios; b) identify a given fraction, decimal, or percent from a representation; c) demonstrate equivalent relationships among fractions,

CCSS for Mathematics – Grade 6	Mathematics SOL
	decimals, and percents; and **d) compare and order fractions, decimals, and percents.** **6.3 The student will** **a) identify and represent integers;** **b) order and compare integers; and** c) identify and describe absolute value of integers. **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.**
7. Understand ordering and absolute value of rational numbers.	
a. Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. *For example, interpret –3 > –7 as a statement that –3 is located to the right of –7 on a number line oriented from left to right.*	**6.3 The student will** a) identify and represent integers; **b) order and compare integers; and** c) identify and describe absolute value of integers.
b. Write, interpret, and explain statements of order for rational numbers in real-world contexts. *For example, write –3°C > –7°C to express the fact that –3°C is warmer than –7°C.*	**6.3 The student will** a) identify and represent integers; **b) order and compare integers; and** c) identify and describe absolute value of integers. **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.**
c. Understand the absolute value of a rational number as its distance from 0 on the number line; interpret absolute value as magnitude for a positive or negative quantity in a real-world	**6.3 The student will** a) identify and represent integers; b) order and compare integers; and

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situation. *For example, for an account balance of –30 dollars, write |–30| = 30 to describe the size of the debt in dollars.*	**c) identify and describe absolute value of integers.** **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.**
d. Distinguish comparisons of absolute value from statements about order. *For example, recognize that an account balance less than –30 dollars represents a debt greater than 30 dollars.*	**6.3 The student will** a) identify and represent integers; b) order and compare integers; and **c) identify and describe absolute value of integers.** **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.**
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.**
Expressions and Equations 6.EE	

<table>
<tr><th>CCSS for Mathematics – Grade 6</th><th>Mathematics SOL</th></tr>
<tr><td>Apply and extend previous understandings of arithmetic to algebraic expressions.</td><td></td></tr>
<tr><td>1. Write and evaluate numerical expressions involving whole-number exponents.</td><td>6.8 The student will evaluate whole number numerical expressions, using the order of operations.
6.8 CF
• Find the value of numerical expressions, using order of operations, mental mathematics, and appropriate tools. Exponents are limited to positive values.
7.13 The student will
a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and
b) evaluate algebraic expressions for given replacement values of the variables.</td></tr>
<tr><td>2. Write, read, and evaluate expressions in which letters stand for numbers.</td><td></td></tr>
<tr><td>a. Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation “Subtract y from 5” as 5 – y.</td><td>5.17 The student will describe the relationship found in a number pattern and express the relationship.
5.17 CF
• When the pattern data are expressed in a T-table, an expression can represent that data. An example is:
<table><tr><th>x</th><th>y</th></tr><tr><td>6</td><td>9</td></tr><tr><td>7</td><td>10</td></tr><tr><td>11</td><td>14</td></tr><tr><td>15</td><td>18</td></tr></table>This example defines the relationship as x + 3.
7.13 The student will</td></tr>
</table>

CCSS for Mathematics – Grade 6	Mathematics SOL
	a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and b) evaluate algebraic expressions for given replacement values of the variables.
b. Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. *For example, describe the expression 2 (8 + 7) as a product of two factors; view (8 + 7) as both a single entity and a sum of two terms.*	**6.18 The student will solve one-step linear equations in one variable involving whole number coefficients and positive rational solutions.** **6.18 CF** • **Identify and use the following algebraic terms appropriately: *equation*, *variable, expression, term,* and *coefficient*.** **7.13 The student will** **a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and** b) evaluate algebraic expressions for given replacement values of the variables.
c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). *For example, use the formulas $V = s^3$ and $A = 6 s^2$ to find the volume and surface area of a cube with sides of length s = 1/2.*	**5.7 The student will evaluate whole number numerical expressions, using the order of operations limited to parentheses, addition, subtraction, multiplication, and division.** **6.8 The student will evaluate whole number numerical expressions, using the order of operations.** **7.13 The student will** a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and **b) evaluate algebraic expressions for given replacement values of the variables.** **8.4 The student will apply the order of operations to evaluate algebraic expressions for given replacement values of the variables.**
3. Apply the properties of operations to generate equivalent	**6.19 The student will investigate and recognize**

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expressions. *For example, apply the distributive property to the expression 3 (2 + x) to produce the equivalent expression 6 + 3x; apply the distributive property to the expression 24x + 18y to produce the equivalent expression 6 (4x + 3y); apply properties of operations to y + y + y to produce the equivalent expression 3y.*	**a) the identity properties for addition and multiplication;** **b) the multiplicative property of zero; and** **c) the inverse property for multiplication.** **7.16 The student will apply the following properties of operations with real numbers:** **a) the commutative and associative properties for addition and multiplication;** **b) the distributive property;** **c) the additive and multiplicative identity properties;** **d) the additive and multiplicative inverse properties; and** **e) the multiplicative property of zero.**
4. Identify when two expressions are equivalent (i.e., when the two expressions name the same number regardless of which value is substituted into them). *For example, the expressions y + y + y and 3y are equivalent because they name the same number regardless of which number y stands for.*	**8.4 The student will apply the order of operations to evaluate algebraic expressions for given replacement values of the variables.** **8.4 CF** • **Substitute numbers for variables in algebraic expressions and simplify the expressions by using the order of operations. Exponents are positive and limited to whole numbers less than 4. Square roots are limited to perfect squares.**
Reason about and solve one-variable equations and inequalities.	
5. Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true.	**6.18 The student will solve one-step linear equations in one variable involving whole number coefficients and positive rational solutions.** **6.18 CF** • **When solving an equation, why is it necessary to perform the same operation on both sides of an equal sign?** • **Represent and solve a one-step equation, using a variety of concrete materials such as colored chips, algebra tiles, or**

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	weights on a balance scale. **6.20 The student will graph inequalities on a number line.** **7.15 The student will** **a) solve one-step inequalities in one variable; and** **b) graph solutions to inequalities on the number line.** **7.15 CF** • **Identify a numerical value that satisfies the inequality.**
6. Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.	**5.17 The student will describe the relationship found in a number pattern and express the relationship.** **5.17 CF** • **Describe the relationship found in patterns, using words, tables, and symbols to express the relationship.** **5.18 The student will** **a) investigate and describe the concept of variable;** b) write an open sentence to represent a given mathematical relationship, using a variable; c) model one-step linear equations in one variable, using addition and subtraction; and d) create a problem situation based on a given open sentence, using a single variable.
7. Solve real-world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers.	**5.18 The student will** a) investigate and describe the concept of variable; **b) write an open sentence to represent a given mathematical relationship, using a variable;** **c) model one-step linear equations in one variable, using addition and subtraction; and** **d) create a problem situation based on a given open sentence, using a single variable.** **6.18 The student will solve one-step linear equations in one**

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	variable involving whole number coefficients and positive rational solutions.
8. Write an inequality of the form $x > c$ or $x < c$ to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form $x > c$ or $x < c$ have infinitely many solutions; represent solutions of such inequalities on number line diagrams.	**6.20 The student will graph inequalities on a number line.** **6.20 CF** • **Given a simple inequality with integers, graph the relationship on a number line.** • **Given the graph of a simple inequality with integers, represent the inequality two different ways using symbols (<, >, <, >).** **7.15 The student will** **a) solve one-step inequalities in one variable; and** **b) graph solutions to inequalities on the number line.** **7.15 CF** • **Represent and demonstrate steps in solving inequalities in one variable, using concrete materials, pictorial representations, and algebraic sentences.** • **Graph solutions to inequalities on the number line.** • **Identify a numerical value that satisfies the inequality.**
Represent and analyze quantitative relationships between dependent and independent variables.	
9. Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. *For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation d = 65t to*	**7.12 The student will represent relationships with tables, graphs, rules, and words.** **8.17 The student will identify the domain, range, independent variable or dependent variable in a given situation.**

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represent the relationship between distance and time.	
Geometry 6.G	
Solve real-world and mathematical problems involving area, surface area, and volume.	
1. Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure;** **b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;** c) identify equivalent measurements within the metric system; d) estimate and then measure to solve problems, using U.S. Customary and metric units; and e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units. **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. **8.11 The student will solve practical area and perimeter problems involving composite plane figures.** **8.11 CF** • **Subdivide a figure into triangles, rectangles, squares, trapezoids and semicircles. Estimate the area of subdivisions and combine to determine the area of the composite figure.**

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	• **Use the attributes of the subdivisions to determine the perimeter and circumference of a figure.** • **Apply perimeter, circumference and area formulas to solve practical problems.**
2. Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas *V = l w h* and *V = b h* to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.	**5.8 The student will** **a) find perimeter, area, and volume in standard units of measure;** **b) differentiate among perimeter, area, and volume and identify whether the application of the concept of perimeter, area, or volume is appropriate for a given situation;** **c) identify equivalent measurements within the metric system;** **d) estimate and then measure to solve problems, using U.S. Customary and metric units; and** **e) choose an appropriate unit of measure for a given situation involving measurement using U.S. Customary and metric units.** **5.8 CF** • **Develop a procedure for finding volume using manipulatives (e.g., cubes).** **6.10 The student will** a) define π (pi) 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.**
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	**6.12 The student will determine congruence of segments, angles, and polygons.** **6.12 CF**

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coordinate. Apply these techniques in the context of solving real-world and mathematical problems.	• **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.**
4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.	**6.10 The student will** a) define π (pi) 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.** **7.5 The student will** **a) describe volume and surface area of cylinders;** **b) solve practical problems involving the volume and surface area of rectangular prisms and cylinders; and** **c) describe how changing one measured attribute of a rectangular prism affects its volume and surface area.** **7.5 CF** • **A rectangular prism can be represented on a flat surface as a net that contains six rectangles — two that have measures of the length and width of the base, two others that have measures of the length and height, and two others that have measures of the width and height. The surface area of a rectangular prism is the sum of the areas of all six faces ($SA = 2lw + 2lh + 2wh$).**
Statistics and Probability 6.SP	
Develop understanding of statistical variability.	

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1. Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. *For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.*	**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** **d) describe the range of a set of data as a measure of variation.** **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.** **6.14 CF** **• To collect data for any problem situation, an experiment can be designed, a survey can be conducted, or other data-gathering strategies can be used. The data can be organized, displayed, analyzed, and interpreted to answer the problem.**
2. Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.	**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** **d) describe the range of a set of data as a measure of variation.** **6.15 The student will** **a) describe mean as balance point; and** **b) decide which measure of center is appropriate for a given purpose.**
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 single number.	**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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	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.** **6.15 The student will** **a) describe mean as balance point; and** **b) decide which measure of center is appropriate for a given purpose.**
Summarize and describe distributions.	
4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.	**3.17 The student will** a) collect and organize data, using observations, measurements, surveys, or experiments; **b) construct a line plot, a picture graph, or a bar graph to represent the data; and** c) read and interpret the data represented **7.11 The student, given data for a practical situation, will** **a) construct and analyze histograms; and** b) compare and contrast histograms with other types of graphs presenting information from the same data set. **A.10 The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.**
5. Summarize numerical data sets in relation to their context, such as by:	
a. Reporting the number of observations.	**6.14 The student, given a problem situation, will** **a) construct circle graphs;** **b) draw conclusions and make predictions, using circle graphs;** **c) compare and contrast graphs that present information from the same data set.** **6.14 CF**

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	• To collect data for any problem situation, an experiment can be designed, a survey can be conducted, or other data-gathering strategies can be used. The data can be organized, displayed, analyzed, and interpreted to answer the problem. **• Different types of graphs are used to display different types of data.** **– Bar graphs use categorical (discrete) data (e.g., months or eye color).** **– Line graphs use continuous data (e.g., temperature and time).** **– Circle graphs show a relationship of the parts to a whole.** **6.15 The student will** **a) describe mean as balance point; and** **b) decide which measure of center is appropriate for a given purpose.** **6.15 CF** **• Mean can be defined as the point on a number line where the data distribution is balanced. This means that the sum of the distances from the mean of all the points above the mean is equal to the sum of the distances of all the data points below the mean. This is the concept of mean as the balance point.** **7.11 The student, given data for a practical situation, will** **a) construct and analyze histograms; and** **b) compare and contrast histograms with other types of graphs presenting information from the same data set.**
b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.	**5.15 The student, given a problem situation, will collect, organize, and interpret data in a variety of forms, using stem-and-leaf plots and line graphs.** **5.15 CF**

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	• A key is often included to explain how to read the plot. **6.14 The student, given a problem situation, will** **a) construct circle graphs;** **b) draw conclusions and make predictions, using circle graphs;** **c) compare and contrast graphs that present information from the same data set.** **6.14 CF** **• To collect data for any problem situation, an experiment can be designed, a survey can be conducted, or other data-gathering strategies can be used. The data can be organized, displayed, analyzed, and interpreted to answer the problem.** **• Different types of graphs are used to display different types of data.** **– Bar graphs use categorical (discrete) data (e.g., months or eye color).** **– Line graphs use continuous data (e.g., temperature and time).** **– Circle graphs**
c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.	**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** **d) describe the range of a set of data as a measure of variation.** **A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-scores.** **A.10 The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.** **6.15 The student will**

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	a) describe mean as balance point; and **b) decide which measure of center is appropriate for a given purpose.**
d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.	**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** **d) describe the range of a set of data as a measure of variation.** **6.15 The student will** **a) describe mean as balance point; and** **b) decide which measure of center is appropriate for a given purpose.** **A.10 The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.**

Mathematics SOL for grade 6 aligned with the CCSS at other grade levels	
Grade 5 — Number and Operations in Base Ten 2. Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.	**6.5 The student will investigate and describe concepts of positive exponents and perfect squares.**
Geometry [high school] – Congruence 1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	**6.12 The student will determine congruence of segments, angles, and polygons.**
Statistics [high school] — Conditional Probability and the Rules of Probability	**6.16 The student will** **a) compare and contrast dependent and independent events;**

Mathematics SOL for grade 6 aligned with the CCSS at other grade levels	
1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not"). 2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. 3. Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of *A*, and the conditional probability of *B* given *A* is the same as the probability of *B*.	**and** **b) determine probabilities for dependent and independent events.**
Functions [high school] — Building Functions 1. Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context.	**6.17 The student will identify and extend geometric and arithmetic sequences.**

Mathematics SOL for grade 6 not explicitly stated in the CCSS at any grade level	
	6.9 The student will make ballpark comparisons between measurements in the U.S. Customary System of measurement and measurements in the metric system.

Grade 7

CCSS for Mathematics – Grade 7	Mathematics SOL
Ratios and Proportional Relationships 7.RP	
Analyze proportional relationships and use them to solve real-world and mathematical problems.	
1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. *For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction 1/2/1/4 miles per hour, equivalently 2 miles per hour.*	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** **• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute.**
2. Recognize and represent proportional relationships between quantities.	
a. Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** **• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute.** **7.6 The student will determine whether plane figures—quadrilaterals and triangles—are similar and write proportions to express the relationships between corresponding sides of similar figures.** **7.12 The student will represent relationships with tables, graphs, rules, and words.**
b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** **• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute.**

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	7.12 The student will represent relationships with tables, graphs, rules, and words. **A.8 The student, given a situation in a real-world context, will analyze a relation to determine whether a direct or inverse variation exists, and represent a direct variation algebraically and graphically and an inverse variation algebraically.** **A.8 CF** **• The constant of proportionality in a direct variation is represented by the ratio of the dependent variable to the independent variable.** **• A direct variation can be represented by a line passing through the origin.**
c. Represent proportional relationships by equations. *For example, if total cost t is proportional to the number n of items purchased at a constant price p, the relationship between the total cost and the number of items can be expressed as t = pn*.	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** **• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and revolutions/minute.** **7.12 The student will represent relationships with tables, graphs, rules, and words.** **8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.**
d. Explain what a point *(x, y)* on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, *r)* where *r* is the unit rate.	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** **• A rate is a ratio that compares two quantities measured in different units. A unit rate is a rate with a denominator of 1. Examples of rates include miles/hour and**

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	revolutions/minute. **7.12 The student will represent relationships with tables, graphs, rules, and words.** **8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.**
3. Use proportional relationships to solve multistep ratio and percent problems. *Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.*	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **8.3 The student will** **a) solve practical problems involving rational numbers, percents, ratios, and proportions; and** **b) determine the percent increase or decrease for a given situation.**
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.	
a. Describe situations in which opposite quantities combine to make 0. *For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.*	**7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** b) add, subtract, multiply, and divide integers. **7.16 The student will apply the following properties of operations with real numbers:** a) the commutative and associative properties for addition and multiplication;

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	b) the distributive property; c) the additive and multiplicative identity properties; **d) the additive and multiplicative inverse properties; and** e) the multiplicative property of zero.
b. Understand $p + q$ as the number located a distance $\|q\|$ from p, in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.	**6.3 The student will** a) identify and represent integers; b) order and compare integers; and **c) identify and describe absolute value of integers.** **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.** **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** b) add, subtract, multiply, and divide integers. **7.16 The student will apply the following properties of operations with real numbers:** a) the commutative and associative properties for addition and multiplication; b) the distributive property; c) the additive and multiplicative identity properties; **d) the additive and multiplicative inverse properties; and** e) the multiplicative property of zero.
c. Understand subtraction of rational numbers as adding the	**6.3 The student will**

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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.	a) identify and represent integers; b) order and compare integers; and **c) identify and describe absolute value of integers.** **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.** **7.16 The student will apply the following properties of operations with real numbers:** a) the commutative and associative properties for addition and multiplication; b) the distributive property; c) the additive and multiplicative identity properties; **d) the additive and multiplicative inverse properties; and** e) the multiplicative property of zero.
d. Apply properties of operations as strategies to add and subtract rational numbers.	**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.**

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	5.6 The student will solve single-step and multistep practical problems involving addition and subtraction with fractions and mixed numbers and express answers in simplest form. **6.6 The student will** a) multiply and divide fractions and mixed numbers; and **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.** **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** **b) add, subtract, multiply, and divide integers.** **7.16 The student will apply the following properties of operations with real numbers:** **a) the commutative and associative properties for addition and multiplication;** b) the distributive property; **c) the additive and multiplicative identity properties;** **d) the additive and multiplicative inverse properties; and** e) the multiplicative property of zero.
2. Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.	
a. Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as (–1)(–1) = 1 and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.	**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.**

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	6.6 The student will **a) multiply and divide fractions and mixed numbers; and** b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions. **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** **b) add, subtract, multiply, and divide integers.** **7.16 The student will apply the following properties of operations with real numbers:** **a) the commutative and associative properties for addition and multiplication;** **b) the distributive property;** **c) the additive and multiplicative identity properties;** **d) the additive and multiplicative inverse properties; and** **e) the multiplicative property of zero.**
b. Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If p and q are integers, then $-(p/q) = (-p)/q = p/(-q)$. Interpret quotients of rational numbers by describing real world contexts.	**6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.** **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** **b) add, subtract, multiply, and divide integers.**
c. Apply properties of operations as strategies to multiply and divide rational numbers.	**6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** **b) estimate solutions and then solve single-step and multistep**

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	practical problems involving addition, subtraction, multiplication, and division of fractions. **6.7 The student will solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of decimals.** **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** **b) add, subtract, multiply, and divide integers.** **7.16 The student will apply the following properties of operations with real numbers:** **a) the commutative and associative properties for addition and multiplication;** **b) the distributive property;** **c) the additive and multiplicative identity properties;** **d) the additive and multiplicative inverse properties; and** **e) the multiplicative property of zero.**
d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats.	**6.2 The student will** **a) investigate and describe fractions, decimals and percents as ratios;** **b) identify a given fraction, decimal or percent from a representation;** **c) demonstrate equivalent relationships among fractions, decimals, and percents; and** **d) compare and order fractions, decimals, and percents.** **6.2 CF** **• Percents are used in real life for taxes, sales, data description, and data comparison.** **8.2 The student will describe orally and in writing the**

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	relationships between the subsets of the real number system. **8.2 CF** • **The set of rational numbers includes the set of all numbers that can be expressed as fractions in the form a/b where a and b are integers and b does not equal zero.**
3. Solve real-world and mathematical problems involving the four operations with rational numbers.	**6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.** **6.7 The student will solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of decimals.** **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** **b) add, subtract, multiply, and divide integers.** **8.3 The student will** **a) solve practical problems involving rational numbers, percents, ratios, and proportions; and** **b) determine the percent increase or decrease for a given situation.**
Expressions and Equations 7.EE	
Use properties of operations to generate equivalent expressions.	
1. Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.	**7.14 The student will** **a) solve one- and two-step linear equations in one variable; and** b) solve practical problems requiring the solution of one- and two-step linear equations.

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	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.** **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.**
2. Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. *For example, a + 0.05a = 1.05a means that "increase by 5%" is the same as "multiply by 1.05."*	**7.13 The student will** **a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and** b) evaluate algebraic expressions for given replacement values of the variables. **7.14 The student will** a) solve one- and two-step linear equations in one variable; and **b) solve practical problems requiring the solution of one- and two-step linear equations.**
Solve real-life and mathematical problems using numerical and algebraic expressions and equations.	
3. Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole	**5.4 The student will create and solve single-step and multistep practical problems involving addition, subtraction,**

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numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.*	**multiplication, and division with and without remainders of whole numbers.** **6.6 The student will** **a) multiply and divide fractions and mixed numbers; and** **b) estimate solutions and then solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of fractions.** **6.7 The student will solve single-step and multistep practical problems involving addition, subtraction, multiplication, and division of decimals.** **7.3 The student will** **a) model addition, subtraction, multiplication, and division of integers; and** **b) add, subtract, multiply, and divide integers.** **7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **8.3 The student will** **a) solve practical problems involving rational numbers, percents, ratios, and proportions; and** **b) determine the percent increase or decrease for a given situation.**
4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.	
a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. *For example, the*	**7.14 The student will** **a) solve one- and two-step linear equations in one variable; and** **b) solve practical problems requiring the solution of one- and two-step linear equations.** **8.15 The student will**

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perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?	**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.**
b. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. *For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.*	**7.15 The student will** **a) solve one-step inequalities in one variable; and** **b) graph solutions to inequalities on the number line.** **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.**
Geometry 7.G	
Draw, construct, and describe geometrical figures and describe the relationships between them.	
1. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.4 CF** • **Apply proportions to solve practical problems, including scale drawings. Scale factors shall have denominators no greater than 12 and decimals no less than tenths.** **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.**
2. Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides,	**3.15 The student will identify and draw representations of points, line segments, rays, angles, and lines.** **3.15 CF**

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noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.	• **Draw representations of points, line segments, rays, angles, and lines, using a ruler or straightedge.** **5.11 The student will measure right, acute, obtuse, and straight angles.** **5.11 CF** • **Identify the appropriate tools (e.g., protractor and straightedge or angle ruler as well as available software) used to measure and draw angles and triangles.**
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.	
4. Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.	**5.9 The student will identify and describe the diameter, radius, chord, and circumference of a circle.** **6.10 The student will** **a) define π (pi) 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

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	rectangular prism.
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.**
6. Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.	**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;** **d) describe and determine the volume and surface area of a rectangular prism.** **7.5 The student will** **a) describe volume and surface area of cylinders;** **b) solve practical problems involving the volume and surface area of rectangular prisms and cylinders; and** **c) describe how changing one measured attribute of a rectangular prism affects its volume and surface area.**
Statistics and Probability 7.SP	
Use random sampling to draw inferences about a population.	
1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand	**6.14 The student, given a problem situation, will** **a) construct circle graphs;** **b) draw conclusions and make predictions, using circle graphs; and**

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that random sampling tends to produce representative samples and support valid inferences.	**c) compare and contrast graphs that present information from the same data set.** **A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-scores.** **AFDA.8 The student will design and conduct an experiment/survey. Key concepts include** **a) sample size;** **b) sampling technique;** c) controlling sources of bias and experimental error; **d) data collection; and** **e) data analysis and reporting.**
2. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. *For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.*	**A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-scores.** **AFDA.8 The student will design and conduct an experiment/survey. Key concepts include** **a) sample size;** **b) sampling technique;** c) controlling sources of bias and experimental error; **d) data collection; and** **e) data analysis and reporting.**
Draw informal comparative inferences about two populations.	
3. Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. *For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability*	**6.15 The student will** **a) describe mean as balance point; and** **b) decide which measure of center is appropriate for a given purpose.** **A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute**

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(mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.	**deviation, standard deviation, and z-scores.**
4. Use measures of center and measures of variability for numerical data from random samples to draw informal comparative inferences about two populations. *For example, decide whether the words in a chapter of a seventh-grade science book are generally longer than the words in a chapter of a fourth-grade science book.*	**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** **d) describe the range of a set of data as a measure of variation.** **6.15 The student will** a) describe mean as balance point; and **b) decide which measure of center is appropriate for a given purpose.**
Investigate chance processes and develop, use, and evaluate probability models.	
5. Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	**4.13 The student will** **a) predict the likelihood of an outcome of a simple event; and** **b) represent probability as a number between 0 and 1, inclusive.**
6. Approximate the probability of a chance event by collecting data on the chance process that produces it and observing its long-run relative frequency, and predict the approximate relative frequency given the probability. *For example, when rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.*	**5.14 The student will make predictions and determine the probability of an outcome by constructing a sample space.** **7.9 The student will investigate and describe the difference between the experimental probability and theoretical probability of an event.**
7. Develop a probability model and use it to find probabilities of events. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible	

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sources of the discrepancy.	
a. Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. *For example, if a student is selected at random from a class, find the probability that Jane will be selected and the probability that a girl will be selected.*	**7.9 The student will investigate and describe the difference between the experimental probability and theoretical probability of an event.**
b. Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. *For example, find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?*	**7.9 The student will investigate and describe the difference between the experimental probability and theoretical probability of an event.**
8. Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.	
a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.	**5.14 The student will make predictions and determine the probability of an outcome by constructing a sample space.** **6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent events.** **7.10 The student will determine the probability of compound events, using the Fundamental (Basic) Counting Principle.**
b. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. For an event described in everyday language (e.g., "rolling double sixes"), identify the outcomes in the sample space which compose the event.	**5.14 The student will make predictions and determine the probability of an outcome by constructing a sample space.** **6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent**

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	events **7.10 The student will determine the probability of compound events, using the Fundamental (Basic) Counting Principle.**
c. Design and use a simulation to generate frequencies for compound events. *For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?*	**6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent events.** **7.10 The student will determine the probability of compound events, using the Fundamental (Basic) Counting Principle.**

Mathematics SOL for grade 7 aligned with the CCSS at other grade levels	
Grade 8 — Expressions and Equations 1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example, 32 × 3–5 = 3–3 = 1/33 = 1/27.* 2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational. 3. Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. *For example, estimate the population of the United States as 3 × 108 and the population of the world as 7 × 109, and determine that the world population is more than 20 times larger.*	**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.

Mathematics SOL for grade 7 aligned with the CCSS at other grade levels	
4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.	
Grade 5—Operations and Algebraic Thinking 3. Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. *For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.* Functions [high school] — Building Functions 1. Write a function that describes a relationship between two quantities. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. 2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.	**7.2 The student will describe and represent arithmetic and geometric sequences, using variable expressions.**
Grade 6 — Statistics and Probability 4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.	**7.11 The student, given data for a practical situation, will** **a) construct and analyze histograms; and** **b) compare and contrast histograms with other types of graphs presenting information from the same data set.**

Mathematics SOL for grade 7 aligned with the CCSS at other grade levels	
Grade 6 — Expressions and Equations 1. Write and evaluate numerical expressions involving whole-number exponents. 2. Write, read, and evaluate expressions in which letters stand for numbers. c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). *For example, use the formulas $V = s^3$ and $A = 6 s^2$ to find the volume and surface area of a cube with sides of length s = 1/2.*	**7.13 The student will** a) write verbal expressions as algebraic expressions and sentences as equations and vice versa; and **b) evaluate algebraic expressions for given replacement values of the variables.**

Mathematics SOL for grade 7 not explicitly stated in the CCSS at any grade level	
	7.7 The student will compare and contrast the following quadrilaterals based on properties: parallelogram, rectangle, square, rhombus, and trapezoid.

Grade 8

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The Number System 8.NS	
Know that there are numbers that are not rational, and approximate them by rational numbers.	
1. Know that numbers that are not rational are irrational. Understand informally that every number has a decimal expansion; the rational numbers are those with decimal expansions that terminate in 0s or eventually repeat. Know that other numbers are called irrational.	**8.2 The student will describe orally and in writing the relationships between the subsets of the real number system.**
2. Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2). *For example, by truncating the decimal expansion of √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.*	**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. **8.2 The student will describe orally and in writing the relationships between the subsets of the real number system.** **8.5 The student will** **a) determine whether a given number is a perfect square; and** **b) find the two consecutive whole numbers between which a square root lies.** **A.3 The student will express the square roots and cube roots of whole numbers and the square root of a monomial algebraic expression in simplest radical form.**
Expressions and Equations 8.EE	
Work with radicals and integer exponents.	
1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5}$	**6.5 The student will investigate and describe concepts of positive exponents and perfect squares.**

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= 3^{-3} = $(1/3)^3$ = 1/27.	**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. **8.1 The student will** **a) simplify numerical expressions involving positive exponents, using rational numbers, order of operations, and properties of operations with real numbers; and** **b) compare and order decimals, fractions, percents, and numbers written in scientific notation.** **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.
2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.	**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;

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	d) determine square roots; and e) identify and describe absolute value for rational numbers. **8.2 The student will describe orally and in writing the relationships between the subsets of the real number system.** **8.5 The student will** **a) determine whether a given number is a perfect square; and** **b) find the two consecutive whole numbers between which a square root lies.** **A.3 The student will express the square roots and cube roots of whole numbers and the square root of a monomial algebraic expression in simplest radical form.**
3. Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. *For example, estimate the population of the United States as 3×10^8 and the population of the world as 7×10^9, and determine that the world population is more than 20 times larger.*	**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. **8.1 The student will** a) simplify numerical expressions involving positive exponents, using rational numbers, order of operations, and properties of operations with real numbers; and **b) compare and order decimals, fractions, percents, and numbers written in scientific notation.**
4. Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small	**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;**

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quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.	**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. **8.1 The student will** **a) simplify numerical expressions involving positive exponents, using rational numbers, order of operations, and properties of operations with real numbers; and** **b) compare and order decimals, fractions, percents, and numbers written in scientific notation.**
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, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **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 represented in different ways.** **A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** b) writing the equation of a line when given the graph of the line,

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	two points on the line, or the slope and a point on the line.
6. Use similar triangles to explain why the slope *m* is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation *y* = *mx* for a line through the origin and the equation *y* = *mx* + *b* for a line intercepting the vertical axis at *b*.	**7.6 The student will determine whether plane figures—quadrilaterals and triangles—are similar and write proportions to express the relationships between corresponding sides of similar figures.** **A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.
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).	**8.15 The student will** **a) solve multistep linear equations in one variable with the 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. **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;

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	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.**
b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.	**8.15 The student will** **a) solve multistep linear equations in one variable with the 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.** **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

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	equations. Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions.
8. Analyze and solve pairs of simultaneous linear equations.	
a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.	**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 whether a system of two linear equations has one solution, no solution, or infinite solutions.**
b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. *For example, 3x + 2y = 5 and 3x + 2y = 6 have no solution because 3x + 2y cannot simultaneously be 5 and 6.*	**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;

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	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.
c. Solve real-world and mathematical problems leading to two linear equations in two variables. *For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.*	**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** • **Systems of two linear equations can be used to model two real-world conditions that must be satisfied simultaneously.**
Functions 8.F	
Define, evaluate, and compare functions.	
1. Understand that a function is a rule that assigns to each input	**7.12 The student will represent relationships with tables,**

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exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.	**graphs, rules, and words.** **8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **8.16 The student will graph a linear equation in two variables.** **8.17 The student will identify the domain, range, independent variable, or dependent variable in a given situation.**
2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.*	**7.12 The student will represent relationships with tables, graphs, rules, and words.** **8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **8.14 CF** • **Describe and represent relations and functions, using tables, graphs, words, and rules. Given one representation, students will be able to represent the relation in another form.**
3. Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line.*	**8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **8.16 The student will graph a linear equation in two variables.** **A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** **b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.** **A.6 The student will graph linear equations and linear**

CCSS for Mathematics – Grade 8	Mathematics SOL
	inequalities in two variables, including **a) determining the slope of a line when given an equation of the line, the graph of the line, or** **two points on the line. Slope will be described as rate of change and will be positive,** **negative, zero, or undefined; and** **b) writing the equation of a line when given the graph of the line, two points on the line, or the** **slope and a point on the line.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** b) domain and range; c) zeros of a function; d) *x*- and *y*-intercepts; e) finding the values of a function for elements in its domain; and **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.**
Use functions to model relationships between quantities.	
4. Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x*, *y*) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.	**8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **8.16 The student will graph a linear equation in two variables.** **8.16 CF** • **A linear equation represents a situation with a constant rate. For example, when driving at a rate of 35 mph, the distance increases as the time increases, but the rate of speed remains**

CCSS for Mathematics – Grade 8	Mathematics SOL
	the same. **A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** **b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their** **characteristics both algebraically and graphically, including** a) determining whether a relation is a function; b) domain and range; c) zeros of a function; **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** f) making connections between and among multiple representations.
5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.	**8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **8.14 CF** • **Describe and represent relations and functions, using tables, graphs, words, and rules. Given one representation, students will be able to represent the relation in another form.** **8.16 The student will graph a linear equation in two variables.** **A.7 The student will investigate and analyze function (linear and**

CCSS for Mathematics – Grade 8	Mathematics SOL
	quadratic) families and their characteristics both algebraically and graphically, including a) determining whether a relation is a function; b) domain and range; c) zeros of a function; d) *x*- and *y*-intercepts; e) finding the values of a function for elements in its domain; and **f) making connections between and among multiple representations.**
Geometry 8.G	
Understand congruence and similarity using physical models, transparencies, or geometry software.	
1. Verify experimentally the properties of rotations, reflections, and translations:	
a. Lines are taken to lines, and line segments to line segments of the same length.	**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.** **8.8 The student will** **a) apply transformations to plane figures; and** **b) identify applications of transformations.**
b. Angles are taken to angles of the same measure.	
c. Parallel lines are taken to parallel lines.	
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.	**4.11 The student will** **a) investigate congruence of plane figures after geometric transformations, such as reflection, translation, and rotation, using mirrors, paper folding, and tracing; and** **b) recognize the images of figures resulting from geometric transformations, such as translation, reflection, and rotation.** **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.**

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	8.8 The student will **a) apply transformations to plane figures; and** **b) identify applications of transformations.**
3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.	**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.** **8.8 The student will** **a) apply transformations to plane figures; and** **b) identify applications of transformations.**
4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two dimensional figures, describe a sequence that exhibits the similarity between them.	**7.6 The student will determine whether plane figures—quadrilaterals and triangles—are similar and write proportions to express the relationships between corresponding sides of similar figures.** **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.** **8.8 The student will** **a) apply transformations to plane figures; and** **b) identify applications of transformations.**
5. Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. *For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.*	**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°.** **G.2 The student will use the relationships between angles formed by two lines cut by a transversal to** **a) determine whether two lines are parallel;** **b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and**

CCSS for Mathematics – Grade 8	Mathematics SOL
	c) solve real-world problems involving angles formed when parallel lines are cut by a transversal. **G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.**
Understand and apply the Pythagorean Theorem	
6. Explain a proof of the Pythagorean Theorem and its converse.	**8.10 The student will** **a) verify the Pythagorean Theorem; and** b) apply the Pythagorean Theorem.
7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.	**8.10 The student will** a) verify the Pythagorean Theorem; and **b) apply the Pythagorean Theorem.**
8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.	**8.10 The student will** **a) verify the Pythagorean Theorem; and** **b) apply the Pythagorean Theorem.** **8.10 CF** • **Find the measure of a side of a right triangle, given the measures of the other two sides.** • **Solve practical problems involving right triangles by using the Pythagorean Theorem.**
Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.	
9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.	**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.**
Statistics and Probability 8.SP	
Investigate patterns of association in bivariate data.	

CCSS for Mathematics – Grade 8	Mathematics SOL
1. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.	**8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** **b) construct and analyze scatterplots.**
2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.	**8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** **b) construct and analyze scatterplots.** **8.13 CF** • **Collect, organize, and interpret a data set of no more than 20 items using scatterplots. Predict from the trend an estimate of the line of best fit with a drawing.**
3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. *For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.*	**8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** **b) construct and analyze scatterplots.** **A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line. **A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models.**

CCSS for Mathematics – Grade 8	Mathematics SOL
	Mathematical models will include linear and quadratic functions.
4. Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. *For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?*	**PS.7 The student, using two-way tables, will analyze categorical data to describe patterns and departure from patterns and to find marginal frequency and relative frequencies, including conditional frequencies.**

Mathematics SOL for grade 8 aligned with the CCSS at other grade levels	
Grade 6 – Ratios and Proportional Relationships 3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. c. Find a percent of a quantity as a rate per 100 (e.g., 30% of a quantity means 30/100 times the quantity); solve problems involving finding the whole, given a part and the percent. Grade 7 – The Number System 3. Solve real-world and mathematical problems involving the four operations with rational numbers. Grade 7 – Ratios and Proportional Relationships	**8.3 The student will** **a) solve practical problems involving rational numbers, percents, ratios, and proportions; and** **b) determine the percent increase or decrease for a given situation.**

Mathematics SOL for grade 8 aligned with the CCSS at other grade levels	
3. Use proportional relationships to solve multistep ratio and percent problems. *Examples: simple interest, tax, markups and markdowns, gratuities, and commissions, fees, percent increase and decrease, percent error.*	
Grade 6 – Expressions and Equations 2. Write, read, and evaluate expressions in which letters stand for numbers. c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). *For example, use the formulas $V = s^3$ and $A = 6 s^2$ to find the volume and surface area of a cube with sides of length s = 1/2.*	**8.4 The student will apply the order of operations to evaluate algebraic expressions for given replacement values of the variables.**
Grade 6 – Geometry 1. Find the area of right triangles, other triangles, special and polygons by composing into rectangles or decomposing triangles and other shapes; apply these techniques solving real-world and mathematical problems.	**8.11 The student will solve practical area and perimeter problems involving composite plane figures.**
Statistics [high school] – Conditional Probability and the Rules for Probability 2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. 3. Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the	**8.12 The student will determine the probability of independent and dependent events with and without replacement.**

Mathematics SOL for grade 8 aligned with the CCSS at other grade levels	
probability of *A*, and the conditional probability of *B* given *A* is the same as the probability of *B*.	
Grade 7 – Expressions and Equations 4. Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. b. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p, q, and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. *For example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, and describe the solutions.*	**8.15 The student will** a) solve multistep linear equations in one variable with the 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.

Mathematics SOL for grade 8 not explicitly stated in the CCSS at any grade level	
	8.9 The student will construct a three-dimensional model, given the top or bottom, side, and front views.

Mathematics | High School – Number and Quantity

- The Common Core State Standards in high school mathematics are not presented in a format for each course, such as Algebra I, Geometry, Algebra II, etc. Rather, they are organized in the conceptual categories of:
  - Number and Quantity;
  - Algebra;
  - Functions;
  - Modeling (embedded within content and indicated with ⋆);
  - Geometry; and
  - Statistics and Probability.
- The CCSS conceptual categories for high school specify content that all students should learn in order to be college and career ready. In addition, the CCSS include content, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics.

CCSS for Mathematics – Number and Quantity	Mathematics SOL
The Real Number System N-RN	
Extend the properties of exponents to rational exponents.	
1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.*	**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.
2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.	**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. **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;

CCSS for Mathematics – Number and Quantity	Mathematics SOL
	c) write radical expressions as expressions containing rational exponents and vice versa; and d) factor polynomials completely.
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 number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.	**8.2 The student will describe orally and in writing the relationships between the subsets of the real number system.** **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.**
Quantities★ N-Q	
Reason quantitatively and use units to solve problems.	
1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	**7.4 The student will solve single-step and multistep practical problems, using proportional reasoning.** **7.5 The student will** a) describe volume and surface area of cylinders; **b) solve practical problems involving the volume and surface area of rectangular prisms and cylinders; and** **c) describe how changing one measured attribute of a rectangular prism affects its volume and surface area.** **7.11 The student, given data for a practical situation, will** a) construct and analyze histograms; and **b) compare and contrast histograms with other types of graphs presenting information from the same data set.** **7.14 The student will** **a) solve one- and two-step linear equations in one variable; and**
2. Define appropriate quantities for the purpose of descriptive modeling.	
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	

CCSS for Mathematics – Number and Quantity	Mathematics SOL
	b) solve practical problems requiring the solution of one- and two-step linear equations. **8.3 The student will** **a) solve practical problems involving rational numbers, percents, ratios, and proportions; and** b) determine the percent increase or decrease for a given situation. **8.11 The student will solve practical area and perimeter problems involving composite plane figures.** **8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** **b) construct and analyze scatterplots.**
The Complex Number System N–CN	
Perform arithmetic operations with complex numbers.	
1. Know there is a complex number *i* such that $i^2 = –1$, and every complex number has the form $a + bi$ with *a* and *b* real.	**AII.3 The student will perform operations on complex numbers, express the results in simplest form using patterns of the powers of *i*, and identify field properties that are valid for the complex numbers.**
2. Use the relation $i^2 = –1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.	**AII.3 The student will perform operations on complex numbers, express the results in simplest form using patterns of the powers of *i*, and identify field properties that are valid for the complex numbers.**
3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.	**AII.3 The student will perform operations on complex numbers, express the results in simplest form using patterns of the powers of *i*, and identify field properties that are valid for the complex numbers.**
Represent complex numbers and their operations on the complex plane.	

CCSS for Mathematics – Number and Quantity	Mathematics SOL
4. (+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers), and explain why the rectangular and polar forms of a given complex number represent the same number.	**MA.10 The student will investigate and identify the characteristics of the graphs of polar equations, using graphing utilities. This will include classification of polar equations, the effects of changes in the parameters in polar equations, conversion of complex numbers from rectangular form to polar form and vice versa, and the intersection of the graphs of polar equations.**
5. (+) Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. *For example,* $(-1 - \sqrt{3}i)^3 = 8$ *because* $(-1 - \sqrt{3}i)$ *has modulus* 2 *and argument* 120°.	**MA.10 The student will investigate and identify the characteristics of the graphs of polar equations, using graphing utilities. This will include classification of polar equations, the effects of changes in the parameters in polar equations, conversion of complex numbers from rectangular form to polar form and vice versa, and the intersection of the graphs of polar equations.**
6. (+) Calculate the distance between numbers in the complex plane as the modulus of the difference, and the midpoint of a segment as the average of the numbers at its endpoints.	**MA.10 The student will investigate and identify the characteristics of the graphs of polar equations, using graphing utilities. This will include classification of polar equations, the effects of changes in the parameters in polar equations, conversion of complex numbers from rectangular form to polar form and vice versa, and the intersection of the graphs of polar equations.**
Use complex numbers in polynomial identities and equations.	
7. Solve quadratic equations with real coefficients that have complex solutions.	**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.
8. (+) Extend polynomial identities to the complex numbers. *For example, rewrite* $x^2 + 4$ *as* $(x + 2i)(x - 2i)$.	

CCSS for Mathematics – Number and Quantity	Mathematics SOL
9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.	**AII.8 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, *x*-intercepts of a graph, and factors of a polynomial expression.** **AII.8 CF** • **The *Fundamental Theorem of Algebra* states that, including complex and repeated solutions, an nth degree polynomial equation has exactly n roots (solutions).**
Vector and Matrix Quantities N–VM	
Represent and model with vector quantities.	
1. (+) Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., ***v***, |***v***|, ||***v***||, ***v***).	**MA.11 The student will perform operations with vectors in the coordinate plane and solve real-world problems, using vectors. This will include the following topics: operations of addition, subtraction, scalar multiplication, and inner (dot) product; norm of a vector; unit vector; graphing; properties; simple proofs; complex numbers (as vectors); and perpendicular components.**
2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.	
3. (+) Solve problems involving velocity and other quantities that can be represented by vectors.	
Perform operations on vectors.	
4. (+) Add and subtract vectors.	
a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.	**MA.11 The student will perform operations with vectors in the coordinate plane and solve real-world problems, using vectors. This will include the following topics: operations of addition, subtraction, scalar multiplication, and inner (dot) product; norm of a vector; unit vector; graphing; properties; simple proofs; complex numbers (as vectors); and perpendicular components.**
b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.	
c. Understand vector subtraction ***v*** – ***w*** as ***v*** + (–***w***), where –***w*** is the additive inverse of ***w***, with the same magnitude as ***w*** and pointing in the opposite direction. Represent vector subtraction	

CCSS for Mathematics – Number and Quantity	Mathematics SOL
graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.	
5. (+) Multiply a vector by a scalar.	
a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as $c(v_x, v_y) = (cv_x, cv_y)$.	**MA.11 The student will perform operations with vectors in the coordinate plane and solve real-world problems, using vectors. This will include the following topics: operations of addition, subtraction, scalar multiplication, and inner (dot) product; norm of a vector; unit vector; graphing; properties; simple proofs; complex numbers (as vectors); and perpendicular components.**
b. Compute the magnitude of a scalar multiple $c\boldsymbol{v}$ using $\|\|c\boldsymbol{v}\|\| = \|c\|\boldsymbol{v}$. Compute the direction of $c\boldsymbol{v}$ knowing that when $\|c\|\boldsymbol{v} \neq 0$, the direction of $c\boldsymbol{v}$ is either along $\boldsymbol{v}$ (for $c > 0$) or against $\boldsymbol{v}$ (for $c < 0$).	
Perform operations on matrices and use matrices in applications.	
6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.	**MA.14 The student will use matrices to organize data and will add and subtract matrices, multiply matrices, multiply matrices by a scalar, and use matrices to solve systems of equations.**
7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.	
8. (+) Add, subtract, and multiply matrices of appropriate dimensions.	
9. (+) Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.	
10. (+) Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.	
11. (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.	

CCSS for Mathematics – Number and Quantity	Mathematics SOL
12. (+) Work with 2 × 2 matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area.	

Mathematics | High School – Algebra

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  - Number and Quantity;
  - Algebra;
  - Functions;
  - Modeling (embedded within content and indicated with ⋆);
  - Geometry; and
  - Statistics and Probability.
- The CCSS conceptual categories for high school specify content that all students should learn in order to be college and career ready. In addition, the CCSS include content, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics.

CCSS for Mathematics – Algebra	Mathematics SOL
Seeing Structure in Expressions A-SSE	
Interpret the structure of expressions	
1. Interpret expressions that represent a quantity in terms of its context.⋆	
a. Interpret parts of an expression, such as terms, factors, and coefficients.	**6.18 The student will solve one-step linear equations in one variable involving whole number coefficients and positive rational solutions.** **6.18 CF** • **Identify and use the following algebraic terms appropriately: *equation*, *variable, expression, term,* and *coefficient*.**
b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1+r)^n$ *as the product of P and a factor not depending on P.*	**A.1 The student will represent verbal quantitative situations algebraically and evaluate these expressions for given replacement values of the variables.**
2. Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$, *thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.	**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.** **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;

CCSS for Mathematics – Algebra	Mathematics SOL
	c) write radical expressions as expressions containing rational exponents and vice versa; and **d) factor polynomials completely.** **AII.1 CF** • **Factor polynomials by applying general patterns including difference of squares, sum and difference of cubes, and perfect square trinomials.**
Write expressions in equivalent forms to solve problems	
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.⋆	
a. Factor a quadratic expression to reveal the zeros of the function it defines.	**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.** **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

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	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** • **Identify the roots or zeros of a quadratic function over the real number system as the solution(s) to the quadratic equation that is formed by setting the given quadratic expression equal to zero.** **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.**
b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.	**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**

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	trinomials in one or two variables. Graphing calculators will be used as a tool for factoring and for confirming algebraic factorizations. **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and** **logarithmic) families and their characteristics. Key concepts include** a) continuity; **b) local and absolute maxima and minima;** c) domain and range; d) zeros; e) intercepts; f) intervals in which the function is increasing/decreasing; g) end behaviors; and h) asymptotes. **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.**
c. Use the properties of exponents to transform expressions for exponential functions. *For example the expression* 1.15^t *can be rewritten as* $(1.15^{1/12})^{12t} \approx 1.012^{12t}$ *to reveal the approximate equivalent monthly interest rate if the annual rate*	**A.2 The student will perform operations on polynomials, including** **a) applying the laws of exponents to perform operations on expressions;**

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is 15%.	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. **AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models.** **AII.9 The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.**
4. Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. *For example, calculate mortgage payments.*⋆	**AII.2 The student will investigate and apply the properties of arithmetic and geometric sequences and series to solve real-world problems, including writing the first *n* terms, finding the *n*th term, and evaluating summation formulas. Notation will include Σ and *an*.**
Arithmetic with Polynomials and Rational Expressions A-APR	
Perform arithmetic operations on polynomials	
1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.	**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

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	trinomials in one or two variables. Graphing calculators will be used as a tool for factoring and for confirming algebraic factorizations. **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.
Understand the relationship between zeros and factors of polynomials	
2. Know and apply the Remainder Theorem: For a polynomial $p(x)$ and a number a, the remainder on division by $x - a$ is $p(a)$, so $p(a) = 0$ if and only if $(x - a)$ is a factor of $p(x)$.	**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.

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3. Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** a) determining whether a relation is a function; b) domain and range; **c) zeros of a function;** d) *x*- and *y*-intercepts; e) finding the values of a function for elements in its domain; and f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic. **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** a) continuity; b) local and absolute maxima and minima; c) domain and range; **d) zeros;** e) intercepts; f) intervals in which the function is increasing/decreasing; g) end behaviors; and h) asymptotes. **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;

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	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. **AII.8 The student will investigate and describe the relationships among solutions of an equation, zeros of a function, *x*-intercepts of a graph, and factors of a polynomial expression.**
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.*	**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.** **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.**

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	AII.1 CF • **Verify polynomial identities including the difference of squares, sum and difference of cubes, and perfect square trinomials.**
5. (+) Know and apply the Binomial Theorem for the expansion of $(x+y)^n$ in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascal's Triangle.	**MA.4 The student will expand binomials having positive integral exponents through the use of the Binomial Theorem, the formula for combinations, and Pascal's Triangle.**
Rewrite rational expressions	
6. Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or, for the more complicated examples, a computer algebra system.	**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.
7. (+) Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions.	
Creating Equations★ A-CED	
Create equations that describe numbers or relationships	
1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*	**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;**

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	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** **• Solve multistep linear equations in one variable.** **A.5 The student will solve multistep linear inequalities in two variables, including** **a) solving multistep linear inequalities algebraically and graphically;** b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets; c) solving real-world problems involving inequalities; and d) solving systems of inequalities. **A.5 CF** **• Solve multistep linear inequalities in one variable.** **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. **AII.7 The student will investigate and analyze functions algebraically and graphically. Key concepts include** a) domain and range, including limited and discontinuous domains

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	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.
2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	**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.6 The student will graph linear equations** and linear inequalities **in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be**

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	described as rate of change and will be positive, negative, zero, or undefined; and **b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.**
3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*	**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.5 The student will solve multistep linear inequalities in two variables, including** a) solving multistep linear inequalities algebraically and graphically; b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets; **c) solving real-world problems involving inequalities; and** **d) solving systems of inequalities.** **AFDA.5 The student will determine optimal values in problem situations by identifying constraints and using linear programming techniques.**

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	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.
4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*	**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.
Reasoning with Equations and Inequalities A-REI	
Understand solving equations as a process of reasoning and explain the reasoning	
1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.	**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;

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	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.
2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.	**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.**
Solve equations and inequalities in one variable	
3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.	**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.

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	A.4 CF **• Solve multistep linear equations in one variable.** **A.5 The student will solve multistep linear inequalities in two variables, including** **a) solving multistep linear inequalities algebraically and graphically;** b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets; c) solving real-world problems involving inequalities; and d) solving systems of inequalities. **A.5 CF** **• Solve multistep linear 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.	**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. **AII.4 The student will solve, algebraically and graphically,**

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	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. **AII.4 CF** • **Recognize that the quadratic formula can be derived by applying the completion of squares to any quadratic equation in standard form.** **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.**
b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.	**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.

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	Graphing calculators will be used both as a primary tool in solving problems and to verify algebraic solutions. **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 **Graphing calculators will be used for solving and for confirming the algebraic solutions.**
Solve systems of equations	
5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.	**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.
6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.	
7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line* $y = -3x$ and the circle $x^2 + y^2 = 3$.	**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.**
8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.	**MA.14 The student will use matrices to organize data and will add and subtract matrices, multiply matrices, multiply matrices by a**

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9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater).	**scalar, and use matrices to solve systems of equations.**
Represent and solve equations and inequalities graphically	
10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).	**A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line. **AFDA.4 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.** **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.**
11. Explain why the *x*-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations.	**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

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Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.⋆	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.** **AFDA.5 The student will determine optimal values in problem situations by identifying constraints and using linear programming techniques.** **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.**
12. Graph the solutions to a linear inequality in two variables as a half plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	**A.5 The student will solve multistep linear inequalities in two variables, including** a) solving multistep linear inequalities algebraically and graphically; b) justifying steps used in solving inequalities, using axioms of inequality and properties of order that are valid for the set of real numbers and its subsets; **c) solving real-world problems involving inequalities; and** **d) solving systems of inequalities.** **A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or**

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	undefined; and b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.

Mathematics | High School – Functions

- The Common Core State Standards in high school mathematics are not presented in a format for each course, such as Algebra I, Geometry, Algebra II, etc. Rather, they are organized in the conceptual categories of:
  - Number and Quantity;
  - Algebra;
  - Functions;
  - Modeling (embedded within content and indicated with ⋆);
  - Geometry; and
  - Statistics and Probability.
- The CCSS conceptual categories for high school specify content that all students should learn in order to be college and career ready. In addition, the CCSS include content, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics.

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Interpreting Functions F-IF	
Understand the concept of a function and use function notation	
1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is an element of its domain, then *f*(*x*) denotes the output of *f* corresponding to the input *x*. The graph of *f* is the graph of the equation *y* = *f*(*x*).	**8.14 The student will make connections between any two representations (tables, graphs, words, and rules) of a given relationship.** **8.14 CF** • **Describe and represent relations and functions, using tables, graphs, words, and rules. Given one representation, students will be able to represent the relation in another form.** • **A relation is any set of ordered pairs. For each first member, there may be many second members.** • **A function is a relation in which there is one and only one second member for each first member.** • **As a table of values, a function has a unique value assigned to the second variable for each value of the first variable.** • **As a graph, a function is any curve (including straight lines) such that any vertical line would pass through the curve only once.** • **Some relations are functions; all functions are relations.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** c) zeros of a function; d) *x*- and *y*-intercepts; **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric,**

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	graphic, and algebraic.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** a) determining whether a relation is a function; b) domain and range; c) zeros of a function; d) *x*- and *y*-intercepts; **e) finding the values of a function for elements in its domain; and** f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.
3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.*	**AII.2 The student will investigate and apply the properties of arithmetic and geometric sequences and series to solve real-world problems, including writing the first *n* terms, finding the *n*th term, and evaluating summation formulas. Notation will include Σ and a_n.**
Interpret functions that arise in applications in terms of the context	
4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*⋆	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric,**

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	graphic, and algebraic. **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **AFDA.2 The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).** **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.**
5. Relate the domain of a function to its graph and, where	**8.17 The student will identify the domain, range, independent**

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applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.*⋆	**variable or dependent variable in a given situation.** **8.17 CF** • **Identify examples of domain, range, independent variable, and dependent variable.** • **Determine the domain of a function.** • **Determine the range of a function.** • **Determine the independent variable of a relationship.** • **Determine the dependent variable of a relationship.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** c) zeros of a function; d) *x*- and *y*-intercepts; **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.**
6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.⋆	**A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.
Analyze functions using different representations	
7. Graph functions expressed symbolically and show key	

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features of the graph, by hand in simple cases and using technology for more complicated cases.⋆	
a. Graph linear and quadratic functions and show intercepts, maxima, and minima.	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** a) determining whether a relation is a function; **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** e) finding the values of a function for elements in its domain; and f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic. **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** a) continuity; **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** g) end behaviors; and h) asymptotes. **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;**

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	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.**
b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.	**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. **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.**
c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;**

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	e) finding the values of a function for elements in its domain; and **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.** **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** h) asymptotes. **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.**
d. (+) Graph rational functions, identifying zeros and	**AFDA.1 The student will investigate and analyze function (linear,**

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asymptotes when suitable factorizations are available, and showing end behavior.	**quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **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.** **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**

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	functions.
e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.	**AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **AFDA.2 The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).** **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.** **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;**

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	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.** **T.6 The student, given one of the six trigonometric functions in standard form, will** **a) state the domain and the range of the function;** **b) determine the amplitude, period, phase shift, vertical shift, and asymptotes;** **c) sketch the graph of the function by using transformations for at least a two-period interval; and** **d) investigate the effect of changing the parameters in a trigonometric function on the graph of the function.**
8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.	
a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.	**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.** **A.4 The student will solve multistep linear and quadratic equations in two variables, including**

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	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. **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.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.

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	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.
b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{t/10}$, *and classify them as representing exponential growth or decay.*	**AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models.** **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.** **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;**

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	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.**
9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.** **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and**

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	h) asymptotes. **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.** **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.**
Building Functions F-BF	
Build a function that models a relationship between two quantities	
1. Write a function that describes a relationship between two quantities.⋆	
a. Determine an explicit expression, a recursive process, or steps for calculation from a context.	**6.17 The student will identify and extend geometric and arithmetic sequences.**
b. Combine standard function types using arithmetic	**7.2 The student will describe and represent arithmetic and**

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operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*	**geometric sequences, using variable expressions.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.** **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **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;**

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	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.**
c. (+) Compose functions. *For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time.*	**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.
2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.⋆	**AII.2 The student will investigate and apply the properties of arithmetic and geometric sequences and series to solve real-world problems, including writing the first *n* terms, finding the *n*th term, and evaluating summation formulas. Notation will include Σ and a_n.**
Build new functions from existing functions	
3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, k $f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with	**A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the**

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cases and illustrate an explanation of the effects on the graph using technology. *Include recognizing even and odd functions from their graphs and algebraic expressions for them.*	**line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** **b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.** **A.6 CF** **• Use the parent function *y* = *x* and describe transformations defined by changes in the slope or *y*-intercept.** **• Use transformational graphing to investigate effects of changes in equation parameters on the graph of the equation.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.** **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;**

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	f) intervals in which the function is increasing/decreasing; **g) end behaviors; and** **h) asymptotes.** **AFDA.2 The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).** **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.** **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.**
4. Find inverse functions.	
a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. *For*	**AII.7 The student will investigate and analyze functions algebraically and graphically. Key concepts include**

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example, $f(x) = 2x^3$ for $x > 0$ or $f(x) = (x+1)/(x–1)$ for $x \neq 1$.	**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.** **AII.7 CF** • **Find the inverse of a function.** • **Find the composition of two functions.** • **Graph the inverse of a function as a reflection across the line *y* = *x*.** • **Use composition of functions to verify two functions are inverses. Investigate exponential and logarithmic functions, using the graphing calculator.** • **Convert between logarithmic and exponential forms of an equation with bases consisting of natural numbers.**
b. (+) Verify by composition that one function is the inverse of another.	
c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.	
d. (+) Produce an invertible function from a non-invertible function by restricting the domain.	
5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.	
Linear, Quadratic, and Exponential Models★ F-LE	
Construct and compare linear and exponential models and solve problems	
1. Distinguish between situations that can be modeled with linear functions and with exponential functions.	
a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.	**A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models.**

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b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.	**Mathematical models will include linear and quadratic functions.** **AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models.** **AFDA.4 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.** **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.** **AII.9 The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.**
c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.	
2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).	**A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero,**

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	or undefined; and **b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line.** **A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.** **A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models. Mathematical models will include linear and quadratic functions.** **AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify** **conclusions with algebraic and/or graphical models.** **AFDA.4 The student will transfer between and analyze multiple representations of functions, including algebraic formulas, graphs, tables, and words. Students will select and use appropriate representations for analysis, interpretation, and prediction.**

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	AII.2 The student will investigate and apply the properties of arithmetic and geometric sequences and series to solve real-world problems, including writing the first *n* terms, finding the *n*th term, and evaluating summation formulas. Notation will include Σ and a_n. **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.** **AII.9 The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.**
3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.	**AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **AFDA.2 The student will use knowledge of transformations to**

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	write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic). **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.** **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.** **AII.9 The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.**
4. For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where *a*, *c*, and *d* are numbers and the base *b* is 2,	**AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their**

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10, or *e*; evaluate the logarithm using technology.	**characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;** **e) intercepts;** **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **AFDA.2 The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).** **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.** **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**

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	h) composition of multiple functions. **Graphing calculators will be used as a tool to assist in investigation of functions.** **MA.9 The student will investigate and identify the characteristics of exponential and logarithmic functions in order to graph these functions and solve equations and real-world problems. This will include the role of e, natural and common logarithms, laws of exponents and logarithms, and the solution of logarithmic and exponential equations.**
Interpret expressions for functions in terms of the situation they model	
5. Interpret the parameters in a linear or exponential function in terms of a context.	**A.7 The student will investigate and analyze function (linear and quadratic) families and their characteristics both algebraically and graphically, including** **a) determining whether a relation is a function;** **b) domain and range;** **c) zeros of a function;** **d) *x*- and *y*-intercepts;** **e) finding the values of a function for elements in its domain; and** **f) making connections between and among multiple representations of functions including concrete, verbal, numeric, graphic, and algebraic.** **AFDA.1 The student will investigate and analyze function (linear, quadratic, exponential, and logarithmic) families and their characteristics. Key concepts include** **a) continuity;** **b) local and absolute maxima and minima;** **c) domain and range;** **d) zeros;**

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	e) intercepts; **f) intervals in which the function is increasing/decreasing;** **g) end behaviors; and** **h) asymptotes.** **AFDA.2 The student will use knowledge of transformations to write an equation, given the graph of a function (linear, quadratic, exponential, and logarithmic).** **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.** **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.** **AII.9 The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve**

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	real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.
Trigonometric Functions F-TF	
Extend the domain of trigonometric functions using the unit circle	
1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.	**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.** **T.3 The student will find, without the aid of a calculator, the values of the trigonometric functions of the special angles and their related angles as found in the unit circle. This will include converting angle measures from radians to degrees and vice versa.**
2. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.	**T.1 The student, given a point other than the origin on the terminal side of an angle, will use the definitions of the six trigonometric functions to find the sine, cosine, tangent, cotangent, secant, and cosecant of the angle in standard position. Trigonometric functions defined on the unit circle will be related to trigonometric functions defined in right triangles.**
3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for pi/3, pi/4 and pi/6, and use the unit circle to express the values of sine, cosines, and tangent for *x*, pi+*x*, and 2pi–*x* in terms of their values for *x*, where *x* is any real number.	**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.** **T.1 The student, given a point other than the origin on the terminal side of an angle, will use the definitions of the six trigonometric functions to find the sine, cosine, tangent,**

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	cotangent, secant, and cosecant of the angle in standard position. Trigonometric functions defined on the unit circle will be related to trigonometric functions defined in right triangles.
4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.	**T.6 The student, given one of the six trigonometric functions in standard form, will** **a) state the domain and the range of the function;** **b) determine the amplitude, period, phase shift, vertical shift, and asymptotes;** **c) sketch the graph of the function by using transformations for at least a two-period interval; and** **d) investigate the effect of changing the parameters in a trigonometric function on the graph of the function.**
Model periodic phenomena with trigonometric functions	
5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.⋆	**T.6 The student, given one of the six trigonometric functions in standard form, will** **a) state the domain and the range of the function;** **b) determine the amplitude, period, phase shift, vertical shift, and asymptotes;** **c) sketch the graph of the function by using transformations for at least a two-period interval; and** **d) investigate the effect of changing the parameters in a trigonometric function on the graph of the function.**
6. (+) Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed.	**T.7 The student will identify the domain and range of the inverse trigonometric functions and recognize the graphs of these functions. Restrictions on the domains of the inverse trigonometric functions will be included.**
7. (+) Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.⋆	**T.4 The student will find, with the aid of a calculator, the value of any trigonometric function and inverse trigonometric function.** **T.7 The student will identify the domain and range of the inverse**

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	trigonometric functions and recognize the graphs of these functions. Restrictions on the domains of the inverse trigonometric functions will be included.
Prove and apply trigonometric identities	
8. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to find sin(θ), cos(θ), or tan(θ) given sin(θ), cos(θ), or tan(θ) and the quadrant of the angle.	**T.2 The student, given the value of one trigonometric function, will find the values of the other trigonometric functions, using the definitions and properties of the trigonometric functions.** **T.5 The student will verify basic trigonometric identities and make substitutions, using the basic 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.**

Mathematics | High School – Geometry

- The Common Core State Standards in high school mathematics are not presented in a format for each course, such as Algebra I, Geometry, Algebra II, etc. Rather, they are organized in the conceptual categories of:
  - Number and Quantity;
  - Algebra;
  - Functions;
  - Modeling (embedded within content and indicated with ⋆);
  - Geometry; and
  - Statistics and Probability.
- The CCSS conceptual categories for high school specify content that all students should learn in order to be college and career ready. In addition, the CCSS include content, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics.

CCSS for Mathematics – Geometry	Mathematics SOL
Congruence G-CO	
Experiment with transformations in the plane	
1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.	**G.2 The student will use the relationships between angles formed by two lines cut by a transversal to** **a) determine whether two lines are parallel;** **b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and** **c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.** **G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** **a) investigating and using formulas for finding distance, midpoint, and slope;** b) applying slope to verify and determine whether lines are parallel or perpendicular; c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods. **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.**
2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as	**G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will**

CCSS for Mathematics – Geometry	Mathematics SOL
inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).	**include** a) investigating and using formulas for finding distance, midpoint, and slope; b) applying slope to verify and determine whether lines are parallel or perpendicular; c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and **d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.**
3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.	**G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** a) investigating and using formulas for finding distance, midpoint, and slope; b) applying slope to verify and determine whether lines are parallel or perpendicular; **c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and** **d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.**
4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.	**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.** **G.2 The student will use the relationships between angles formed by two lines cut by a transversal to** **a) determine whether two lines are parallel;** **b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and**

CCSS for Mathematics – Geometry	Mathematics SOL
	c) solve real-world problems involving angles formed when parallel lines are cut by a transversal. **G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** **a) investigating and using formulas for finding distance, midpoint, and slope;** **b) applying slope to verify and determine whether lines are parallel or perpendicular;** **c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and** **d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.**
5. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software. Specify a sequence of transformations that will carry a given figure onto another.	**8.8 The student will** **a) apply transformations to plane figures; and** b) identify applications of transformations. **G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** a) investigating and using formulas for finding distance, midpoint, and slope; b) applying slope to verify and determine whether lines are parallel or perpendicular; c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and **d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.**

CCSS for Mathematics – Geometry	Mathematics SOL
Understand congruence in terms of rigid motions	
6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.	**G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** a) investigating and using formulas for finding distance, midpoint, and slope; b) applying slope to verify and determine whether lines are parallel or perpendicular; c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and **d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.** **G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.**
7. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.	**G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.**
8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.	**G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.**
Prove geometric theorems	
9. Prove theorems about lines and angles. *Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from*	**G.2 The student will use the relationships between angles formed by two lines cut by a transversal to** **a) determine whether two lines are parallel;** **b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and**

CCSS for Mathematics – Geometry	Mathematics SOL
the segment's endpoints.	**c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.**
10. Prove theorems about triangles. *Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point.*	**G.5 The student, given information concerning the lengths of sides and/or measures of angles in triangles, will** **a) order the sides by length, given the angle measures;** **b) order the angles by degree measure, given the side lengths;** **c) determine whether a triangle exists; and** **d) determine the range in which the length of the third side must lie.** **These concepts will be considered in the context of real-world situations.** **G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.**
11. Prove theorems about parallelograms. *Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.*	**G.9 The student will verify characteristics of quadrilaterals and use properties of quadrilaterals to solve real-world problems.**
Make geometric constructions	
12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). *Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.*	**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.**

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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	
Understand similarity in terms of similarity transformations	
1. Verify experimentally the properties of dilations given by a center and a scale factor:	
a. A dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged.	**8.8 The student will** **a) apply transformations to plane figures; and** b) identify applications of transformations. **8.8 CF** • **A dilation of a geometric figure is a transformation that changes the size of a figure by a scale factor to create a similar figure.**
b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.	
2. Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides.	**G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.** **G.14 The student will use similar geometric objects in two- or three-dimensions to** **a) compare ratios between side lengths, perimeters, areas, and**

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	volumes; b) determine how changes in one or more dimensions of an object affect area and/or volume of the object; c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and **d) solve real-world problems about similar geometric objects.**
3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.	**G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.**
Prove theorems involving similarity	
4. Prove theorems about triangles. *Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.*	**G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.**
5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.	**G.6 The student, given information in the form of a figure or statement, will prove two triangles are congruent, using algebraic and coordinate methods as well as deductive proofs.** **G.7 The student, given information in the form of a figure or statement, will prove two triangles are similar, using algebraic and coordinate methods as well as deductive proofs.** **G.10 The student will solve real-world problems involving angles of polygons.** **G.14 The student will use similar geometric objects in two- or three-dimensions to** **a) compare ratios between side lengths, perimeters, areas, and volumes;** **b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;** **c) determine how changes in area and/or volume of an object**

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	affect one or more dimensions of the object; and **d) solve real-world problems about similar geometric objects.**
Define trigonometric ratios and solve problems involving right triangles	
6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute 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** • **The ratios of side lengths in similar right triangles (adjacent/hypotenuse or opposite/hypotenuse) are independent of the scale factor and depend only on the angle the hypotenuse makes with the adjacent side, thus justifying the definition and calculation of trigonometric functions using the ratios of side lengths for similar right triangles.** • **Determine whether a triangle formed with three given lengths is a right triangle.** • **Solve for missing lengths in geometric figures, using properties of 45°-45°-90° triangles.** • **Solve for missing lengths in geometric figures, using properties of 30°-60°-90° triangles.** • **Solve problems involving right triangles, using sine, cosine, and tangent ratios.** • **Solve real-world problems, using right triangle trigonometry and properties of 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.**

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	G.8 CF • **Explain and use the relationship between the sine and cosine of complementary angles.**
8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.★	**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.**
Apply trigonometry to general triangles	
9. (+) Derive the formula $A = 1/2\ ab\ \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.	**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** • **Another formula for the area of a triangle is $\frac{1}{2}ab\sin(C)$.**
10. (+) Prove the Laws of Sines and Cosines 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.**
11. (+) Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in right and non-right triangles (e.g., surveying problems, resultant forces).	
Circles G-C	
Understand and apply theorems about circles	
1. Prove that all circles are similar.	**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.

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2. Identify and describe relationships among inscribed angles, radii, and chords. *Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.*	**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. **G.11 CF** • **Find lengths, angle measures, and arc measures associated with** – **two intersecting chords;** – **two intersecting secants;** – **an intersecting secant and tangent;** – **two intersecting tangents; and** – **central and inscribed angles.**
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	**G.4 The student will construct and justify the constructions of**

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circle to the circle.	**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 a tangent line from a point outside a given circle to the circle.**
Find arc lengths and areas of sectors of circles	
5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.	**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.** **G.11 CF** • **Calculate the area of a sector and the length of an arc of a circle, using proportions.** • **Verify properties of circles, using deductive reasoning, algebraic, and coordinate methods.**
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** • **Identify the center, radius, and diameter of a circle from a given**

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	standard equation. • **Use the distance formula to find the radius of a circle.** • **Given the coordinates of the center and radius of the circle, identify a point on the circle.** • **Given the equation of a circle in standard form, identify the coordinates of the center and find the radius of the circle.** • **Given the coordinates of the endpoints of a diameter, find the equation of the circle.** • **Given the coordinates of the center and a point on the circle, find the equation of the circle.** • **Recognize that the equation of a circle of given center and radius is derived using the Pythagorean Theorem.**
2. Derive the equation of a parabola given a focus and directrix.	**MA.8 The student will investigate and identify the characteristics of conic section equations in (*h, k*) and standard forms. Transformations in the coordinate plane will be used to graph conic sections.**
3. (+) Derive the equations of ellipses and hyperbolas given foci and directrices.	**MA.8 The student will investigate and identify the characteristics of conic section equations in (*h, k*) and standard forms. Transformations in the coordinate plane will be used to graph conic sections.**
Use coordinates to prove simple geometric theorems algebraically	
4. Use coordinates to prove simple geometric theorems algebraically. *For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point (1, √3) lies on the circle centered at the origin and containing the point (0, 2).*	**G.2 The student will use the relationships between angles formed by two lines cut by a transversal to** a) determine whether two lines are parallel; **b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and** c) solve real-world problems involving angles formed when parallel lines are cut by a transversal.

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	G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include **a) investigating and using formulas for finding distance, midpoint, and slope;** **b) applying slope to verify and determine whether lines are parallel or perpendicular;** c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods. **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.**
5. Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).	**G.2 The student will use the relationships between angles formed by two lines cut by a transversal to** **a) determine whether two lines are parallel;** **b) verify the parallelism, using algebraic and coordinate methods as well as deductive proofs; and** c) solve real-world problems involving angles formed when parallel lines are cut by a transversal. **G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** **a) investigating and using formulas for finding distance, midpoint, and slope;** **b) applying slope to verify and determine whether lines are parallel or perpendicular;**

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	c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.
6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.	**G.3 The student will use pictorial representations, including computer software, constructions, and coordinate methods, to solve problems involving symmetry and transformation. This will include** **a) investigating and using formulas for finding distance, midpoint, and slope;** b) applying slope to verify and determine whether lines are parallel or perpendicular; c) investigating symmetry and determining whether a figure is symmetric with respect to a line or a point; and d) determining whether a figure has been translated, reflected, rotated, or dilated, using coordinate methods.
7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.⋆	
Geometric Measurement and Dimension G-GMD	
Explain volume formulas and use them to solve problems	
1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. *Use dissection arguments, Cavalieri's principle, and informal limit arguments.*	**6.10 The student will** **a) define π (pi) 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. **8.7 The student will** **a) investigate and solve practical problems involving volume and**

CCSS for Mathematics – Geometry	Mathematics SOL
	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. **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. **G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.** **G.14 The student will use similar geometric objects in two- or three-dimensions to** **a) compare ratios between side lengths, perimeters, areas, and volumes;** **b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;** **c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and** **d) solve real-world problems about similar geometric objects.**
2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.	**G.14 The student will use similar geometric objects in two- or three-dimensions to** **a) compare ratios between side lengths, perimeters, areas, and volumes;** **b) determine how changes in one or more dimensions of an object affect area and/or volume of the object;** **c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and** **d) solve real-world problems about similar geometric objects.**
3. Use volume formulas for cylinders, pyramids, cones, and	**8.7 The student will**

CCSS for Mathematics – Geometry	Mathematics SOL
spheres to solve problems.⋆	**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. **G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.**
Visualize relationships between two-dimensional and three-dimensional objects	
4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.	**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.
Modeling with Geometry G-MG	
Apply geometric concepts in modeling situations	
1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).⋆	**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. **8.9 The student will construct a three-dimensional model, given the top or bottom, side, and front views.** **G.10 The student will solve real-world problems involving angles of polygons.** **G.10 CF** **• Identify tessellations in art, construction, and nature.** **G.13 The student will use formulas for surface area and volume of three-dimensional objects to solve real-world problems.** **G.14 The student will use similar geometric objects in two- or**
2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).⋆	
3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).⋆	

CCSS for Mathematics – Geometry	Mathematics SOL
	three-dimensions to **a) compare ratios between side lengths, perimeters, areas, and volumes;** b) determine how changes in one or more dimensions of an object affect area and/or volume of the object; c) determine how changes in area and/or volume of an object affect one or more dimensions of the object; and **d) solve real-world problems about similar geometric objects.**

Mathematics | High School – Statistics and Probability

- The Common Core State Standards in high school mathematics are not presented in a format for each course, such as Algebra I, Geometry, Algebra II, etc. Rather, they are organized in the conceptual categories of:
  - Number and Quantity;
  - Algebra;
  - Functions;
  - Modeling (embedded within content and indicated with ⋆);
  - Geometry; and
  - Statistics and Probability.
- The CCSS conceptual categories for high school specify content that all students should learn in order to be college and career ready. In addition, the CCSS include content, indicated with "(+)", that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics.

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
Interpreting Categorical and Quantitative Data S-ID	
Summarize, represent, and interpret data on a single count or measurement variable	
1. Represent data with plots on the real number line (dot plots, histograms, and box plots).	**7.11 The student, given data for a practical situation, will** **a) construct and analyze histograms; and** **b) compare and contrast histograms with other types of graphs presenting information from the same data set.** **8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** b) construct and analyze scatterplots. **A.10 The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.** **PS.1 The student will analyze graphical displays of univariate data, including dotplots, stemplots, and histograms, to identify and describe patterns and departures from patterns, using central tendency, spread, clusters, gaps, and outliers.** **Appropriate technology will be used to create graphical displays.**
2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.	**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** **d) describe the range of a set of data as a measure of variation.** **6.15 The student will** **a) describe mean as balance point; and** **b) decide which measure of center is appropriate for a given purpose.** **A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	deviation, standard deviation, and z-scores. **A.10 The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.** **PS.2 The student will analyze numerical characteristics of univariate data sets to describe patterns, and departures from patterns, using mean, median, mode, variance, standard deviation, interquartile range, range, and outliers.** **PS.3 The student will compare distributions of two or more univariate data sets, analyzing center and spread (within group and between group variations), clusters and gaps, shapes, outliers, or other unusual features.**
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).	**A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-scores.** **A.10 The student will compare and contrast multiple univariate data sets, using box-and-whisker plots.** **PS.2 The student will analyze numerical characteristics of univariate data sets to describe patterns, and departures from patterns, using mean, median, mode, variance, standard deviation, interquartile range, range, and outliers.** **PS.3 The student will compare distributions of two or more univariate data sets, analyzing center and spread (within group and between group variations), clusters and gaps, shapes, outliers, or other unusual features.**
4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.	**AFDA.7 The student will analyze the normal distribution. Key concepts include** **a) characteristics of normally distributed data;** **b) percentiles;** **c) normalizing data, using z-scores; and**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	d) area under the standard normal curve and probability. **AII.11 The student will identify properties of a normal distribution and apply those properties to determine probabilities associated with areas under the standard normal curve.** **PS.16 The student will identify properties of a normal distribution and apply the normal distribution to determine probabilities, using a table or graphing calculator.**
Summarize, represent, and interpret data on two categorical and quantitative variable	
5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.	**PS.7 The student, using two-way tables, will analyze categorical data to describe patterns and departure from patterns and to find marginal frequency and relative frequencies, including conditional frequencies.**
6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.	
a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. *Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.*	**8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** **b) construct and analyze scatterplots.** **A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models. Mathematical models will include linear and quadratic functions.** **AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values,**
b. Informally assess the fit of a function by plotting and analyzing residuals.	
c. Fit a linear function for a scatter plot that suggests a linear association.	

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	make decisions, and justify conclusions with algebraic and/or graphical models. **AII.9 The student will collect and analyze data, determine the equation of the curve of best fit, make predictions, and solve real-world problems, using mathematical models. Mathematical models will include polynomial, exponential, and logarithmic functions.** **PS.5 The student will find and interpret linear correlation, use the method of least squares regression to model the linear relationship between two variables, and use the residual plots to assess linearity.**
Interpret linear models	
7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.	**A.6 The student will graph linear equations and linear inequalities in two variables, including** **a) determining the slope of a line when given an equation of the line, the graph of the line, or two points on the line. Slope will be described as rate of change and will be positive, negative, zero, or undefined; and** b) writing the equation of a line when given the graph of the line, two points on the line, or the slope and a point on the line. **A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models.**
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.	**A.11 The student will collect and analyze data, determine the equation of the curve of best fit in order to make predictions, and solve real-world problems, using mathematical models.** **AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models. **AFDA.3 CF** • **Least squares regression generates the equation of the line that minimizes the sum of the squared distances between the data points and the line.** • **A correlation coefficient measures the degree of association between two variables that are related linearly.** **PS.5 The student will find and interpret linear correlation, use the method of least squares regression to model the linear relationship between two variables, and use the residual plots to assess linearity.**
9. Distinguish between correlation and causation.	**8.13 The student will** **a) make comparisons, predictions, and inferences, using information displayed in graphs; and** **b) construct and analyze scatterplots.** **8.13 CF** • **Interpret a set of data points in a scatterplot as having a positive relationship, a negative relationship, or no relationship.** **AFDA.3 The student will collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models.** **PS.4 The student will analyze scatterplots to identify and describe the relationship between two variables, using shape;**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	strength of relationship; clusters; positive, negative, or no association; outliers; and influential points. **PS.5 The student will find and interpret linear correlation, use the method of least squares regression to model the linear relationship between two variables, and use the residual plots to assess linearity.**
Making Inferences and Justifying Conclusions S-IC	
Understand and evaluate random processes underlying statistical experiments	
1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.	**AFDA.8 The student will design and conduct an experiment/survey. Key concepts include** **a) sample size;** **b) sampling technique;** **c) controlling sources of bias and experimental error;** **d) data collection; and** **e) data analysis and reporting.** **PS.8 The student will describe the methods of data collection in a census, sample survey, experiment, and observational study and identify an appropriate method of solution for a given problem setting.** **PS.9 The student will plan and conduct a survey. The plan will address sampling techniques (e.g., simple random, stratified) and methods to reduce bias.** **PS.10 The student will plan and conduct an experiment. The plan will address control, randomization, and measurement of experimental error.**
2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. *For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?*	
Make inferences and justify conclusions from sample surveys, experiments, and observational studies	
3. Recognize the purposes of and differences among sample	**AFDA.8 The student will design and conduct an**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
surveys, experiments, and observational studies; explain how randomization relates to each.	**experiment/survey. Key concepts include** **a) sample size;** **b) sampling technique;** **c) controlling sources of bias and experimental error;** **d) data collection; and** **e) data analysis and reporting.** **PS.8 The student will describe the methods of data collection in a census, sample survey, experiment, and observational study and identify an appropriate method of solution for a given problem setting.** **PS.9 The student will plan and conduct a survey. The plan will address sampling techniques (e.g., simple random, stratified) and methods to reduce bias.** **PS.10 The student will plan and conduct an experiment. The plan will address control, randomization, and measurement of experimental error.**
4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.	
5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.	
6. Evaluate reports based on data.	
Conditional Probability and the Rules of Probability S-CP	
Understand independence and conditional probability and use them to interpret data	
1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).	**6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent events.** **6.16 CF** • **The probability of an event occurring is equal to the ratio of desired outcomes to the total number of possible outcomes (sample space).** **AFDA.6 The student will calculate probabilities. Key concepts**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	include **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and **e) Law of Large Numbers.** **PS.11 The student will identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.**
2. Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent.	**6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent events.** **8.12 The student will determine the probability of independent and dependent events with and without replacement.** **AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and **e) Law of Large Numbers.** **PS.11 The student will identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.** **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	Large Numbers concept, the addition rule, and the multiplication rule.
3. Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of *A*, and the conditional probability of *B* given *A* is the same as the probability of *B*.	**6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent events.** **7.10 The student will determine the probability of compound events, using the Fundamental (Basic) Counting Principle.** **8.12 The student will determine the probability of independent and dependent events with and without replacement.** **AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and **e) Law of Large Numbers.** **PS.11 The student will identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.** **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of Large Numbers concept, the addition rule, and the multiplication rule.**
4. Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if	**PS.7 The student, using two-way tables, will analyze categorical data to describe patterns and departure from patterns and to find marginal frequency and relative frequencies, including**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
events are independent and to approximate conditional probabilities. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.*	**conditional frequencies.**
5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.*	**6.16 The student will** **a) compare and contrast dependent and independent events; and** **b) determine probabilities for dependent and independent events.** **7.10 The student will determine the probability of compound e vents, using the Fundamental (Basic) Counting Principle.** **8.12 The student will determine the probability of independent and dependent events with and without replacement.** **AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and **e) Law of Large Numbers.** **PS.11 The student will identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.** **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
	Large Numbers concept, the addition rule, and the multiplication rule.
Use the rules of probability to compute probabilities of compound events in a uniform probability model	
6. Find the conditional probability of *A* given *B* as the fraction of *B*'s outcomes that also belong to *A,* and interpret the answer in terms of the model.	**AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and **e) Law of Large Numbers.** **PS.11 The student will identify and describe two or more events as complementary, dependent, independent, and/or mutually exclusive.** **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of Large Numbers concept, the addition rule, and the multiplication rule.**
7. Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.	
8. (+) Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model.	
9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.	**AFDA.6 The student will calculate probabilities. Key concepts include** a) conditional probability; b) dependent and independent events; c) addition and multiplication rules; **d) counting techniques (permutations and combinations); and** e) Law of Large Numbers. **AII.12 The student will compute and distinguish between permutations and combinations and use technology for applications.**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
Using Probability to Make Decisions S-MD	
Calculate expected values and use them to solve problems	
1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.	**PS.14 The student will simulate probability distributions, including binomial and geometric.** **PS.19 The student will identify the meaning of sampling distribution with reference to random variable, sampling statistic, and parameter and explain the Central Limit Theorem. This will include sampling distribution of a sample proportion, a sample mean, a difference between two sample proportions, and a difference between two sample means.**
2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.	**AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and e) Law of Large Numbers. **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of Large Numbers concept, the addition rule, and the multiplication rule.** **PS.13 The student will develop, interpret, and apply the binomial probability distribution for discrete random variables, including computing the mean and standard deviation for the binomial variable.**
3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. *For example, find*	**PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of**

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected grade under various grading schemes.	**Large Numbers concept, the addition rule, and the multiplication rule.** **PS.13 The student will develop, interpret, and apply the binomial probability distribution for discrete random variables, including computing the mean and standard deviation for the binomial variable.** **PS.14 The student will simulate probability distributions, including binomial and geometric.**
4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. *For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?*	**AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and e) Law of Large Numbers. **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of Large Numbers concept, the addition rule, and the multiplication rule.**
Use probability to evaluate outcomes of decisions	
5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.	
a. Find the expected payoff for a game of chance. *For example, find the expected winnings from a state lottery ticket or a game at a fast food restaurant.*	**AFDA.6 The student will calculate probabilities. Key concepts include** **a) conditional probability;** **b) dependent and independent events;** **c) addition and multiplication rules;** d) counting techniques (permutations and combinations); and
b. Evaluate and compare strategies on the basis of expected values. *For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but*	

CCSS for Mathematics – Statistics and Probability	Mathematics SOL
reasonable, chances of having a minor or a major accident.	**e) Law of Large Numbers.** **PS.12 The student will find probabilities (relative frequency and theoretical), including conditional probabilities for events that are either dependent or independent, by applying the Law of Large Numbers concept, the addition rule, and the multiplication rule.**
6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).	
7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).	