



**Core Content Connectors 2016  
Maine's Alternate Achievement Standards**

**2020 Mathematics Maine Learning Results K-12  
MAINE DEPARTMENT OF EDUCATION**

**HIGH ACADEMIC STANDARDS FOR STUDENTS**

# Document Introductions

**Core Content Connectors (CCCs)** are only used for students with the most significant cognitive disabilities. They identify the most salient grade-level, core academic content in Mathematics found in the Maine Learning Results and the [Learning Progressions Frameworks \(LPF\)](#). CCCs illustrate the necessary knowledge and skills in order to reach the learning targets within the LPF and the Maine Learning Results, focus on the core content, knowledge and skills needed at each grade to promote success at the next, and identify priorities in each content area to guide the instruction for students in this population and for the alternate assessment.

**[Learning Progressions Frameworks](#) Designed for Use with the Common Core State Stands in Mathematics K-12**  
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**STRAND 1: Symbolic Expression (SE)** – Symbolic Expression, presented in this document as the first strand, is a reminder NOT to teach symbolic representations before students have begun to demonstrate conceptual understanding of what the symbols or procedures actually mean (e.g., what joining together (+) and taking apart (-) sets means; understanding relative magnitude of part-whole; that “equivalence” (=) means different names for the same number). Progress indicators for the Symbolic Expression strand should be taught in conjunction with skills and concepts described in PIs from other strands and introduced with building conceptual understanding in mind.

**STRAND 2: The Nature of Numbers & Operations (NO)** – The skills and concepts within the Nature of Numbers and Operations strands form the foundation - and often are the prerequisite skills and concepts - for many of the other mathematics strands. Local curriculum development efforts should always consider how the skills and concepts described in the Numbers & Operations progress indicators can be introduced, practiced, and extended with skills/concepts found in the other strands. The third N&O strand focuses on mathematical reasoning and problem solving. These progress indicators can be integrated with many CCSS standards at each grade level using problem solving contexts. While listed under the Nature of Numbers & Operations strand, the skills and concepts described in these progress indicators could apply to concepts in different mathematics strands, such as when developing proofs in Geometry.

**STRAND 3: Measurement (ME)** – Progress indicators are organized under two key learning targets for each grade span.

**STRAND 4: Patterns, Relations, & Functions (PFR)** – Progress indicators are organized under two key learning targets for each grade span.

**STRAND 5: Geometry (GM)** – Progress indicators are organized under one key learning target for each grade span.

**STRAND 6: Data Analysis, Probability, & Statistics (DPS)** – Progress indicators are organized under two key learning targets for each grade span. There is minimal emphasis in the CCSS on Data Analysis, Probability, & Statistics at grades K-6. Because many of the DPS mathematics skills and concepts are essential to science and social studies instruction at these grade levels, progress indicators are included in the DPS strand to guide unit development where organizing and interpreting data is important. However, you will not find many links to the CCSS mathematics standards in this strand at the lower grade levels.

**STRAND 1: Symbolic Expression (SE):** The use and manipulation of symbols and expressions provide a variety of representations for solving problems and expressing mathematical concepts, relationships, and reasoning.

<b>(K-4) Elementary School Learning Targets</b>	<b>(5-8) Middle School Learning Targets</b>	<b>(9-12) High School Learning Targets</b>
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<p><b>E.SE-1</b> Use equations and expressions involving basic operations to represent a given context.</p> <ul style="list-style-type: none"> <li>• Represent numerical relationships using combinations of symbols (=, &gt;, &lt;) and numbers to form expressions and equations</li> <li>• Solve for unknown in simple number binary number sentences (e.g., ____ + 4 = 7);</li> <li>• Write equations showing inverse operations and related operations (e.g., addition-multiplication).</li> </ul>		<p><b>M.SE-1</b> Represent relationships and interpret expressions and equations in terms of a given context for determining an unknown value.</p> <ul style="list-style-type: none"> <li>• Represent mathematical relationships symbolically and solve for any variable (for 1st degree equations and for common formula (literal equation));</li> <li>• Explain how to manipulate an algebraic expression to create equivalent expressions and provide step-by-step explanations and justifications.</li> </ul>		<p><b>H.SE-1</b> Represent relationships and interpret expressions and equations in terms of a given context (including complex and families of functions) for determining unknown values (including two or more variables).</p> <ul style="list-style-type: none"> <li>• Represent and interpret multi-step problems;</li> <li>• Represent complex numbers and vectors;</li> <li>• Demonstrate the relationship between systems of equations and matrix representations;</li> <li>• Represent the relationship between functions and modeling.</li> </ul>					
<b>Grades K-2</b>		<b>Grades 3-4</b>		<b>Grades 5-6</b>		<b>Grades 7-8</b>		<b>Grades 9-12</b>	
<p><b>Students use symbolic expression when...</b></p> <p><b>E.SE.1a</b> recognizing that symbols correspond to specific quantities (e.g., matching symbols to sets of quantities above three) K.CC-3</p> <p><b>E.SE.1b</b> using oral and then written numerals and symbols to express quantities K.CC-3 (0-20); K.CC-4; 1.NBT-1 (0-120); 1.MD-3 (time); 2.NBT-3 (0-1000); 2.MD-7 (time), 8 (money)</p> <p><b>E.SE.1c</b> using symbols (=, &gt;, &lt;) to compare whole number quantities, write equations, and</p>		<p><b>Students use symbolic expression when...</b></p> <p><b>E.SE.1f</b> extending finding unknown numbers in equations using multiplication and division, including using letters for unknown quantities 3.OA-4, 8; 4.OA-3</p> <p><b>E.SE.1g</b> using symbols (=, &gt;, &lt;) to compare whole numbers, fractions, or decimals; write equations; and express inverse or related operations 3.NF-3d; 4.OA-1; 4.NF-2, 7</p> <p><b>E.SE.1h</b> expressing whole numbers as fractions, and fractions as equivalent decimals; recognizing that a</p>		<p><b>Students use symbolic expression when...</b></p> <p><b>M.SE.1a</b> using symbols (=, &gt;, &lt;) to compare whole numbers, fractions, or decimals; write equations; and express inverse or related operations 5.NBT-3b</p> <p><b>M.SE.1b</b> writing, interpreting, and using expressions, equations, and inequalities (including using brackets, parentheses, or braces) 5.OA-1, 2; 6.EE-2a, 2b, 6, 8, 9</p> <p><b>M.SE.1c</b> maintaining equality between both sides of the equation to solve equations of the form <math>x + p = q</math> and <math>px =</math></p>		<p><b>Students use symbolic expression when...</b></p> <p><b>M.SE.1e</b> interpreting and using symbols to express relationships or solutions (e.g., formulas; ordered pairs, ratios, exponents, squaring and cubing) 7.RP-2c, 2d; 7.G-4; 8.EE-1, 2; 8.G-9</p> <p><b>M.SE.1f</b> writing and interpreting mathematical expressions, equations, and inequalities that correspond to given situations 7.EE-4a, 4b; 8.EE-8c; 8.F-3</p> <p><b>M.SE.1g</b> evaluating expressions; using expressions, linear equations, inequalities,</p>		<p><b>Students use symbolic expression when...</b></p> <p><b>H.SE.1a</b> interpreting and using symbols to express relationships (e.g., identifying parts of expressions, generating equivalent expressions, formulas; exponents) A.SSE-1, 2, 3; F.IF-8b</p> <p><b>H.SE.1b</b> creating mathematical models, using rules and relationships to describe and predict objects and events in the real world F.BF-1a; S.ID-6a</p> <p><b>H.SE.1c</b> identifying essential quantitative relationships in a situation, using symbolic expressions to represent it, and drawing reasonable conclusions from it A.SSE-1,2, 3; G.GMD-3</p> <p><b>H.SE.1d</b> interpreting and using symbols to express relationships and solve problems (e.g., volume formulas; exponents, square and cube roots) F.IF-8b; N.RN-1; G.GMD-3</p> <p><b>H.SE.1e</b> recognizing that there limitations in mathematics models A.CED-3; S.IC-2</p>	

<p>determine if equations are true 1.OA-7; 1.NBT-3; 2.OA-3, 4; 2.NBT-4</p> <p><b>E.SE.1d</b> representing addition and subtraction in multiple formats, including expressions K.OA-1; 1.OA-1, 2, 3, 4; 2.OA-1, 4</p> <p><b>E.SE.1e</b> demonstrating understanding of finding the unknown in addition and subtraction equations (e.g., when all but 1 of 3 numbers is known-what makes this true?) K.OA-1, 3, 4; 1.OA-7, 8; 2.MD-5; 2.OA-4</p>	<p>fraction is one number, not two 3.NF-3c; 4.NF-6</p>	<p>q for cases in which p, q and x are all nonnegative rational numbers 6.EE- 7</p> <p><b>M.SE.1d</b> interpreting and using symbols to express relationships (e.g., simple formulas - volume, area; ordered pairs, ratios, percents, positive-negative numbers, exponents) 5.MD-5b; 5.G-1; 6.RP-1, 3c; 6.NS-6a, 6b; 6.EE-1, 6</p>	<p>and formulas to solve problems 7.EE-4a, 4b; 8.EE-8c; 8.F-3</p>	
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**STRAND 2: The Nature of Numbers and Operations (NO):** Understandings of number - “how many” or “how much” – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms.

<b>STRAND 2: The Nature of Numbers and Operations (NO):</b> Understandings of number - “how many” or “how much” – and number types extend applications of arithmetic properties, operations, and number systems and guide the use of computational strategies and algorithms.				
<b>(K-4) Elementary School Learning Targets</b>		<b>(5-8) Middle School Learning Targets</b>		<b>(9-12) High School Learning Targets</b>
<p><b>E.NO-1</b> Build flexibility using whole numbers, fractions, and decimals to understand the nature of number and number systems:</p> <ul style="list-style-type: none"> <li>Count, model, and estimate quantities;</li> <li>Compare, represent, and order numbers;</li> <li>Apply place value concepts and expanded notation to compose and decompose whole numbers.</li> </ul>		<p><b>M.NO-1</b> Build flexibility using rational and irrational numbers to expand understanding of number systems:</p> <ul style="list-style-type: none"> <li>Estimate, compare, and represent numbers (fractions, decimals, and percents; integers);</li> <li>Use exponents to express quantities and relationships;</li> <li>Use integers in problem solving.</li> </ul>		<p><b>H.NO-1</b> Demonstrate flexibility using rational and irrational numbers and number systems, including complex numbers and matrices.</p>
<b>Grades K-2</b>	<b>Grades 3-4</b>	<b>Grades 5-6</b>	<b>Grades 7-8</b>	<b>Grades 9-12</b>
<b>Demonstrate an understanding of</b>	<b>Demonstrate an understanding of</b>	<b>Demonstrate an understanding of</b>	<b>Demonstrate an understanding of</b>	<b>Demonstrate an understanding of number and number systems...</b>

<p><b>number and number systems...</b></p> <p><b>E.NO.1a</b> showing mastery of the prerequisite core skills of cardinality, constancy, and 1:1 correspondence K.CC-2, 4</p> <p><b>E.NO.1b</b> developing an understanding of number and principles of quantity (e.g., hold up 5 fingers at once to show 5, locate things in 2s without counting; using number words to indicate small exact numbers or relative change in quantity – more/less, small/big) K.CC-4b, 4c; K.OA-4</p> <p><b>E.NO.1c</b> developing number line skills (linear representations) using 0 to 20, and later 0 to 100</p> <p><b>E.NO.1d</b> identifying numbers (names, symbols, quantity) and the count sequence K.CC-1, 2, 4</p> <p><b>E.NO.1e</b> reading and writing numbers; counting and estimating (e.g., how many?; skip counting by 2s, 5s, 10s; even/odd)</p>	<p><b>number and number systems...</b></p> <p><b>E.NO.1j</b> applying place value concepts to: read, write, and compare whole numbers up to 100,000; use expanded form; and round numbers to a given place 3.NBT-1; 4.NBT-2, 3</p> <p><b>E.NO.1k</b> explaining the meaning of place value (that a digit in one place represents 10 times what it represents in the place to its right) 4.NBT-1</p> <p><b>E.NO.1l</b> identifying and locating fractions on the number line or as regions, or parts of a set or unit, and recognizing that whole numbers are a subset of rational numbers 3.NF-1, 2, 3a, 3c</p> <p><b>E.NO.1m</b> composing and representing equivalent fractions in the form <math>a/b</math> 3.NF-1, 2, 3a, 3b; 4.NF-1, 2</p>	<p><b>number and number systems...</b></p> <p><b>M.NO.1a</b> explaining the meaning of place value (that a digit in one place represents 10 times what it represents in the place to its right) 5.NBT-1</p> <p><b>M.NO.1b</b> extending place value understanding to reading (e.g., naming the values with number words, rather than “point four”), writing, comparing, and rounding decimals 5.NBT-3, 4</p> <p><b>M.NO.1c</b> using a variety of fractional and decimal representations and locating them on a number line 5.NBT-3a; 5.NF-1</p> <p><b>M.NO.1d</b> representing integers (positive/negative numbers) and locating them on a number line 6.NS-5, 6c, 7a</p> <p><b>M.NO.1e</b> describing, representing, and</p>	<p><b>number and number systems...</b></p> <p><b>M.NO.1g</b> representing and using integers; comparing and expressing absolute value and additive inverse relationships 7.NS-1a, 1b, 1c, 2b</p> <p><b>M.NO.1h</b> recognizing and modeling fractions, decimals, and percents as different representations of rational numbers 7.NS-2d; 8.NS-1</p> <p><b>M.NO.1i</b> using exponents and scientific notation to express very large or very small quantities 8.EE-1, 3, 4</p> <p><b>M.NO.1j</b> making interpretations and comparisons of scientific notation produced by technology or appearing in various media 8.EE-3, 4</p> <p><b>M.NO.1k</b> distinguishing rational numbers (terminating and repeating) from</p>	<p><b>H.NO.1a</b> using exponents and scientific notation to represent quantities and expressions (Also addressed at grade 8: 8.EE-1, 2, 3, 4); N.RN-2; A.SSE-2, 3c</p> <p><b>H.NO.1b</b> distinguishing rational numbers (terminating and repeating) from irrational numbers (non-terminating and non-repeating), and recognizing that together they form the real number system and that both can be represented on the number line (Also addressed at grade 8: 8.NS-1, 2); N.RN-3</p> <p><b>H.NO.1c</b> modeling and describing that complex numbers augment real numbers</p> <p><b>H.NO.1d</b> extending operations and properties to work with complex numbers N.CN-2</p> <p><b>H.NO.1e</b> using matrices to store and manipulate data</p>
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<p><b>K.CC-1, 2, 3, 4, 5; 1.NBT-1; 2.NBT-2, 3; 2.OA-3</b></p> <p><b>E.NO.1f</b> representing, ordering, and comparing whole numbers K.CC-6, 7; 1.NBT-1, 3; 2.NBT-4</p> <p><b>E.NO.1g</b> recognizing that numbers can be divided (represented as fractions)</p> <p><b>E.NO.1h</b> applying place value understanding to compare and order numbers, express number relationships (<math>,</math> <math>=</math>), and express numbers in expanded form 1.NBT-2c, 3; 2.NBT-1, 4</p> <p><b>E.NO.1i</b> recognizing zero as an additive identify, origin for the number line, and representing no units as a quantity or in place value K.CC-3; 1.NBT-2; 2.NBT-1</p>	<p><b>E.NO.1n</b> comparing and modeling fractions, including with different denominators 3.NF-2, 3a, 3b, 3c, 3d; 4.NF-1, 2</p> <p><b>E.NO.1o</b> rewriting fractions as equivalent decimals 4.NF-5, 6</p> <p><b>E.NO.1p</b> using number words to indicate decimal values (tenths, hundredths)</p> <p><b>E.NO.1q</b> using and comparing decimals to the hundredths 4.NF-7</p>	<p>comparing absolute value relationships 6.NS-7c, 7d</p> <p><b>M.NO.1f</b> recognizing equivalence of representations using fractions, decimals, and percents and using them to solve ratio problems 6.RP-1, 3</p>	<p>irrational numbers (non-terminating and non-repeating), and recognizing that together they form the real number system and that both can be represented on the number line 8.NS-1, 2</p>	
<b>(K-4) Elementary School Learning Targets</b>		<b>(5-8) Middle School Learning Targets</b>		<b>(9-12) High School Learning Targets</b>
<p><b>E.NO-2</b> Build an understanding of computational strategies and algorithms:</p> <ul style="list-style-type: none"> <li>Fluently add, subtract, multiply, divide, and estimate;</li> <li>Perform and represent operations with whole numbers, fractions, and mixed numbers;</li> <li>Identify multiples and factors of whole numbers.</li> </ul>		<p><b>M.NO-2</b> Expand use of computational strategies and algorithms to rational numbers:</p> <ul style="list-style-type: none"> <li>Perform operations fluently with rational numbers, including fractions, decimals, and percents;</li> <li>Identify equivalence of indicated division and fractional parts.</li> </ul>		<p><b>H.NO-2</b> Build an understanding of computational strategies and algorithms including matrices and irrational and complex numbers:</p> <ul style="list-style-type: none"> <li>Use matrix operations and complex and irrational number operations;</li> <li>Apply exponential expressions (laws and properties).</li> </ul>
<b>Grades K-2</b>	<b>Grades 3-4</b>	<b>Grades 5-6</b>	<b>Grades 7-8</b>	<b>Grades 9-12</b>

<p><b>Build understanding and fluency with operations...</b></p> <p><b>E.NO.2a</b> representing addition and subtraction in multiple ways (composing/decomposing numbers, diagrams, using objects, arrays, equations, number lines), including regrouping K.OA-1, 2, 3, 4; K.NBT-1; 1.OA-1, 2, 5, 6; 1.NBT-4, 5, 6; 2.OA-1, 4; 2.NBT-7</p> <p><b>E.NO.2b</b> explaining or modeling the relationship between addition and subtraction 1.OA-3, 4; 1.NBT-4, 6; 2.NBT-5, 7, 9</p> <p><b>E.NO.2c</b> working flexibly with common addition and subtraction situation K.OA- 2; 1.OA-3, 5, 6, 8; 1.NBT-5, 6; 2.OA-1, 2; 2.NBT- 2, 5, 7</p>	<p><b>Build understanding and fluency with operations...</b></p> <p><b>E.NO.2d</b> modeling multiplication (equal-sized groups, arrays, area models, equal-sized jumps on number lines, multiplicative comparisons) and division (successive subtraction, partitioning, sharing) of whole numbers 3.OA-1, 2, 3, 4, 5; 4.OA-1, 2, 3; 4.NBT- 5, 6</p> <p><b>E.NO.2e</b> describing relationships between addition-multiplication; multiplication-division; addition-subtraction; why commutativity does not apply to subtraction or division 3.OA-5, 7, 9; 3.NBT-2; 4.OA-2</p> <p><b>E.NO.2f</b> identifying factors and multiples of numbers 3.OA-6; 4.OA-4</p> <p><b>E.NO.2g</b> recognizing fractions as one number (one quantity), rather than two numbers (numerator and denominator) and</p>	<p><b>Build understanding and fluency with operations...</b></p> <p><b>M.NO.2a</b> working flexibility with common addition, subtraction, multiplication, and division situations 5.NBT-5, 6; 5.NF-5a; 6.NS-2, 3, 4</p> <p><b>M.NO.2b</b> recognizing fractions as one number (one quantity), rather than two numbers (numerator and denominator) and using number lines to represent magnitude of fractions and equivalent /non-equivalent fractions 5.NF-3</p> <p><b>M.NO.2c</b> using operations and standard algorithms with whole numbers, fractions (unlike denominators), and decimals (to hundredths) 5.NBT-5, 6, 7; 5.NF-1, 2, 4, 7; 6.NS-1, 3</p> <p><b>M.NO.2d</b> contrasting situations as additive or multiplicative</p>	<p><b>Build understanding and fluency with operations...</b></p> <p>M.NO.2f describing proportional relationships and solving related problems (Also addressed at grade 6: 6.RP-2, 3); 7.RP-1, 2, 3</p> <p>M.NO.2g using operations with complex fractions</p> <p>M.NO.2h using operations involving percents and percent increase/decrease 7.RP-3</p> <p>M.NO.2i using operations with rational numbers; representing rational numbers and approximations of irrational numbers on a number line 7.NS-1, 2; 7.EE-3; 8.NS-1, 2</p>	<p><b>Build understanding and fluency with operations...</b></p> <p><b>H.NO.2a</b> using operations with rational numbers; representing rational numbers and approximations of irrational numbers on a number line N.RN-3; A.SSE-3b; A.REI-2; A.APR-1</p> <p><b>H.NO.2b</b> operating with irrational and complex numbers A.REI-2, N.RN-3, N.CN-1, 2</p> <p><b>H.NO.2c</b> identifying exponential situations and applying the laws and properties of exponents in simplifying expressions and solving equations A.SSE- 2, 3; N.RN-1, 2</p> <p><b>H.NO.2d</b> using matrices to represent situations; perform and interpret basic matrix operations</p>
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	<p>using number lines to represent magnitude of fractions 3.NF-1, 2, 3a, 3c</p> <p><b>E.NO.2h</b> adding, subtracting, and multiplying fractions, including mixed numbers 4-NF-3, 4</p>	<p><b>M.NO.2e</b> ordering/comparing integers and representing them on the number line 6.NS-6a, 6c, 7</p>		
<b>(K-4) Elementary School Learning Targets</b>		<b>(5-8) Middle School Learning Targets</b>		<b>(9-12) High School Learning Targets</b>
<p><b>E.NO-3</b> Use reasoning to support solutions and informal arguments and to develop metacognitive skills:</p> <ul style="list-style-type: none"> <li>• Use estimation and rounding to support informal arguments;</li> <li>• Develop both additive and multiplicative thinking;</li> <li>• Test, model, and explain solutions.</li> </ul>		<p><b>M.NO-3</b> Develop metacognitive skills through making conjectures and justifying mathematical solutions and arguments:</p> <ul style="list-style-type: none"> <li>• Use estimation and rounding to support reasonableness of arguments/justifications;</li> <li>• Apply multiplicative and proportional reasoning;</li> <li>• Make, test, and justify conjectures using mathematical concepts and models.</li> </ul>		<p><b>H.NO-3</b> Develop metacognitive skills through use of mathematical arguments to justify reasonableness of outcomes, to support formal proofs (including technology applications), and to develop metacognitive skills.</p>
<b>Grades K-2</b>	<b>Grades 3-4</b>	<b>Grades 5-6</b>	<b>Grades 7-8</b>	<b>Grades 9-12</b>
<p><b>Students demonstrate mathematical reasoning...</b></p> <p><b>E.NO.3a</b> exploring and explaining answers to questions, such as “Does this answer make sense?” K.CC-4, 5, 6; KOA-1; 1.OA-1, 2, 7, 8; 1.G-3; 2.OA-1; 2.NBT-7, 9</p> <p><b>E.NO.3b</b> constructing arguments using concrete referents such as objects, diagrams, tables, actions (e.g., clapping,</p>	<p><b>Students demonstrate mathematical reasoning...</b></p> <p><b>E.NO.3c</b> evaluating the reasonableness of answers using mental computation, arithmetic patterns, and estimation strategies, including rounding to the nearest 10 or 100 3.OA-5, 8, 9; 3.NBT-1, 2, 3; 3.MD-2; 4.OA-3, 4, 5; 4.NBT-3</p>	<p><b>Students demonstrate mathematical reasoning...</b></p> <p><b>M.NO.3a</b> using informal and rule-based arguments, evidence, and examples (e.g., estimation, rounding, arrays, visual models, diagrams) to justify mathematical solutions 5.OA-3; 5.NBT-2, 6, 7; 5.NF-2, 4a, 5, 6, 7c; 6.RP-3a, 3d; 6.NS-1, 6c, 8; 6.EE-5</p>	<p><b>Students demonstrate mathematical reasoning...</b></p> <p><b>M.NO.3c</b> using stated assumptions, definitions, patterns, and previously established results in constructing mathematical arguments 7.RP-2a, 2d; 7.NS-1a, 2a, 3; 7.EE-3; 8.NS-2; 8.EE-6; 8.F-5; 8.SP-4</p>	<p><b>Students demonstrate mathematical reasoning...</b></p> <p><b>H.NO.3a</b> comparing the effectiveness of two plausible arguments, distinguishing correct logic or reasoning from that which is flawed, and if there is a flaw in an argument, explaining it F.IF-9; F.LE-1a; F.TF-8; N.RN-1, 3; N.Q-1; A.REI-1, 2, 5, 11; A.SSE-2, 3c; A.CED-3, 4; A.APR-4, 6; G.SRT-4; G.C-1; G.CO-9, 10, 11; G.GPE-4; S.ID-3, 4, 9; S.IC-2, 3, 5, 6</p>

<p>movement) and estimating  K.OA.1, 2; K.G-5; 1.OA-1, 2, 7, 8; 1.G-3; 1.MD-4; 2.OA-1; 2.NBT-7, 9; 2.MD-3; 2.G-3</p>	<p><b>E.NO.3d</b> constructing arguments and explaining reasonableness of outcomes using a variety of concrete supports (e.g., models, diagrams, tables)  3.OA-8, 9; 3.MD-1, 3, 4, 7b, 7c, 7d, 8; 4.OA-3, 5; 4.NBT- 5, 6; 4.NF-1, 2, 3b, 3d, 4a, 6, 7; 4.MD-4</p>	<p><b>M.NO.3b</b> critiquing the mathematical arguments provided by others  5.OA-3; 5.NBT-2, 6, 7; 5.NF-2, 4a, 5; 6.RP-3a, 3d; 6.NS-1, 7b, 7d, 8; 6.EE-5</p>	<p><b>M.NO.3d</b> building a logical progression of statements to explore and evaluate the truth of conjectures  7.RP-2a, 2d; 7.NS-2a; 7.EE-3; 7.G-4; 8.NS-2; 8.EE-6; 8.F-5; 8.SP-4</p>	
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**STRAND 3: Measurement (ME):** Measurement attributes, processes, and tools help us quantify, compare, and solve problems involving objects, situations, and events.

(K-4) Elementary School Learning Targets	(5-8) Middle School Learning Targets	(9-12) High School Learning Targets
<p><b>E.ME-1</b> Explore relationships among units, attributes, and measures within a system of measurement:</p> <ul style="list-style-type: none"> <li>Identify measurement attributes and units;</li> <li>Use measurement attributes to describe and compare objects, situations, or events.</li> </ul>	<p><b>M.ME-1</b> Extend understanding of attributes and units:</p> <ul style="list-style-type: none"> <li>Make conversions within measurement systems;</li> <li>Relate measurement attributes, measures, models, and formulas.</li> </ul>	<p><b>H.ME-1</b> Explore measurable attributes, measurement systems, and processes of measurement of more complex or abstract quantities.</p>

Grades K-2	Grades 3-4	Grades 5-6	Grades 7-8	Grades 9-12
<p><b>Students understand measurable attributes by...</b></p> <p><b>E.ME.1a</b> recognizing, identifying, and describing the measurable attributes of objects  K.MD-1(length/height, weight); 1.MD-2 (l/h); 1.MD-3 (time); 2.MD-1 (l/h/w); 2.MD-7 (time); 2.MD-8 (money)</p>	<p><b>Students understand measurable attributes by...</b></p> <p><b>E.ME.1d</b> describing and demonstrating: unit attributes, iterating, tiling, identical units, number line intervals, standardization, proportionality, additivity, and origin  3.MD-1, 4, 5, 6, 7a, 7c, 7d; 4.MD-7</p>	<p><b>Students understand measurable attributes by...</b></p> <p><b>M.ME.1a</b> identifying and describing measurable attributes (including area, surface area, volume, fractional units, absolute value with temperature), and selecting appropriate customary or metric units of measure when solving problems</p>	<p><b>Students understand measurable attributes by...</b></p> <p><b>M.ME.1d</b> applying proportional reasoning to problems with ratios of length, area, and quantities measured in like or different units  7.RP-1, 2b; 7.G-1</p> <p><b>M.ME.1e</b> exploring what happens to 2- and 3- dimensional</p>	<p><b>Students understand measurable attributes by...</b></p> <p><b>H.ME.1a</b> making decisions about units and scales that are appropriate for problem-solving situations within or across mathematics disciplines or real-world contexts  N.Q-1, 2; G.CO-12; G.MG-1, 2, 3</p> <p><b>H.ME.1b</b> investigating the results when linear dimensions of objects change by some factor (e.g., area and volume change disproportionately: area in proportion to the square of the factor and volume in proportion to its cube)  A.REI-3; F.BF-1a</p>

<p><b>E.ME.1b</b> comparing and ordering objects/events according to their specified attributes (using standard or non-standard units of measure), including indirectly by using a third object, or using common referents to estimate or compare <a href="#">K.MD-2, 3</a>; <a href="#">1.MD-1</a>; <a href="#">2.MD-3, 4</a></p> <p><b>E.ME.1c</b> recognizing that the smaller the unit, the more units are needed to measure an object ; and that units can be decomposed/partitioned into smaller units <a href="#">1.MD-2</a>; <a href="#">2.MD-2, 3</a></p>	<p><b>E.ME.1e</b> justifying the need for measuring with standard units as compared to non-standard units</p> <p><b>E.ME.1f</b> selecting the appropriate unit for measuring a given attribute (length, area, mass, liquid volume, size of angle), recognizing that a unit must have the same attributes as the object (e.g., unit of length must measure an object that has length) <a href="#">3.MD-2,5</a>; <a href="#">4.MD-1, 2, 6</a></p> <p><b>E.ME.1g</b> exploring what happens to 2-dimensional measurements (perimeter or area) when the dimensions of the figure are changed <a href="#">3.MD-7, 8</a>; <a href="#">4.MD-3</a></p>	<p><a href="#">5.MD-1, 3</a>; <a href="#">6.NS-7b</a></p> <p><b>M.ME.1b</b> recognizing relationships among units and using proportional reasoning to convert measurements from one unit to another within the same system <a href="#">5.MD-1</a>; <a href="#">6.RP-3d</a></p> <p><b>M.ME.1c</b> recognizing how the formulas for area and volume for a variety of shapes and solids are related <a href="#">6.G-1, 2, 4</a></p>	<p>measurements (such as surface area, area, and volume) when the figure is changed in some way (e.g., scale drawings) <a href="#">7.G-1, 6</a>; <a href="#">8.G-4, 9</a></p>	<p><b>H.ME.1c</b> exploring quantifications of real-world applications of abstract units such as sound (decibels, pitch), gigabytes, Richter scale, acceleration, and other less tangible units of measure <a href="#">N.Q-1, 2</a></p>
<b>(K-4) Elementary School Learning Targets</b>		<b>(5-8) Middle School Learning Targets</b>		<b>(9-12) High School Learning Targets</b>
<b>E.ME-2</b> Apply appropriate techniques (iteration and tiling), tools (standard and non-standard), and formulas (area and perimeter) to determine or estimate measurements.		<b>M.ME-2</b> Apply appropriate techniques, strategies, and formulas to solve problems involving measurements (including derived measurements and rates).		<b>H.ME-2</b> Apply and analyze techniques at an appropriate level of precision and use formulas to quantify or interpret abstract events, objects, and situations.
<b>Grades K-2</b>	<b>Grades 3-4</b>	<b>Grades 5-6</b>	<b>Grades 7-8</b>	<b>Grades 9-12</b>
<p><b>Determine measurements...</b></p> <p><b>E.ME.2a</b> applying nonstandard and</p>	<p><b>Determine measurements...</b></p> <p><b>E.ME.2e</b> selecting and applying appropriate</p>	<p><b>Determine measurements...</b></p> <p><b>M.ME.2a</b> selecting and applying appropriate</p>	<p><b>Determine measurements...</b></p> <p><b>M.ME.2c</b> selecting and applying appropriate</p>	<p><b>Determine measurements...</b></p> <p><b>H.ME.2a</b> analyzing levels of precision, accuracy, and approximate error in measurement situations <a href="#">N.Q-3</a></p>

<p>common standard units to measure or estimate (length, height, weight, time) 1.MD-2, 3; 2.MD-1, 2, 3, 4, 7</p> <p><b>E.ME.2b</b> selecting tools and using units of measures appropriately and consistently, with no gaps or overlaps in the technique of measuring 1.MD-2, 3; 2.MD-1, 3, 7</p> <p><b>E.ME.2c</b> recognizing situations that require precision and those where an estimation or proportional matching is appropriate 2.MD-1, 3</p> <p><b>E.ME.2d</b> describing a unit as an amount/quantity (rather than an object or a mark on a scale)</p>	<p>customary or metric units and tools to measure or estimate (liquid volume, mass, perimeter, area, time, and angles) 3.MD-1, 2, 4, 6, 7a, 8; 4.MD-5a, 6</p> <p><b>E.ME.2f</b> recognizing relative sizes of units of measure and making simple conversions within systems when solving problems (e.g., 12 in. = 1 ft) 4.MD-1</p> <p><b>E.ME.2g</b> recognizing situations that require precision (money, time, distances, fractions, decimals) and those where an estimation is appropriate 3.MD-2; 4.MD-2</p> <p><b>E.ME.2h</b> using a variety of strategies (decomposing complex shapes, using counting strategies, arrays, formulas) to estimate or measure area and perimeter (including irregular shapes/objects) 4.MD-3</p>	<p>standard units, tools, and level of precision in real-world measurement problems (e.g., area, surface area, volume, rate) 5.MD-1, 4; 6.G-1, 2, 4</p> <p><b>M.ME.2b</b> using a variety of strategies (decomposing complex shapes, using formulas and models) to measure area (triangles, quadrilaterals, polygons) and volume (rectangular prisms) 5.MD-4, 5; 6.G-1, 2, 4</p>	<p>standard units and tools to measure to an appropriate level of precision</p> <p><b>M.ME.2d</b> using various strategies (decomposing complex shapes, using formulas) to measure volume (cones, cylinders, spheres) and area and circumference of circles 7.G-4; 8.G-9</p> <p><b>M.ME.2e</b> solving simple problems involving scale factors, rates, and derived measures 7.G-1; 7.RP-1</p> <p><b>M.ME.2f</b> applying the Pythagorean theorem to determine lengths/distances in real-world situations 8.G-7, 8</p>	<p><b>H.ME.2b</b> using techniques of measurement, estimating, or calculating to compare or analyze two- and three-dimensional figures and their parts G.SRT-1, 2; G.C-5; G.MG-1, 2, 3</p>
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	E.ME.2i selecting and using benchmarks to estimate measurements 3.MD-2			
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<b>STRAND 4: Patterns, Relations, and Functions (PRF):</b> Patterns, relations, and functions are used to represent and analyze change in various contexts, make predictions and generalizations, and provide models and explanations for real-world phenomena.				
<b>(K-4) Elementary School Learning Targets</b>		<b>(5-8) Middle School Learning Targets</b>		<b>(9-12) High School Learning Targets</b>
<b>E.PRF-1</b> Use concrete, pictorial, and symbolic representations to identify, describe, compare, and model situations that involve change.		<b>M.PRF-1</b> Describe and compare situations that involve change and use the information to draw conclusions: <ul style="list-style-type: none"> <li>• Model contextual situations using multiple representations;</li> <li>• Calculate rates of change for real-world situations (constant).</li> </ul>		<b>H.PRF-1</b> Approximate, calculate, model, and interpret change: <ul style="list-style-type: none"> <li>• Use graphical and numerical data resulting from complex situations;</li> <li>• Model complex real-world phenomena to make predictions and provide explanations.</li> </ul>
Grades K-2	Grades 3-4	Grades 5-6	Grades 7-8	Grades 9-12
<b>Demonstrate understanding of change by...</b>  <b>E.PRF.1a</b> describing changes qualitatively (e.g., growing taller) and quantitatively (e.g., growing 2 inches in one year) K.CC-6; K.MD-2; 1.OA-1; 1.NBT-3; 1.MD-1; 2.NBT-4  <b>E.PRF.1b</b> exploring and describing how addition or subtraction changes a quantity K.OA-1, 2; 1.OA-1, 5  <b>E.PRF.1c</b> modeling problem-solving	<b>Demonstrate understanding of change by...</b>  <b>E.PRF.1d</b> describing and modeling how addition, subtraction, multiplication, or division changes a quantity, including with fractions 3.OA-1, 2, 7; 4.OA-1; 4.NBT-1; 4.NF-3, 4  <b>E.PRF.1e</b> using representations (tables, graphs, equations) to show how values of one quantity are related to values of another and to draw conclusions	<b>Demonstrate understanding of change by...</b>  <b>M.PRF.1a</b> describing how multiplication or division changes a quantity, including with fractions or decimals 5.NF-4a, 5, 7b; 6.NS-1  <b>M.PRF.1b</b> distinguishing linear from nonlinear relationships as represented in graphical and tabular representations 5.OA-3; 6.RP-3a  <b>M.PRF.1c</b> comparing two rates and evaluating them for a	<b>Demonstrate understanding of change by...</b>  <b>M.PRF.1e</b> representing and computing unit rates associated with ratios of lengths, areas, and other quantities measured in like or different units 7.RP-1, 2, 3; 8.EE-5  <b>M.PRF.1f</b> identifying essential quantitative relationships in a situation and using symbolic expressions to represent it and draw reasonable conclusions from it	<b>Demonstrate understanding of change by...</b>  <b>H.PRF.1a</b> approximating, calculating, and interpreting rates of change using graphical and numerical data S.ID-1, 2, 7; F.LE-1b, 1c, 3  <b>H.PRF.1b</b> exploring how the rate of change of something depends on how much there is of something else (e.g., as the rate of change of speed is proportional to the amount of force acting) A.CED-4; S.ID-3; F.LE-1b  <b>H.PRF.1c</b> creating mathematical models, using rules and relationships to describe and predict objects and events in the real world A.CED-2; S.IC-2; F.LE-1; F.TF-5  <b>H.PRF.1d</b> recognizing that there are limitations in mathematics models A.CED-3; A.REI-2; S.IC-2

<p>situations that involve addition and subtraction of whole numbers using objects, diagrams, and symbols  <a href="#">K.OA-1, 2</a>; <a href="#">1.OA-1, 5</a>; <a href="#">2.OA-1, 3, 4</a>; <a href="#">2.NBT-7</a>; <a href="#">2.MD-5</a></p>	<p><a href="#">3.OA-9</a>; <a href="#">3.MD-3, 4</a>; <a href="#">4.OA-2</a></p> <p><b>E.PRF.1f</b> representing and explaining equivalence concretely, graphically, and symbolically (equations, rules)  <a href="#">3.MD-1, 7c</a>; <a href="#">4.OA-5</a>; <a href="#">4.NBT-5, 6</a>; <a href="#">4.MD-4</a></p> <p><b>E.PRF.1g</b> identifying situations with constant or varying rates of change (with two quantities)</p>	<p>given situation (e.g., best value)  <a href="#">6.RP-1, 2, 3b</a>; <a href="#">6.EE-4, 6</a></p> <p><b>M.PRF.1d</b> using symbolic equations to summarize how the quantity of something changes  <a href="#">6.EE-4, 7, 9</a></p>	<p><a href="#">7.RP-1, 2, 3</a>; <a href="#">7.EE-2, 3, 4</a>; <a href="#">8.EE-5, 7</a>; <a href="#">8.F-1, 2, 3, 4, 5</a></p> <p><b>M.PRF.1g</b> modeling, solving, and explaining contextualized problems using various representations such as graphs, tables, functions, and equations  <a href="#">7.RP-2, 3</a>; <a href="#">7.EE-2, 4</a>; <a href="#">8.EE-5, 7</a>; <a href="#">8.F-2, 3, 4, 5</a></p> <p><b>M.PRF.1h</b> representing and describing how rates of change can be computed from differences in magnitudes and vice versa</p>	
<b>(K-4) Elementary School Learning Targets</b>		<b>(5-8) Middle School Learning Targets</b>		<b>(9-12) High School Learning Targets</b>
<b>E.PRF-2</b> Give examples, interpret, and analyze repeating and growing patterns and functions involving the four basic operations.		<b>M.PRF-2</b> Give examples, interpret, and analyze a variety of mathematical patterns, relations, and explicit and recursive functions.		<b>H.PRF-2</b> Use trends and analyze a variety of mathematical patterns, relations, and explicit and recursive functions.
<b>Grades K-2</b>	<b>Grades 3-4</b>	<b>Grades 5-6</b>	<b>Grades 7-8</b>	<b>Grades 9-12</b>
<p><b>Demonstrate understanding of patterns by...</b></p> <p><b>E.PRF.2a</b> recognizing, describing, and extending simple repeating (ABAB) and growing (A+1, A+2, A+3) patterns (e.g., colors, sounds, words, shapes,</p>	<p><b>Demonstrate understanding of patterns by...</b></p> <p><b>E.PRF.2d</b> representing and analyzing patterns and rules (e.g. doubling, adding 3) using words, tables, graphs, and models  <a href="#">3.OA-3, 5, 7, 9</a>; <a href="#">4.OA-4, 5</a></p>	<p><b>Demonstrate understanding of patterns by...</b></p> <p><b>M.PRF.2a</b> representing, analyzing, extending, and generalizing a variety of patterns using tables, graphs, words, and symbolic rules</p>	<p><b>Demonstrate understanding of patterns by...</b></p> <p><b>M.PRF.2c</b> relating and comparing different forms of representation and identifying functions as linear or nonlinear  <a href="#">8.F-3</a></p>	<p><b>Demonstrate understanding of patterns by...</b></p> <p><b>H.PRF.2a</b> interpreting and rewriting a variety of expressions or functions to solve problems  <a href="#">A.SSE-1, 2, 3, 4</a>; <a href="#">F.BF-1a, 1b, 2</a></p> <p><b>H.PRF.2b</b> creating equations and inequalities (in one or two variables) and use them to solve problems and graph solutions  <a href="#">A.CED-1, 2</a>; <a href="#">A-REI-3, 4, 6, 7, 10, 12</a>; <a href="#">S.ID-6</a></p>

<p>numeric – counting, odd-even) K.CC-6; K.OA-1, 4; K.G-2; 1.OA-1, 5; 1.NBT-2b, 2c, 5, 6; 2.OA-3, 4; 2.NBT-1b, 2</p> <p><b>E.PRF.2b</b> creating and explaining repeating and growing patterns using objects or numbers K.OA-1, 4; K.NBT-1; K.G-2; 1.OA-1, 5; 1.NBT-2, 5, 6; 2.OA-3, 4; 2.NBT-1, 2</p> <p><b>E.PRF.2c</b> extending and analyzing simple numeric patterns with rules that involve addition and subtraction K.OA-1, 4; K.NBT-1; 1.OA-1, 5; 1.NBT-2, 5, 6; 2.OA-3, 4; 2.NBT-1, 2, 8</p>	<p><b>E.PRF.2e</b> extending, translating, and analyzing numeric patterns and their rules using addition, subtraction, multiplication, and division 3.OA-3, 5, 7, 9; 3.NBT-3; 4.OA-4, 5</p>	<p>5.OA-3; 5.NBT-2; 6.EE-6, 9</p> <p><b>M.PRF.2b</b> relating and comparing different forms of representation and identifying functions as linear or nonlinear 5.OA-3; 6.RP-1, 2, 3; 6.EE-6, 7, 9</p>	<p><b>M.PRF.2d</b> solving linear equations and formulating and explaining reasoning about expressions and equations 7.EE-2, 4a; 8.EE-6, 7</p> <p><b>M.PRF.2e</b> using functions to describe quantitative relationships 8.EE-5, 7; 8.F-1, 3, 4, 5</p>	<p><b>H.PRF.2c</b> using trends that follow a pattern and are described mathematically to make generalizations or predictions A-REI-11; F.BF-3, 4a</p> <p><b>H.PRF.2d</b> analyzing functions (using technology) by investigating significant characteristics (e.g. intercepts, asymptotes) F.IF-7a, b, e; F.BF-3; S.ID-8</p> <p><b>H.PRF.2e</b> comparing the properties of classes of functions F.IF-9</p>
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<p><b>STRAND 5: Geometry (GM):</b> Visualizations, spatial reasoning, and properties of two- and three-dimensional figures can be used to analyze, represent, and model geometric concepts and relationships.</p>		
<p><b>(K-4) Elementary School Learning Targets</b></p>	<p><b>(5-8) Middle School Learning Targets</b></p>	<p><b>(9-12) High School Learning Targets</b></p>
<p><b>E.GM-1</b> Recognize that two- and three-dimensional shapes have particular attributes:</p> <ul style="list-style-type: none"> <li>Describe and compare objects and figures based on geometric attributes;</li> <li>Compose, decompose, and draw figures based on spatial reasoning and the properties and attributes of the shapes;</li> <li>Apply concepts of symmetry.</li> </ul>	<p><b>M.GM-1</b> Apply reasoning using properties of two- and three-dimensional shapes to analyze, represent, and model geometric relationships:</p> <ul style="list-style-type: none"> <li>Classify objects based on attributes and properties and solve problems using geometric relationships and properties;</li> <li>Decompose figures into new figures and construct figures with given conditions;</li> <li>Apply concepts of parallel and perpendicular.</li> </ul>	<p><b>H.GM-1</b> Explain solutions using geometric attributes and relationships in diverse contexts:</p> <ul style="list-style-type: none"> <li>Extend understanding of congruence and similarity working with complex figures and situations;</li> <li>Solve problems involving quadrilaterals and triangles;</li> <li>Perform geometric constructions and use informal proofs to describe relationships and transformations.</li> </ul>

Grades K-2	Grades 3-4	Grades 5-6	Grades 7-8	Grades 9-12
<p><b>Demonstrate understanding of 2- and 3- dimensional shapes and their attributes...</b></p> <p><b>E.GM.1a</b> recognizing, describing (using spatial language) and naming shapes regardless of orientation or size and locating shapes in the environment K.G-1, 2</p> <p><b>E.GM.1b</b> analyzing and comparing 2- (and later) 3- dimensional shapes using informal language (e.g., flat, solid, corners) to describe their differences and similarities, as well as their component parts (number of sides, vertices) and other attributes (e.g., sides of equal length) K.G-3, 4</p> <p><b>E.GM.1c</b> composing two-dimensional shapes (rectangles, squares, triangles, half-circles, and quarter-circles) K.G-6; 1.G-2</p>	<p><b>Demonstrate understanding of 2- and 3- dimensional shapes and their attributes...</b></p> <p><b>E.GM.1h</b> describing, analyzing, comparing, and classifying two-dimensional figures (triangles, quadrilaterals) using shared attributes 3.G-1; 4.G-2</p> <p><b>E.GM.1i</b> partitioning shapes into equal parts with equal areas and recognizing that each part is a unit fraction of the whole 3.G-2</p> <p><b>E.GM.1j</b> recognizing and drawing points, lines, line segments, rays, angles, and perpendicular and parallel lines and identifying these in plane figures 4.G-1</p> <p><b>E.GM.1k</b> recognizing and drawing lines of symmetry in a variety of figures 4.G-3</p>	<p><b>Demonstrate understanding of 2- and 3- dimensional shapes and their attributes...</b></p> <p><b>M.GM.1a</b> describing and classifying plane figures based on their properties 5.G-3, 4</p> <p><b>M.GM.1b</b> recognizing and using properties belonging to categories and subcategories of plane figures (e.g., all rectangles have four right angles, so all squares are rectangles and have four right angles) 5.G-3</p> <p><b>M.GM.1c</b> demonstrating the use of a coordinate system by locating/graphing a given point or polygon using ordered pairs 5.G-1, 2; 6.G-3</p> <p><b>M.GM.1d</b> solving area, surface area, and volume problems by composing and decomposing figures 5.MD-5c; 6.G-1, 2, 4</p>	<p><b>Demonstrate understanding of 2- and 3- dimensional shapes and their attributes...</b></p> <p><b>M.GM.1e</b> constructing or drawing geometric shapes from given conditions (e.g., draw triangles given three angle or side measures; change scale) 7.G-1, 2</p> <p><b>M.GM.1f</b> recognizing and demonstrating rotations, reflections, and translations using multiple contexts (e.g., using coordinates, models, drawings, technology) 8.G-1, 2, 3, 4</p> <p><b>M.GM.1g</b> demonstrating congruence and similarity using a variety of two-dimensional figures 8.G-2, 4</p> <p><b>M.GM.1h</b> solving real-world area, surface area, and volume problems using different strategies</p>	<p><b>Demonstrate understanding of 2- and 3- dimensional shapes and their attributes...</b></p> <p><b>H.GM.1a</b> applying the Pythagorean Theorem G.SRT-8</p> <p><b>H.GM.1b</b> using congruence and similarity relationships to solve problems, including triangle congruence relationships G.CO-7, 8; G.SRT-2, 3, 5</p> <p><b>H.GM.1c</b> applying understanding of rotations, reflections, and translations to construct figures (e.g., using coordinates, models, drawings, transparencies, dynamic geometry software) G.CO-3, 5</p> <p><b>H.GM.1d</b> applying scale factors in solving multiple similarity problems, including transformations in the coordinate plane and similarity relationships with right triangles G.CO-2; G.SRT-1b, 2</p> <p><b>H.GM.1e</b> making various geometric constructions, including use of dynamic geometry software, and creating informal proofs of relationships (lines and angles, circles, polygons) G.CO-12, 13</p> <p><b>H.GM.1f</b> solving problems (including proofs) using the relationships among special quadrilaterals (parallelogram, rectangle, rhombus, square, trapezoid, and kite) and describing the characteristics of parallelograms using side, angle, and diagonal properties and relationships G.CO-9, 10, 11</p>

<p><b>E.GM.1d</b> composing three-dimensional shapes, using concrete models/materials (cubes, prisms, cones, and cylinders) 1.G-2</p> <p><b>E.GM.1e</b> drawing and identifying shapes with specific attributes (e.g., number of sides or equal angles) not determined by direct measuring) 2.G-1</p> <p><b>E.GM.1f</b> partitioning shapes into 2, 3, or 4 equal parts and describing the parts (halves, quarters, fourths, thirds) 1.G-3; 2.G-2, 3</p> <p><b>E.GM.1g</b> using spatial language to describe and name more complex or atypical shapes based on their defining characteristics</p>			<p>(formulas and decomposing figures) 7.G-4, 6; 8.G-9</p> <p><b>M.GM.1i</b> exploring and explaining angle relationships (e.g., pairs of parallel lines cut by a transversal, including perpendicular lines) 8.G-5</p> <p><b>M.GM.1j</b> applying the Pythagorean Theorem 8.G-7, 8</p>	
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<p><b>STRAND 6: Data Analysis, Probability, and Statistics (DPS):</b> Questions are posed and investigated by collecting data or retrieving existing data, and representing, analyzing, and interpreting data. Investigations, inferences, and predictions are used to make critical and informed decisions.</p>		
<p><b>(K-4) Elementary School Learning Targets</b></p>	<p><b>(5-8) Middle School Learning Targets</b></p>	<p><b>(9-12) High School Learning Targets</b></p>

<p><b>E.DP S-1</b> Gather and interpret data to answer questions related to a particular/single context.</p> <ul style="list-style-type: none"> <li>Formulate questions, gather data, and build representations;</li> <li>Identify and describe variation in data, and describe and compare shapes of distributions and measures of central tendency.</li> </ul>		<p><b>M.DP S-1</b> Design investigations and gather data to answer questions about multiple populations.</p> <ul style="list-style-type: none"> <li>Formulate questions, gather data, and build representations;</li> <li>Compare populations by analyzing distributions in terms of variability and measures of central tendency.</li> </ul>		<p><b>H.DP S-1</b> Design and conduct statistical studies:</p> <ul style="list-style-type: none"> <li>Use appropriate statistical measures for analysis;</li> <li>Develop the concepts of statistical inference and statistical significance, especially in relation to probability principles and sampling distributions.</li> </ul>
<b>Grades K-2</b>	<b>Grades 3-4</b>	<b>Grades 5-6</b>	<b>Grades 7-8</b>	<b>Grades 9-12</b>
<p><b>Students gather, organize, and interpret data by...</b></p> <p><b>E.DPS.1a</b> posing questions of interest that can be answered by counting or collecting data (e.g., concrete comparisons about students, classroom materials, science topics) with teacher guidance  <a href="#">K.CC-5, 6</a>; <a href="#">1-MD-1</a>; <a href="#">2.MD-2, 5, 9</a></p> <p><b>E.DPS.1b</b> identifying and sorting data/attributes; identifying rules for classifying data/attributes  <a href="#">K.MD-1, 2, 3</a>; <a href="#">K.G-2, 4</a>; <a href="#">1.MD-1, 4</a>; <a href="#">1.G-1</a> <a href="#">2.G-1</a>; <a href="#">2.MD-10</a></p> <p><b>E.DPS.1c</b> collecting and organizing/representing data (e.g.,</p>	<p><b>Students gather, organize, and interpret data by...</b></p> <p><b>E.DPS.1f</b> formulating questions and designing investigations (defining measures and variables)  <a href="#">3.MD-2</a>; <a href="#">4.MD-2</a></p> <p><b>E.DPS.1g</b> collecting data and representing data (e.g., bar graphs, frequency tables, line plots)  <a href="#">3.MD-1, 2, 3, 4</a>; <a href="#">4.MD-1, 2, 4</a></p> <p><b>E.DPS.1h</b> recognizing and identifying sources of variability in the data (measurement variability and natural variability)  <a href="#">3.MD-2, 3, 4</a>; <a href="#">4.MD-2</a></p> <p><b>E.DPS.1i</b> describing data shapes and what the data representations do and do not show (bar graphs, picture graphs,</p>	<p><b>Students gather, organize, and interpret data by...</b></p> <p><b>M.DPS.1a</b> formulating questions about groups larger than classroom groups and comparing different populations or samples  <a href="#">6.SP-1, 2</a></p> <p><b>M.DPS.1b</b> distinguishing among populations, censuses, and sampling  <a href="#">6.SP-1, 2</a></p> <p><b>M.DPS.1c</b> using representations (e.g., dot plots, scatter plots, line plots) to display data from investigations to describe the shapes of the data  <a href="#">5.MD-2</a>; <a href="#">5.G-2</a>; <a href="#">6.SP-2, 3, 4, 5</a></p> <p><b>M.DPS.1d</b> identifying the range, three</p>	<p><b>Students gather, organize, and interpret data by...</b></p> <p><b>M.DPS.1f</b> formulating questions about groups larger than classroom groups, comparing different populations or samples, and involving two variables  <a href="#">7.SP-1</a></p> <p><b>M.DPS.1g</b> displaying and interpreting univariate data using dot plots, histograms, and circle graphs  <a href="#">7.SP-2, 4</a></p> <p><b>M.DPS.1h</b> displaying data in scatter plots and investigating the association between the variables  <a href="#">8.SP-1, 2</a></p> <p><b>M.DPS.1i</b> using box plots, interquartile range, mean absolute deviation, range, and</p>	<p><b>Students gather, organize, and interpret data by...</b></p> <p><b>H.DPS.1a</b> designing and conducting different kinds of studies using categorical and numerical data, explain results, and use data to estimate a population mean or proportion:</p> <ul style="list-style-type: none"> <li>observational studies (e.g., traffic patterns at an intersection near the school);</li> <li>sample surveys (a survey of student nutritional habits);</li> <li>simple comparative experiments (e.g., comparisons of water and fertilizer treatments in a plant growth experiment)</li> </ul> <p><a href="#">S.IC-3, 4, 5</a></p> <p><b>H.DPS.1b</b> representing data with plots on the real number line (dot plots, histograms, box plots)  <a href="#">S.ID-1</a></p> <p><b>H.DPS.1c</b> analyzing and summarizing the data resulting from studies using statistical measures appropriate to shape of the data (median, mean) and spread (interquartile range, standard deviation), and using data to support inferences (population parameters, sample size) or explain possible outliers  <a href="#">S.ID-2, 3, 4, 5</a>; <a href="#">S.IC-1</a></p> <p><b>H.DPS.1d</b> representing and interpreting data (graphs, scatter plots) to explain how variables are related, or to fit a function to the data</p>

<p>picture graphs, tally charts, bar graphs) K.CC-5; K.MD-1, 2, 3; 1-MD-4; 2.MD-1, 2, 4, 5, 6, 9, 10</p> <p><b>E.DPS.1d</b> recognizing that data can take on different values 1.MD-4; 2.MD- 3, 9, 10</p> <p><b>E.DPS.1e</b> describing and comparing data and beginning to identify what the data do or do not show (e.g., bar graphs, line plots, picture graphs) 1.MD-4; 2.MD-2, 4, 5, 6, 9, 10</p>	<p>frequency tables, line plots, circle graphs) including the attributes used</p> <p><b>E.DPS.1j</b> identifying clumps, gaps, trends, or central tendency (mode, median) in the data</p> <p><b>E.DPS.1k</b> using data to make and support claims and interpretations (e.g., making comparisons among individuals, between individuals and the group, and among groups) 3. MD-1, 3, 4</p>	<p>common measures of central tendency (mean, median, and mode) and interpreting the mean as a fair share and a center of balance 6.SP-2, 3, 5c, 5d</p> <p><b>M.DPS.1e</b> making claims about populations from data distributions, supporting interpretations on the basis of mean, median, or mode, and the shape of the distribution 5.G-2; 6.SP-3, 5</p>	<p>the concept of outliers to characterize the distribution (variability) of univariate data 7.SP-2, 3, 4</p> <p><b>M.DPS.1j</b> comparing two unequal distributions of data using number of data points, measures of central tendency, shape, and variability (numerical data), and two-way tables (categorical variables) 7.SP- 3, 4; 8.SP-1, 3, 4</p> <p><b>M.DPS.1k</b> supporting claims about the results of investigations (e.g., coordinating among the measures of central tendency and variability) 7.SP- 3, 4; 8.SP-1, 3, 4</p>	<p>S.ID-6</p>
<p><b>(K-4) Elementary School Learning Targets</b></p>		<p><b>(5-8) Middle School Learning Targets</b></p>		<p><b>(9-12) High School Learning Targets</b></p>
<p><b>E.DPS-2</b> Conduct simple probability experiments and characterize the outcomes in words, diagrams, or numerically.</p>		<p><b>M.DPS-2</b> Conduct probability experiments:</p> <ul style="list-style-type: none"> <li>• Generate random samples to characterize variability in estimates and predictions;</li> <li>• Analyze and build models of the association between two variables.</li> </ul>		<p><b>H.DPS-2</b> Use the rules of probability to interpret data, develop explanations, and address real-world problems.</p>
<p><b>Grades K-2</b></p>	<p><b>Grades 3-4</b></p>	<p><b>Grades 5-6</b></p>	<p><b>Grades 7-8</b></p>	<p><b>Grades 9-12</b></p>
<p><b>Students apply probability concepts by...</b></p> <p><b>E.DPS.2a</b> describing the probability of events as</p>	<p><b>Students apply probability concepts by...</b></p> <p><b>E.DPS.2d</b> describing the probability of events as</p>	<p><b>Students apply probability concepts by...</b></p> <p><b>M.DPS.2a</b> conducting simple probability</p>	<p><b>Students apply probability concepts by...</b></p> <p><b>M.DPS.2d</b> identifying sample spaces for</p>	<p><b>Students apply probability concepts by...</b></p> <p><b>H.DSP.2a</b> explaining the outcomes of probabilities in words and recognizing equivalent representations of probability, such as one out of ten, 10%, 1/10, 0.10</p>

<p>being possible or impossible</p> <p><b>E.DPS.2b</b> describing the probability of events as being certain, likely, unlikely, or impossible</p> <p><b>E.DPS.2c</b> representing all possible outcomes for expectations of varied results (e.g., using words, drawings, tree diagrams to show all different combinations for making sandwiches from a choice of ingredients)</p>	<p>being certain, likely, equally likely, unlikely, or impossible.</p> <p><b>E.DPS.2e</b> identifying expectations for varied results in situations involving randomness (e.g., using coin tosses, spinners, dice, playing cards)</p> <p><b>E.DPS.2f</b> representing all possible outcomes for expectations of varied results (e.g., using words, tree diagrams)</p> <p><b>E.DPS.2g</b> conducting repeated trials of simple probability experiments, using display displays (e.g., tables, tree diagrams, histograms) to understand results and explain variations</p>	<p>experiments and expressing results in terms of relative frequencies or proportions as first estimate of probability</p> <p><b>M.DPS.2b</b> describing and representing (e.g., tree diagrams) all possible outcomes (sample space) and the theoretical probabilities of each outcome (as proportion of a specific outcome relative to all possible outcomes) in simple probability experiments</p> <p><b>M.DPS.2c</b> using two-way tables to characterize distributions of two categorical variables</p>	<p>multi-stage probability experiments (independent events) and determining the theoretical probabilities of specific event combinations 7.SP-5, 6, 7</p> <p><b>M.DPS.2e</b> designing and conducting multi-stage (compound) probability experiments (independent events) and comparing the results with theoretical probabilities 7.SP- 8</p> <p><b>M.DPS.2f</b> distinguishing between association of two variables and cause and effect relationship between two variables</p> <p><b>M.DPS.2g</b> using simple lines to model association between two numerical variables in a bivariate data set 8.SP-2, 3, 4</p>	<p><b>H.DSP.2b</b> exploring (framing effects) the degree to which we rate something as “good” or “bad”/ “desirable or “undesirable” when numerical information is presented positively (75% lean) or negatively (25% fat)</p> <p><b>H.DSP.2c</b> designing and conducting multi-stage (compound) probability experiments (independent events) and comparing the results with theoretical probabilities S.CP-2</p> <p><b>H.DSP.2d</b> constructing and interpreting two-way frequency tables when two categories are associated with each object being classified S.CP-4</p> <p><b>H.DSP.2e</b> researching and finding real-world examples and explaining the concept of conditional probability (e.g., compare the chances of having lung cancer if you are a smoker with the chances of being a smoker if you have lung cancer) S.CP-5</p>
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Common Core State Standards 2010	Revised Maine Learning Results 2020
<p><b>INTRODUCTION</b></p> <p><b>Toward greater focus and coherence</b></p> <p><i>Mathematics experiences in early childhood settings should concentrate on (1) number (which includes whole number, operations, and relations) and (2) geometry, spatial relations, and measurement, with more</i></p>	<p><b>INTRODUCTION</b></p> <p>A strong mathematics education depends upon a clear understanding of its interrelated concepts, skills and practices to ensure students are on the pathway to success in their academic careers. The knowledge and skills students need to be prepared for mathematics in college, career, and life are woven throughout the K-12 mathematics performance expectations.</p>

*mathematics learning time devoted to number than to other topics. Mathematical process goals should be integrated in these content areas.*  
— Mathematics Learning in Early Childhood, National Research Council, 2009

*The composite standards [of Hong Kong, Korea and Singapore] have a number of features that can inform an international benchmarking process for the development of K–6 mathematics standards in the U.S. First, the composite standards concentrate the early learning of mathematics on the number, measurement, and geometry strands with less emphasis on data analysis and little exposure to algebra. The Hong Kong standards for grades 1–3 devote approximately half the targeted time to numbers and almost all the time remaining to geometry and measurement.*  
— Ginsburg, Leinwand and Decker, 2009

*Because the mathematics concepts in [U.S.] textbooks are often weak, the presentation becomes more mechanical than is ideal. We looked at both traditional and non-traditional textbooks used in the US and found this conceptual weakness in both.*  
— Ginsburg et al., 2005

*There are many ways to organize curricula. The challenge, now rarely met, is to avoid those that distort mathematics and turn off students.*  
— Steen, 2007

For over a decade, research studies of mathematics education in high-performing countries have pointed to the conclusion that the mathematics curriculum in the United States must become substantially more focused and coherent in order to improve mathematics achievement in this country. To deliver on the promise of common standards, the standards must address the problem of a curriculum that is “a mile wide and an inch deep.” These Standards are a substantial answer to that challenge.

It is important to recognize that “fewer standards” are no substitute for focused standards. Achieving “fewer standards” would be easy to do by resorting to broad, general statements. Instead, these Standards aim for clarity and specificity.

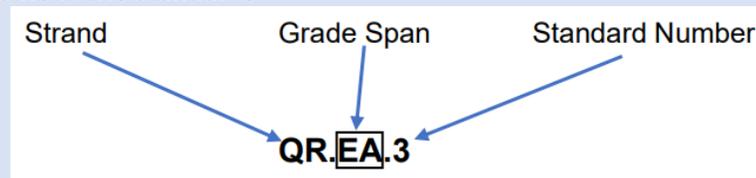
## Outline of Mathematics Strands and Standards

These mathematical performance expectations are building blocks to standards. The standards are grouped into four strands:

- **Quantitative Reasoning** (Blue): Counting and Cardinality, Number and Operations in Base Ten, Number and Operations Fractions, Ratio and Proportional Relations, The Number System, and Number and Quantity.
- **Algebraic Reasoning** (Green): Operations and Algebraic Thinking, Expressions and Equations, Functions, and Algebra
- **Geometric Reasoning** (Red): Geometry
- **Statistical Reasoning** (Purple): Measurement and Data, Statistics and Probability

These mathematical performance expectations are broken into three grade spans: Childhood (K-5), Early Adolescence (6-8), and Adolescence (9-Diploma). The strands are color-coded, as indicated above, for continuity throughout the grade spans. Standards do not work in isolation, they are connected through and across strands.

### How to Read the Standards



Within the high school performance expectations, modeling is woven throughout the four strands and is denoted with a star (★). The high school standards also contain some performance expectations which are denoted by a plus (+). These performance expectations are intended to be extensions of learning. All students should be given opportunities to explore this content, but mastery is not expected.

### Definitions:

**Strand:** A body of knowledge in a content area identified by a simple title.

**Standard:** Enduring understandings and skills that students can apply and transfer to contexts that are new to the student.

**Performance Expectation:** Building blocks to the standard and measurable articulations of what the student understands and can do.

*Assessing the coherence of a set of standards is more difficult than assessing their focus. William Schmidt and Richard Houang (2002) have said that content standards and curricula are coherent if they are: articulated over time as a sequence of topics and performances that are logical and reflect, where appropriate, the sequential or hierarchical nature of the disciplinary content from which the subject matter derives. That is, what and how students are taught should reflect not only the topics that fall within a certain academic discipline, **but also the key ideas** that determine how knowledge is organized and generated within that discipline. This implies that to be coherent, a set of content standards must evolve from particulars (e.g., the meaning and operations of whole numbers, including simple math facts and routine computational procedures associated with whole numbers and fractions) to deeper structures inherent in the discipline. These deeper structures then serve as a means for connecting the particulars (such as an understanding of the rational number system and its properties). (emphasis added)*

These Standards endeavor to follow such a design, not only by stressing conceptual understanding of key ideas, but also by continually returning to organizing principles such as place value or the properties of operations to structure those ideas.

In addition, the “sequence of topics and performances” that is outlined in a body of mathematics standards must also respect what is known about how students learn. As Confrey (2007) points out, developing “sequenced obstacles and challenges for students...absent the insights about meaning that derive from careful study of learning, would be unfortunate and unwise.” In recognition of this, the development of these Standards began with research-based learning progressions detailing what is known today about how students’ mathematical knowledge, skill, and understanding develop over time.

### **Understanding mathematics**

These Standards define what students should understand and be able to do in their study of mathematics. Asking a student to understand something means asking a teacher to assess whether the student has understood it. But what does mathematical understanding look like? One hallmark of mathematical understanding is the ability to justify, in a way appropriate to the student’s mathematical maturity, why a particular mathematical statement is true or

### **Quantitative Reasoning**

Quantitative reasoning is the application of basic mathematics skills to analyze and process real-world information. In the K-5 grades, students use numbers, including written numerals, to represent quantities and to solve quantitative problems. Students will work on counting and cardinality, number and operations in Base Ten and fractions. Students will develop strategies to extend their understanding of the base ten system and apply those strategies to solve real-world problems using all four operations. Students progress from working with whole numbers to fractions and decimals.

In grades 6-8 students use reasoning about multiplication and division to solve ratio and rate problems about quantities. They develop an understanding of proportionality to solve problems and graph relationships. Overall, students extend and develop their understanding of rational numbers and can compute in all operations. Students use these operations to solve real-world problems. Students use this understanding of rational numbers as they formulate expressions and equations in one variable and use these equations to solve problems. They reason about the order and absolute value of rational numbers and about the location of points in all four quadrants of the coordinate plane.

In the high school grades, the foundational concepts of operations with rational numbers and numerical properties built in the K-5 and 6-8 grade spans are applied to irrational numbers. Using a wider variety of units in modeling, (e.g. acceleration, currency conversions, and derived quantities such as person-hours and heating degree days), as well as the properties of rational and irrational numbers students are guided to the solution(s) to multi-step problems. Extending the properties of integer exponents to rational exponents deepens student understanding of how various but equivalent notations can facilitate their algebraic reasoning and problem-solving processes. Students are encouraged to expand these operations and properties into complex numbers, vectors, and matrices to further deepen their understanding of quantitative reasoning.

### **Algebraic Reasoning**

Algebraic reasoning is about generalizing arithmetic operations and determining unknown quantities by recognizing and analyzing patterns along with developing generalizations about these patterns. In this K-5 strand, students explore, analyze, represent, and generalize mathematical ideas and

where a mathematical rule comes from. There is a world of difference between a student who can summon a mnemonic device to expand a product such as  $(a + b)(x + y)$  and a student who can explain where the mnemonic comes from. The student who can explain the rule understands the mathematics, and may have a better chance to succeed at a less familiar task such as expanding  $(a + b + c)(x + y)$ . Mathematical understanding and procedural skill are equally important, and both are assessable using mathematical tasks of sufficient richness.

The Standards set grade-specific standards but do not define the intervention methods or materials necessary to support students who are well below or well above grade-level expectations. It is also beyond the scope of the Standards to define the full range of supports appropriate for English language learners and for students with special needs. At the same time, all students must have the opportunity to learn and meet the same high standards if they are to access the knowledge and skills necessary in their post-school lives. The Standards should be read as allowing for the widest possible range of students to participate fully from the outset, along with appropriate accommodations to ensure maximum participation of students with special education needs. For example, for students with disabilities reading should allow for use of Braille, screen reader technology, or other assistive devices, while writing should include the use of a scribe, computer, or speech-to-text technology. In a similar vein, speaking and listening should be interpreted broadly to include sign language. No set of grade-specific standards can fully reflect the great variety in abilities, needs, learning rates, and achievement levels of students in any given classroom. However, the Standards do provide clear signposts along the way to the goal of college and career readiness for all students.

The Standards begin on page 6 with eight Standards for Mathematical Practice.

### **How to read the grade level standards**

Standards define what students should understand and be able to do.

Clusters are groups of related standards. Note that standards from different clusters may sometimes be closely related, because mathematics is a connected subject.

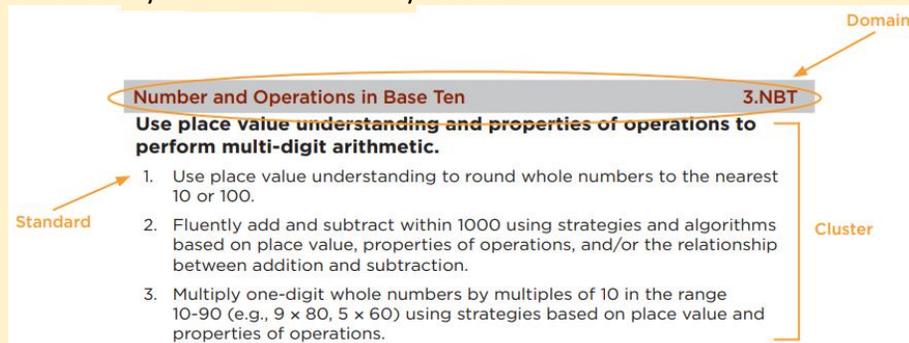
relationships. Students will develop an understanding of the fundamental properties of number and operations, understand the use of the equal sign to represent equivalence, and use quantitative reasoning to understand mathematical relationships.

Students in grades 6-8 progress in their understanding of variables in mathematical expressions and equations. They understand that expressions in different forms can be equivalent, use the properties of operations to rewrite expressions in equivalent forms, and describe relationships between quantities. Students begin to analyze and solve real-world and mathematical problems using equations and inequalities. They construct and interpret tables and graphs. Understanding builds from writing and solving simple equations to solving proportional situations. These skills lead to exploring slope and y-intercept and relationships between variables, and eventually include multiple equations to solve systems of linear equations. Students grow to understand that the concept of a function is a rule that assigns one output to each input, and they learn to translate among different representations of functions.

In grades 9-12, students will continue to develop their understanding of expressions, equations, functions and function notation. They will interpret the structure of algebraic expressions and be able to write expressions in equivalent forms to reveal information and to solve problems. Students will perform arithmetic operations on polynomials and rewrite rational functions. An understanding of the relationship between zeros and factors of polynomials will transition into using polynomial identities to solve problems. Students will create equations that describe relationships and solve equations as a process of reasoning (with appropriate justification). They will represent and solve equations, inequalities, and systems of equations using a variety of mathematically sound techniques.

Students will interpret functions that arise in applications in terms of context and analyze functions using different representations. They will build functions that model relationships between two quantities, and build new functions from existing functions through transformations, combinations, compositions, and examining the inverse. Students will construct and compare linear, quadratic, and exponential models and use those models to solve problems. They will interpret expressions for functions in terms of the situation they model. Students will be encouraged to extend their understanding of algebra and functions and apply similar processes of

Domains are larger groups of related standards. Standards from different domains may sometimes be closely related.



These Standards do not dictate curriculum or teaching methods. For example, just because topic A appears before topic B in the standards for a given grade, it does not necessarily mean that topic A must be taught before topic B. A teacher might prefer to teach topic B before topic A, or might choose to highlight connections by teaching topic A and topic B at the same time. Or, a teacher might prefer to teach a topic of his or her own choosing that leads, as a byproduct, to students reaching the standards for topics A and B.

What students can learn at any particular grade level depends upon what they have learned before. Ideally then, each standard in this document might have been phrased in the form, "Students who already know ... should next come to learn ...." But at present this approach is unrealistic—not least because existing education research cannot specify all such learning pathways. Of necessity therefore, grade placements for specific topics have been made on the basis of state and international comparisons and the collective experience and collective professional judgment of educators, researchers and mathematicians. One promise of common state standards is that over time they will allow research on learning progressions to inform and improve the design of standards to a much greater extent than is possible today. Learning opportunities will continue to vary across schools and school systems, and educators should make every effort to meet the needs of individual students based on their current understanding.

These Standards are not intended to be new names for old ways of doing business. They are a call to take the next step. It is time for states to work together to build on lessons learned from two decades of standards based

reasoning to polynomial, logarithmic and trigonometric functions and their graphs.

### Geometric Reasoning

Geometric reasoning is the use of critical thinking, logical argument and spatial reasoning to solve problems and find new relationships. Students must first have a critical understanding of any underlying assumptions and relationships. This allows them to develop coherent knowledge and apply their reasoning skills. In this K-5 strand, students will develop an understanding of the attributes of two- and three-dimensional shapes and apply this knowledge to real-world problems. Students will also be introduced to the coordinate system.

Students in grades 6-8 work with two- and three-dimensional objects to reason about relationships among shapes. They learn to calculate area, surface area, volume, and circumference using multiple methods including decomposing shapes so that they can develop, justify, and use formulas including the Pythagorean Theorem and its converse. They use scale drawings and informal constructions to gain familiarity with the relationships between angles formed by intersecting lines and transformations.

During high school, students begin to formalize their geometry experiences from elementary and middle school, using more complex definitions and reasoning of proofs. Students make geometric constructions using a variety of technological tools and connect these explorations to reasoning and proofs. Attributes of parallel lines intersected by a transversal are further developed and extended into properties of triangles, quadrilaterals, and regular polygons as well as circles using informal and formal reasoning. Fundamental to the concepts of congruence, similarity, and symmetry are transformations which can preserve distance and angles.

The definitions of sine, cosine, and tangent for acute angles are founded on right triangles and similarity. The Pythagorean Theorem along with these ratios are fundamental in many real-world and theoretical situations. Correspondence between numerical coordinates and geometric points allows methods from algebra to be applied to geometry and vice versa. Concepts of two- and three-dimensional shapes are explored using algebraic formulas and modeling. Students are encouraged to extend their geometric reasoning through the exploration of trigonometric identities and properties of conic sections.

reforms. It is time to recognize that standards are not just promises to our children, but promises we intend to keep.

### Statistical Reasoning

Statistical reasoning is the way people analyze data and make sense of information. It involves generalizations that connect one concept to another. In this K-5 strand, students will develop strategies to represent and interpret data, describe and compare measurable attributes, and understand concepts of measurement including perimeter, area, volume, time, and money.

Students in grades 6-8 continue to develop their ability to think statistically. Measures of central tendency (mean, median, and mode) as well as measures of variability (range, interquartile range, mean absolute deviation) are used to describe data. Previous work with single data distributions is expanded to compare two data distributions and address questions about differences between populations. Informal work with random sampling and learning about the importance of representative samples for drawing inferences is introduced. Students then expand their statistical understanding to include connections involving modeling with linear equations, as well as nonlinear expressions. Looking for patterns in a bivariate data system is emphasized.

In grades 9-12 students extend their statistical understanding of univariate and bi-variate data in a real-world context. This understanding is used to make decisions or predictions based on the data. Since data can be variable, statistics provide the tools for taking this variability into account. Data can be categorical or quantitative in nature. Appropriate methods for collecting, displaying, summarizing, and analyzing data are learned and employed. Algebraic and geometric reasoning are utilized to create linear regression models in order to interpret the relationship between two quantitative variables when appropriate.

The conditions under which data are collected and the use of randomization in the design of a study are necessary for drawing valid conclusions about the population under study. Since random processes can be described mathematically by using a probability model, the role of probability in making predictions or in making decisions becomes evident. Technology makes it possible to generate plots, find regression functions, compute correlation coefficients, and run simulations to better understand data. Statistical reasoning is a deeply rich and complex process which is essential to comprehend in order to stay informed in civic matters and personal decision-making.

**The Guiding Principles & Standards for Mathematical Practice**

	<p>The Guiding Principles influence education in Maine and should be reflected throughout Mathematics curriculum. The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. Full descriptions of the Guiding Principles and Standards for Mathematical Practice can be found in the Supplemental Material. Examples of how students can show evidence of those Guiding Principles and Standards for Mathematical Practice may include:</p> <p><b>Guiding Principles</b></p> <p><b>A. A clear and effective communicator:</b> Students will use written, oral, symbolic, and visual forms of expression to communicate mathematically.</p> <p><b>B. A self-directed and lifelong learner:</b> Students generate and persevere in solving questions while demonstrating a growth mindset.</p> <p><b>C. A creative and practical problem solver:</b> Students will pose and solve mathematical problems by using a variety of strategies that connect to real-world examples.</p> <p><b>D. A responsible and involved citizen:</b> Students make sense of the world around them through mathematics including economic literacy.</p> <p><b>E. An integrative and informed thinker:</b> Students connect mathematics to other learning by understanding the interrelationships of mathematical ideas and the role math plays in other disciplines and life.</p>
<p><b>Standards for Mathematical Practice</b></p> <p>The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education. The first of these are the NCTM process standards of problem solving, reasoning and proof, communication, representation, and connections. The second are the strands of mathematical proficiency specified in the National Research Council’s report Adding It Up: adaptive reasoning, strategic competence, conceptual understanding (comprehension of mathematical concepts, operations and relations), procedural fluency (skill in carrying out procedures flexibly, accurately, efficiently and appropriately), and productive disposition (habitual</p>	<p><b>The Guiding Principles &amp; Standards for Mathematical Practice</b></p> <p>The Guiding Principles influence education in Maine and should be reflected throughout Mathematics curriculum. The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. Full descriptions of the Guiding Principles and Standards for Mathematical Practice can be found in the Supplemental Material. Examples of how students can show evidence of those Guiding Principles and Standards for Mathematical Practice may include:</p>

inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy).

**1 Make sense of problems and persevere in solving them.**

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

**2 Reason abstractly and quantitatively.**

Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize—to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents—and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.

**3 Construct viable arguments and critique the reasoning of others.**

**Standards for Mathematical Practice**

**1. Make sense of problems and persevere in solving them:** Students will plan strategies to use and persevere in solving math problems.

**2. Reason abstractly and quantitatively:** Students will think about numbers in many ways and make sense of numerical relationships as they solve problems.

**3. Construct viable arguments and critique the reasoning of others:** Students will explain their thinking and make sense of the thinking of others.

Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and—if there is a flaw in an argument—explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.

#### **4 Model with mathematics.**

Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

#### **5 Use appropriate tools strategically.**

Mathematically proficient students consider the available tools when solving a mathematical problem. These tools might include pencil and paper,

**4. Model with mathematics:** Students will use representations to show their thinking in a variety of ways.

**5. Use appropriate tools strategically:** Students will use math tools such as tables, diagrams, and technology to explore and deepen their understanding of concepts.

concrete models, a ruler, a protractor, a calculator, a spreadsheet, a computer algebra system, a statistical package, or dynamic geometry software. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful, recognizing both the insight to be gained and their limitations. For example, mathematically proficient high school students analyze graphs of functions and solutions generated using a graphing calculator. They detect possible errors by strategically using estimation and other mathematical knowledge. When making mathematical models, they know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Mathematically proficient students at various grade levels are able to identify relevant external mathematical resources, such as digital content located on a website, and use them to pose or solve problems. They are able to use technological tools to explore and deepen their understanding of concepts.

**6 Attend to precision.**

Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.

**7 Look for and make use of structure.**

Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see  $7 \times 8$  equals the well remembered  $7 \times 5 + 7 \times 3$ , in preparation for learning about the distributive property. In the expression  $x^2 + 9x + 14$ , older students can see the 14 as  $2 \times 7$  and the 9 as  $2 + 7$ . They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being

**6. Attend to precision:** Students will use precise mathematical language and check their work for accuracy.

**7. Look for and make use of structure:** Students will use their current mathematical understandings to identify patterns and structure to make sense of new learning.

composed of several objects. For example, they can see  $5 - 3(x - y)^2$  as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers  $x$  and  $y$ .

**8 Look for and express regularity in repeated reasoning.**

Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation  $(y - 2)/(x - 1) = 3$ . Noticing the regularity in the way terms cancel when expanding  $(x - 1)(x + 1)$ ,  $(x - 1)(x^2 + x + 1)$ , and  $(x - 1)(x^3 + x^2 + x + 1)$  might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.

**Connecting the Standards for Mathematical Practice to the Standards for Mathematical Content**

The Standards for Mathematical Practice describe ways in which developing student practitioners of the discipline of mathematics increasingly ought to engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle and high school years. Designers of curricula, assessments, and professional development should all attend to the need to connect the mathematical practices to mathematical content in mathematics instruction. The Standards for Mathematical Content are a balanced combination of procedure and understanding. Expectations that begin with the word “understand” are often especially good opportunities to connect the practices to the content. Students who lack understanding of a topic may rely on procedures too heavily. Without a flexible base from which to work, they may be less likely to consider analogous problems, represent problems coherently, justify conclusions, apply the mathematics to practical situations, use technology mindfully to work with the mathematics, explain the mathematics accurately to other students, step back for an overview, or deviate from a known procedure to find a shortcut. In short, a lack of understanding effectively prevents a student from engaging in the mathematical practices. In this respect, those content standards which set an expectation of understanding are potential

**8. Look for and express regularity in repeated reasoning:** Students will look for patterns and rules to help create general methods and shortcuts that can be applied to similar mathematical problems.

“points of intersection” between the Standards for Mathematical Content and the Standards for Mathematical Practice. These points of intersection are intended to be weighted toward central and generative concepts in the school mathematics curriculum that most merit the time, resources, innovative energies, and focus necessary to qualitatively improve the curriculum, instruction, assessment, professional development, and student achievement in mathematics.

### Kindergarten Mathematics

#### Counting and Cardinality

- Know number names and the count sequence.
- Count to tell the number of objects.
- Compare numbers.

#### Operations and Algebraic Thinking

- Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

#### Number and Operations in Base Ten

- Work with numbers 11–19 to gain foundations for place value.

#### Measurement and Data

- Describe and compare measurable attributes.
- Classify objects and count the number of objects in categories.

#### Geometry

- Identify and describe shapes.
- Analyze, compare, create, and compose shapes.

Common Core State Standards	Core Content Connectors	Maine Learning Results
<p>In Kindergarten, instructional time should focus on two critical areas: (1) representing, relating, and operating on whole numbers, initially with sets of objects; (2) describing shapes and space. More learning time in Kindergarten should be devoted to number than to other topics.</p> <p>(1) Students use numbers, including written numerals, to represent quantities and to solve quantitative problems, such as counting objects in a set; counting out a given number of objects; comparing sets or numerals; and modeling simple joining and separating situations with sets of</p>		

<p>objects, or eventually with equations such as <math>5 + 2 = 7</math> and <math>7 - 2 = 5</math>. (Kindergarten students should see addition and subtraction equations, and student writing of equations in kindergarten is encouraged, but it is not required.) Students choose, combine, and apply effective strategies for answering quantitative questions, including quickly recognizing the cardinalities of small sets of objects, counting and producing sets of given sizes, counting the number of objects in combined sets, or counting the number of objects that remain in a set after some are taken away.</p> <p>(2) Students describe their physical world using geometric ideas (e.g., shape, orientation, spatial relations) and vocabulary. They identify, name, and describe basic two-dimensional shapes, such as squares, triangles, circles, rectangles, and hexagons, presented in a variety of ways (e.g., with different sizes and orientations), as well as three-dimensional shapes such as cubes, cones, cylinders, and spheres. They use basic shapes and spatial reasoning to model objects in their environment and to construct more complex shapes.</p>		
<p><b>Counting and Cardinality</b> <b>K.CC</b></p>	<p><b>Counting and Cardinality</b> <b>K.CC</b></p>	<p><b>Quantitative Reasoning</b> <b>QR</b></p>
<p><b>Know number names and the count sequence.</b></p>	<p><b>Know number names and the count sequence.</b></p>	<p><b>Standard - QR.C.1 Know the number names and the count sequence.</b></p>
<p>K.CC.1. Count to 100 by ones and by tens.</p> <p>K.CC.2. Count forward beginning from a given number within the known sequence (instead of having to begin at 1).</p> <p>K.CC.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).</p>	<p><i>K.NO.1a1 Rote count up to 10.</i>  <i>K.NO.1a2 Rote count up to 31.</i>  <i>K.NO.1a3 Rote count up to 100.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>K.NO.1d1 Identify numerals 1-10.</i>  <i>K.NO.1d2 Identify the numerals 1-10 when presented the name of the number.</i>  <i>K.NO.1e1 Write or select the numerals 1-10.</i></p>	<p>K.CC.A.1: Count to 100 by ones and by tens</p> <p>K.CC.A.2: Count forward beginning from a given number within the known sequence (instead of having to begin at 1)</p> <p>K.CC.A.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)</p>

Count to tell the number of objects.	Count to tell the number of objects.	Standard - QR.C.2 Count to tell the number of objects.
<p>K.CC.4. Understand the relationship between numbers and quantities; connect counting to cardinality.</p> <p>K.CC.4.a. When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object.</p> <p>K.CC.4.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.</p> <p>K.CC.4.c. Understand that each successive number name refers to a quantity that is one larger.</p> <p>K.CC.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.</p>	<p><i>K.NO.1b2 Identify the set that has more.</i>  <i>K.NO.1a4 Count up to 10 objects in a line, rectangle, or array.</i>  <i>K.NO.1b1 Match the numeral to the number of objects in a set.</i></p> <p><i>K.DPS.1a1 Select a question that is answered by collected data.</i></p>	<p>K.CC.B.4: Understand the relationship between numbers and quantities; connect counting to cardinality.</p> <p>K.CC.B.4a: When counting objects, say the number names in the standard order, pairing each object with one and only one number name and each number name with one and only one object.</p> <p>K.CC.B.4b: 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.</p> <p>K.CC.B.4c: Understand that each successive number name refers to a quantity that is one larger. Recognize the one more pattern of counting using objects.</p> <p>K.CC.B.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.</p>
Compare numbers.	Compare numbers.	Standard - QR.C.3 Compare numbers.
<p>K.CC.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.<sup>1</sup></p> <p>K.CC.7. Compare two numbers between 1 and 10 presented as written numerals.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>K.NO.1f1 Identify the smaller or larger number given 2 numbers between 0-10.</i></p>	<p>K.CC.C.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. Include groups with up to ten objects.</p> <p>K.CC.C.7: Compare two numbers between 1 and 10 presented as written numerals.</p>
Operations and Algebraic Thinking	Operations and Algebraic Thinking	Algebraic Reasoning

K.OA

K.OA

AR

<p><b>Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.</b></p>	<p><b>Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.</b></p>	<p><b>Standard - AR.C.1 Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.</b></p>
<p>K.OA.1. Represent addition and subtraction with objects, fingers, mental images, drawings<sup>2</sup>, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.</p> <p>K.OA.2. Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem.</p> <p>K.OA.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., <math>5 = 2 + 3</math> and <math>5 = 4 + 1</math>).</p> <p>K.OA.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.</p> <p>K.OA.5. Fluently add and subtract within 5.</p>	<p><i>K.PRF.1b1 Use objects or pictures to respond appropriately to “add ___” and “take away ___”.</i></p> <p><i>K.PRF.1b2 Communicate answer after adding or taking away.</i></p> <p><i>K.PRF.1c1 Solve one step addition and subtraction word problems, and add and subtract within 10 using objects, drawings, pictures.</i></p> <p><i>K.NO.2a1 Count two sets to find sums up to 10.</i></p> <p><i>K.NO.2a3 Solve word problems within 10.</i></p> <p><i>K.NO.2a2 Decompose a set of up to ten objects into a group; count the quantity in each group.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>K.OA.A.1: Represent addition and subtraction with objects, fingers, mental images, drawings sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.</p> <p>K.OA.A.2: Solve addition and subtraction word problems, and add and subtract within 10, (e.g., by using objects or drawings to represent the problem).</p> <p>K.OA.A.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., <math>5 = 2 + 3</math> and <math>5 = 4 + 1</math>).</p> <p>K.OA.A.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.</p> <p>K.OA.A.5: Fluently add and subtract within 5 including zero.</p>
<p><b>Number and Operations in Base Ten</b>      <b>K.NBT</b></p>	<p><b>Number and Operations in Base Ten</b>      <b>K.NBT</b></p>	<p><b>Quantitative Reasoning</b>      <b>QR</b></p>
<p><b>Work with numbers 11–19 to gain foundations for place value.</b></p>	<p><b>Work with numbers 11–19 to gain foundations for place value.</b></p>	<p><b>Standard - QR.C.5 Understand place value.</b></p>
<p>K.NBT.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., <math>18 = 10 + 8</math>); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.</p>	<p><i>1.NO.1h1 Build representations of numbers up to 19 by creating a group of 10 and some 1s (e.g., <math>13 = one\ 10\ and\ three\ 1s</math>).</i></p>	<p>K.NBT.A.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., <math>18 = 10 + 8</math> and <math>10+8=18</math>); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.</p>
<p><b>Measurement and Data</b>      <b>K.MD</b></p>	<p><b>Measurement and Data</b>      <b>K.MD</b></p>	<p><b>Statistical Reasoning</b>      <b>SR</b></p>

<b>Describe and compare measurable attributes.</b>	<b>Describe and compare measurable attributes.</b>	<b>Standard - SR.C.1 Describe and compare measurable attributes.</b>
K.MD.1. Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.	<i>K.ME.1a1 Describe objects in terms of measurable attributes (longer, shorter, heavier, lighter...).</i>	K.MD.A.1: Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.
K.MD.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. <i>For example, directly compare the heights of two children and describe one child as taller/shorter.</i>	<i>K.ME.1b2 Compare 2 objects with a measurable attribute in common to see which object has more/less of the attribute (length, height, weight).</i>	K.MD.A.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. <i>For example, directly compare the heights of two children and describe one child as taller/shorter.</i>
<b>Classify objects and count the number of objects in each category.</b>	<b>Classify objects and count the number of objects in each category.</b>	<b>(Repeat) Standard - SR.C.1 Describe and compare measurable attributes.</b>
K.MD.3. Classify objects into given categories; count the numbers of objects in each category and sort the categories by count. <sup>3</sup>	<i>K.ME.1b1 Sort objects by characteristics (e.g., big/little, colors, shapes, etc.).</i>	K.MD.B.3: Classify objects into given categories; count the numbers of objects in each category and sort the categories by count. (Limit category counts to be less than or equal to 10.)
<b>Geometry</b> K.G	<b>Geometry</b> K.G	<b>Geometric Reasoning</b> GR
<b>Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).</b>	<b>Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).</b>	<b>Standard – GR.C.1 Identify, describe, analyze, compare, create, and compose shapes based on their attributes.</b>
K.G.1. Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as <i>above, below, beside, in front of, behind, and next to.</i>	<i>K.GM.1a2 Recognize two dimensional shapes in environment regardless of orientation or size.</i> <i>K.GM.1a3 Use spatial language (e.g., above, below, etc.) to describe two-dimensional shapes.</i>	K.G.A.1: Describe objects in the environment using names of shapes and describe the relative positions of these objects using terms such as <i>above, below, beside, in front of, behind, and next to.</i>
K.G.2. Correctly name shapes regardless of their orientations or overall size.	<i>K.GM.1a1 Recognize two- dimensional shapes (e.g., circle, square, triangle, rectangle) regardless of orientation or size.</i>	K.G.A.2: Correctly name shapes regardless of their orientations or overall size.
K.G.3. Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).	<i>K.GM.1b1 Identify shapes as two-dimensional (lying flat) or three dimensional (solid).</i>	K.G.A.3: Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).
<b>Analyze, compare, create, and compose shapes.</b>	<b>Analyze, compare, create, and compose shapes.</b>	<b>(Repeat) Standard – GR.C.1 Identify, describe, analyze, compare, create, and compose shapes based on their attributes.</b>

<p>K.G.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).</p>	<p><i>No CCC developed for this standard.</i></p>	<p>K.G.B.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).</p>
<p>K.G.5. Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>K.G.B.5: Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.</p>
<p>K.G.6. Compose simple shapes to form larger shapes. For example, “Can you join these two triangles with full sides touching to make a rectangle?”</p>	<p><i>K.GM.1c 1 Compose a larger shape from smaller shapes.</i></p>	<p>K.G.B.6: Compose simple shapes to form larger shapes. For example, “Can you join these two triangles with full sides touching to make a rectangle?”</p>

<sup>1</sup>Include groups with up to ten objects.

<sup>2</sup>Drawings need not show details, but should show the mathematics in the problem. (This applies wherever drawings are mentioned in the Standards.)

<sup>3</sup>Limit category counts to be less than or equal to 10.

## Grade 1 Mathematics

### Operations and Algebraic Thinking

- Represent and solve problems involving addition and subtraction.
- Understand and apply properties of operations and the relationship between addition and subtraction.
- Add and subtract within 20.
- Work with addition and subtraction equations.

### Number and Operations in Base Ten

- Extend the counting sequence.
- Understand place value.
- Use place value understanding and properties of operations to add and subtract.

### Measurement and Data

- Measure lengths indirectly and by iterating length units.
- Tell and write time.
- Represent and interpret data.

### Geometry

- Reason with shapes and their attributes.

Common Core State Standards	Core Content Connectors	Maine Learning Results
<p>In Grade 1, instructional time should focus on four critical areas: (1) developing understanding of addition, subtraction, and strategies for addition and subtraction within 20; (2) developing understanding of whole number relationships and place value, including grouping in tens and ones; (3) developing understanding of linear measurement and measuring lengths as iterating length units; and (4) reasoning about attributes of, and composing and decomposing geometric shapes.</p> <p>(1) Students develop strategies for adding and subtracting whole numbers based on their prior work with small numbers. They use a variety of models, including discrete objects and length-based models (e.g., cubes connected to form lengths), to model add-to, take-from, put-together, take-apart, and compare situations to develop meaning for the operations of addition and subtraction, and to develop strategies to solve arithmetic problems with these operations. Students understand connections between counting and addition and subtraction (e.g., adding two is the same as counting on two). They use properties of addition to add whole numbers and to create and use increasingly sophisticated strategies based on these properties (e.g., “making tens”) to solve addition and subtraction problems within 20. By comparing a variety of solution strategies, children build their understanding of the relationship between addition and subtraction.</p> <p>(2) Students develop, discuss, and use efficient, accurate, and generalizable methods to add within 100 and subtract multiples of 10. They compare whole numbers (at least to 100) to develop understanding of and solve problems involving their relative sizes. They think of whole numbers</p>		

<p>between 10 and 100 in terms of tens and ones (especially recognizing the numbers 11 to 19 as composed of a ten and some ones). Through activities that build number sense, they understand the order of the counting numbers and their relative magnitudes.</p> <p>(3) Students develop an understanding of the meaning and processes of measurement, including underlying concepts such as iterating (the mental activity of building up the length of an object with equal-sized units) and the transitivity principle for indirect measurement.<sup>1</sup></p> <p>(4) Students compose and decompose plane or solid figures (e.g., put two triangles together to make a quadrilateral) and build understanding of part-whole relationships as well as the properties of the original and composite shapes. As they combine shapes, they recognize them from different perspectives and orientations, describe their geometric attributes, and determine how they are alike and different, to develop the background for measurement and for initial understandings of properties such as congruence and symmetry.</p>		
<p><b>Operations and Algebraic Thinking</b>      <b>1.OA</b></p>	<p><b>Operations and Algebraic Thinking</b>      <b>1.OA</b></p>	<p><b>Algebraic Reasoning</b>      <b>AR</b></p>
<p><b>Represent and solve problems involving addition and subtraction.</b></p>	<p><b>Represent and solve problems involving addition and subtraction.</b></p>	<p><b>Standard - AR.C.1 Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.</b></p>
<p>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.<sup>2</sup></p>	<p><i>1.NO.2a9 Use manipulatives or representations to write simple addition or subtraction equations within 20 based upon a word problem.</i></p> <p><i>1.NO.2a10 Use data presented in graphs (i.e., pictorial, object) to solve one step “how many more” or “how many less” word problems.</i></p> <p><i>1.NO.2a11 Solve word problems within 20.</i></p> <p><i>1.PRF.1b3 Using objects or pictures respond appropriately to “add ___” and “take away ___”.</i></p>	<p>1.OA.A.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.</p>

<p>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.</p>	<p><i>1.PR.F.1c2 Solve one step addition and subtraction word problems where the change or result is unknown (<math>4 + \_ = 7</math>) or (<math>4 + 3 = \_</math>), within 20 using objects, drawings, pictures.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>1.OA.A.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.)</p>
<p><b>Understand and apply properties of operations and the relationship between addition and subtraction.</b></p>	<p><b>Understand and apply properties of operations and the relationship between addition and subtraction.</b></p>	<p><b>Standard - AR.C.2 Understand and apply properties of operation and the relationship between addition and subtraction within 20.</b> <i>Students need not use formal terms for these properties.</i></p>
<p>3. Apply properties of operations as strategies to add and subtract.<sup>3</sup> <i>Examples: If <math>8 + 3 = 11</math> is known, then <math>3 + 8 = 11</math> is also known. (Commutative property of addition.) To add <math>2 + 6 + 4</math>, the second two numbers can be added to make a ten, so <math>2 + 6 + 4 = 2 + 10 = 12</math>. (Associative property of addition.)</i></p> <p>4. Understand subtraction as an unknown-addend problem. <i>For example, subtract <math>10 - 8</math> by finding the number that makes 10 when added to 8.</i></p>	<p><i>1.NO.1i2 Recognize zero as an additive identity.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>1.OA.B.3: Apply properties of operations as strategies to add. <i>Examples: If <math>8 + 3 = 11</math> is known, then <math>3 + 8 = 11</math> is also known. (Commutative property of addition.) To add <math>2 + 6 + 4</math>, the second two numbers can be added to make a ten, so <math>2 + 6 + 4 = 2 + 10 = 12</math>. (Associative property of addition.) <math>a + 0 = a</math> (Additive identity property of 0)</i></p> <p>1.OA.B.4: Understand subtraction as an unknown-addend problem. <i>For example, subtract <math>10 - 8</math> by finding the number that makes 10 when added to 8.</i></p>
<p><b>Add and subtract within 20.</b></p>	<p><b>Add and subtract within 20.</b></p>	<p><b>(Repeat) Standard - AR.C.2 Understand and apply properties of operation and the relationship between addition and subtraction within 20.</b> <i>Students need not use formal terms for these properties.</i></p>
<p>5. Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).</p> <p>6. Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., <math>8 + 6 = 8 + 2 + 4 = 10 + 4 = 14</math>); decomposing a</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>1.NO.2a6 Count two sets to find sums up to 20.</i> <i>1.NO.2a8 Decompose a set of up to 20 objects into a group; count the quantity in each group.</i></p>	<p>1.OA.C.5: Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).</p> <p>1.OA.C.6: Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., <math>8 + 6 = 8 + 2 + 4 = 10 + 4 = 14</math>);</p>

<p>number leading to a ten (e.g., <math>13 - 4 = 13 - 3 - 1 = 10 - 1 = 9</math>); using the relationship between addition and subtraction (e.g., knowing that <math>8 + 4 = 12</math>, one knows <math>12 - 8 = 4</math>); and creating equivalent but easier or known sums (e.g., adding <math>6 + 7</math> by creating the known equivalent <math>6 + 6 + 1 = 12 + 1 = 13</math>).</p>		<p>decomposing a number leading to a ten (e.g., <math>13 - 4 = 13 - 3 - 1 = 10 - 1 = 9</math>); using the relationship between addition and subtraction (e.g., knowing that <math>8 + 4 = 12</math>, one knows <math>12 - 8 = 4</math>); and creating equivalent but easier or known sums (e.g., adding <math>6 + 7</math> by creating the known equivalent <math>6 + 6 + 1 = 12 + 1 = 13</math>).</p>
<p><b>Work with addition and subtraction equations.</b></p>	<p><b>Work with addition and subtraction equations.</b></p>	<p><b>(Repeat) Standard - AR.C.2 Understand and apply properties of operation and the relationship between addition and subtraction within 20.</b> <i>Students need not use formal terms for these properties.</i></p>
<p>7. Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. <i>For example, which of the following equations are true and which are false? <math>6 = 6</math>, <math>7 = 8 - 1</math>, <math>5 + 2 = 2 + 5</math>, <math>4 + 1 = 5 + 2</math>.</i></p> <p>8. Determine the unknown whole number in an addition or subtraction equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations <math>8 + ? = 11</math>, <math>5 = \square - 3</math>, <math>6 + 6 = \square</math>.</i></p>	<p><i>1.NO.2c1 Identify and apply addition and equal signs.</i></p> <p><i>2.SE.1d2 Represent a “taking away” situation with the – symbol.</i></p>	<p>1.OA.D.7: Understand the meaning of the equal sign and determine if equations involving addition and subtraction are true or false. <i>For example, which of the following equations are true and which are false? <math>6 = 6</math>, <math>7 = 8 - 1</math>, <math>5 + 2 = 2 + 5</math>, <math>4 + 1 = 5 + 2</math>.</i></p> <p>1.OA.D.8: Determine the unknown whole number in an addition or subtraction equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations <math>8 + ? = 11</math>, <math>5 = \_ - 3</math>, <math>6 + 6 = \_</math>.</i></p>
<p><b>Number and Operations in Base Ten</b>      <b>1.NBT</b></p>	<p><b>Number and Operations in Base Ten</b>      <b>1.NBT</b></p>	<p><b>Quantitative Reasoning</b>      <b>QR</b></p>
<p><b>Extend the counting sequence.</b></p>	<p><b>Extend the counting sequence.</b></p>	<p><b>Standard - QR.C.4 Extend the counting sequence.</b></p>
<p>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.</p>	<p><i>1.NO.1a6 Rote count up to 100.</i></p>	<p>1.NBT.A.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.</p>
<p><b>Understand place value.</b></p>	<p><b>Understand place value.</b></p>	<p><b>QR.C.5 Understand place value.</b></p>
<p>2. Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases:</p> <p>a. 10 can be thought of as a bundle of ten ones — called a “ten.”</p>	<p><i>1.NO.1h1 Build representations of numbers up to 19 by creating a group of 10 and some 1s (e.g., 13 = one 10 and three 1s).</i></p> <p><i>1.NO.1h2 Identify the value of the numbers in the tens and ones place within a given number up to 31.</i></p>	<p>1.NBT.B.2: Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases:</p> <p>1.NBT.B.2a: 10 can be thought of as a bundle of ten ones - called a “ten.”</p>

<p>b. The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones.</p> <p>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).</p> <p>3. Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols <math>&gt;</math>, <math>=</math>, and <math>&lt;</math>.</p>	<p><i>2.NO.1h4 Build representations of 3 digit numbers using tens and ones.</i></p> <p><i>1.NO.1h3 Compare two digit numbers up to 31 using representations and numbers (e.g., identify more tens, less tens, more ones, larger number, smaller number).</i></p>	<p>1.NBT.B.2b: The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones.</p> <p>1.NBT.B.2c: 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).</p> <p>1.NBT.B.3: Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols <math>&gt;</math>, <math>=</math>, and <math>&lt;</math>.</p>
<p><b>Use place value understanding and properties of operations to add and subtract.</b></p>	<p><b>Use place value understanding and properties of operations to add and subtract.</b></p>	<p><b>Standard - QR.C.6 Use place value understanding and properties of operations to add and subtract.</b></p>
<p>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.</p> <p>5. Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used.</p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>2.NO.2c4 Decompose tens into ones and/or hundreds into tens in subtraction situations.</i></p>	<p>1.NBT.C.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.</p> <p>1.NBT.C.5: Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used.</p> <p>1.NBT.C.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.</p>
<p><b>Measurement and Data</b> <b>1.MD</b></p>	<p><b>Measurement and Data</b> <b>1.MD</b></p>	<p><b>Statistical Reasoning</b> <b>SR</b></p>

Measure lengths indirectly and by iterating length units.	Measure lengths indirectly and by iterating length units.	Standard - SR.C.1 Describe and compare measurable attributes.
<p>1. Order three objects by length; compare the lengths of two objects indirectly by using a third object.</p> <p>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 object is the number of same-size length units that span it with no gaps or overlaps. <i>Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.</i></p>	<p><i>1.ME.1b3 Order up to 3 objects based on a measurable attribute (height, weight, length).</i></p> <p><i>1.ME.1b4 Order three objects by length; compare the lengths of two objects indirectly by using a third object.</i></p> <p><i>1.ME.1a2 Measure using copies of 1 object to measure another.</i></p> <p><i>1.ME.2b1 Express length of an object as a whole number of lengths unit by laying multiple copies of a shorter object end to end.</i></p> <p><i>1.ME.1c1 Compare 2 units of measurement and identify which unit would require more or less when measuring a selected object. (I can measure with paper clips or markers, which unit will require more to measure the table?).</i></p>	<p>1.MD.A.1: Order three objects by length; compare the lengths of two objects indirectly by using a third object.</p> <p>1.MD.A.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 object is the number of same-size length units that span it with no gaps or overlaps. <i>Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.</i></p>
Tell and write time.	Tell and write time.	Standard - SR.C.4 Work with time and money.
<p>3. Tell and write time in hours and half-hours using analog and digital clocks.</p>	<p><i>1.ME.2a2 Use time to sequence up to 3 events using a digital or analog clock.</i></p> <p><i>1.ME.1a5 Tell time to the nearest ½ hour using digital clocks.</i></p>	<p>1.MD.B.3: Tell and write time in hours and half-hours using analog and digital clocks.</p> <p>1.MD.D.5: Identify the coins and each corresponding value. (e.g. penny, nickel, dime, and quarter)</p>
Represent and interpret data.	Represent and interpret data.	Standard - SR.C.2 Represent and interpret data.
<p>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.</p>	<p><i>1.DPS.1a2 Select questions that ask about “How many” and represent up to three categories that can be concretely represented.</i></p> <p><i>1.DPS.1a3 Identify 2 categories resulting from a selected question.</i></p> <p><i>1.DPS.1a4 Analyze data by sorting into 2 categories; answer questions about the total number of data points and how many in each category.</i></p>	<p>1.MD.C.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.</p>

		<p><i>1.DPS.1c1 Using a picture graph, represent each object/person counted on the graph (1:1 correspondence) for 2 or more categories.</i></p> <p><i>1.DPS.1d1 Interpret a picture graph to answer questions about how many in each category.</i></p> <p><i>1.DPS.1e1 Compare the values of the 2 categories of data in terms of more or less.</i></p>			
<b>Geometry</b>	<b>1.G</b>	<b>Geometry</b>	<b>1.G</b>	<b>Geometric Reasoning</b>	<b>GR</b>
<b>Reason with shapes and their attributes.</b>		<b>Reason with shapes and their attributes.</b>		<b>Standard - GR.C.1 Identify, describe, analyze, compare, create, and compose shapes based on their attributes. Students should apply the principle of transitivity of measurement to make indirect comparisons, but they need not use this technical term.</b>	
<p>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.</p> <p>2. Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.<sup>4</sup></p> <p>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.</p>		<p><i>1.GM.1b2 Distinguish two-dimensional shapes based upon their defining attributes (i.e., size, corners, and points).</i></p> <p><i>2.GM.1d1 Compose three-dimensional shapes.</i></p> <p><i>1.GM.1c 2 Compose two- and three-- dimensional shapes.</i></p> <p><i>1.GM.1f1 Partition circles and rectangles into 2 and 4 equal parts.</i></p>		<p>1.G.A.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.</p> <p>1.G.A.2: Compose two-dimensional shapes (rectangles, squares, trapezoids, triangles, half-circles, and quarter-circles) or three-dimensional shapes (cubes, right rectangular prisms, right circular cones, and right circular cylinders) to create a composite shape, and compose new shapes from the composite shape.</p> <p>1.G.A.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.</p>	

<sup>1</sup>Students should apply the principle of transitivity of measurement to make indirect comparisons, but they need not use this technical term.

<sup>2</sup>See Glossary, Table 1.

<sup>3</sup>Students need not use formal terms for these properties.

<sup>4</sup>Students do not need to learn formal names such as “right rectangular prism.”

## Grade 2 Mathematics

### Operations and Algebraic Thinking

- Represent and solve problems involving addition and subtraction.
- Add and subtract within 20.
- Work with equal groups of objects to gain foundations for multiplication.

### Number and Operations in Base Ten

- Understand place value.
- Use place value understanding and properties of operations to add and subtract.

### Measurement and Data

- Measure and estimate lengths in standard units.
- Relate addition and subtraction to length.
- Work with time and money.
- Represent and interpret data.

### Geometry

- Reason with shapes and their attributes.

Common Core State Standards	Core Content Connectors	Maine Learning Results
<p>In Grade 2, instructional time should focus on four critical areas: (1) extending understanding of base-ten notation; (2) building fluency with addition and subtraction; (3) using standard units of measure; and (4) describing and analyzing shapes.</p> <p>(1) Students extend their understanding of the base-ten system. This includes ideas of counting in fives, tens, and multiples of hundreds, tens, and ones, as well as number relationships involving these units, including comparing. Students understand multi-digit numbers (up to 1000) written in base-ten notation, recognizing that the digits in each place represent amounts of thousands, hundreds, tens, or ones (e.g., 853 is 8 hundreds + 5 tens + 3 ones).</p>		

<p>(2) Students use their understanding of addition to develop fluency with addition and subtraction within 100. They solve problems within 1000 by applying their understanding of models for addition and subtraction, and they develop, discuss, and use efficient, accurate, and generalizable methods to compute sums and differences of whole numbers in base-ten notation, using their understanding of place value and the properties of operations. They select and accurately apply methods that are appropriate for the context and the numbers involved to mentally calculate sums and differences for numbers with only tens or only hundreds.</p> <p>(3) Students recognize the need for standard units of measure (centimeter and inch) and they use rulers and other measurement tools with the understanding that linear measure involves an iteration of units. They recognize that the smaller the unit, the more iterations they need to cover a given length.</p> <p>(4) Students describe and analyze shapes by examining their sides and angles. Students investigate, describe, and reason about decomposing and combining shapes to make other shapes. Through building, drawing, and analyzing two- and three-dimensional shapes, students develop a foundation for understanding area, volume, congruence, similarity, and symmetry in later grades.</p>		
<p><b>Operations and Algebraic Thinking</b>      <b>2.OA</b></p>	<p><b>Operations and Algebraic Thinking</b>      <b>2.OA</b></p>	<p><b>Algebraic Reasoning</b>      <b>AR</b></p>
<p><b>Represent and solve problems involving addition and subtraction.</b></p>	<p><b>Represent and solve problems involving addition and subtraction.</b></p>	<p><b>Standard - AR.C.1 Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.</b></p>
<p>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</p>	<p><i>2.SE.1d1 Represent addition of 2 sets when shown the + symbol.</i></p> <p><i>2.NO.2a16 Solve word problems within 20.</i></p>	<p>2.OA.A.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,</p>

<p>unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.<sup>1</sup></p>	<p><i>2.NO.2a17 Solve word problems within 100.</i>  <i>2.PRF.1c3 Solve one or two step addition and subtraction problems, and add and subtract within 100, using objects, drawings, pictures.</i>  <i>2. 2.PRF.1c4 Use pictures, drawings or objects represent the steps of a problem.</i>  <i>2.PRF.1c5 Write or select an equation representing the problem and it's solution.</i></p>	<p>with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.</p>
<p><b>Add and subtract within 20.</b></p>	<p><b>Add and subtract within 20.</b></p>	<p><b>Standard - AR.C.2 Understand and apply properties of operation and the relationship between addition and subtraction within 20.</b></p>
<p>2. Fluently add and subtract within 20 using mental strategies.<sup>2</sup> By end of Grade 2, know from memory all sums of two one-digit numbers.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>2.OA.B.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.</p>
<p><b>Work with equal groups of objects to gain foundations for multiplication.</b></p>	<p><b>Work with equal groups of objects to gain foundations for multiplication.</b></p>	<p><b>Standard - AR.C.3 Work with equal groups of objects to gain foundations for multiplication.</b></p>
<p>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.</p> <p>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.</p>	<p><i>2.NO.1e7 Identify numbers as odd or even.</i></p> <p><i>3.NO.2d1 Find the total number of objects when given the number of identical groups and the number of objects in each group neither number larger than 5.</i>  <i>3.NO.2d2 Find total number inside an array with neither number in the columns or rows larger than 5.</i></p>	<p>2.OA.C.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.</p> <p>2.OA.C.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.</p>
<p><b>Number and Operations in Base Ten      2.NBT</b></p>	<p><b>Number and Operations in Base Ten      2.NBT</b></p>	<p><b>Quantitative Reasoning      QR</b></p>
<p><b>Understand place value.</b></p>	<p><b>Understand place value.</b></p>	<p><b>Standard - QR.C.5 Understand place value.</b></p>
<p>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:</p> <p>a. 100 can be thought of as a bundle of ten tens — called a “hundred.”</p>	<p><i>2.NO.1h4 Build representations of 3 digit numbers using tens and ones.</i>  <i>2.NO.1h5 Build representations of 3 digit numbers using hundreds, tens, and ones.</i></p>	<p>2.NBT.A.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:</p> <p>2.NBT.A.1a: 100 can be thought of as a bundle of ten tens - called a “hundred.”</p>

<p>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).</p> <p>2. Count within 1000; skip-count by 5s, 10s, and 100s.</p> <p>3. Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.</p> <p>4. Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using <math>&gt;</math>, <math>=</math>, and <math>&lt;</math> symbols to record the results of comparisons.</p>	<p><i>2.NO.1e4 Skip count by 5s</i></p> <p><i>2.NO.1e5 Skip count by 10s.</i></p> <p><i>2.NO.1e6 Skip count by 100s.</i></p> <p><i>2.NO.3c1 Solve real world problems by using mental math (such as skip counting by 2s within 20, 5s within 50, and 10s within 100).</i></p> <p><i>2.NO.1d5 Identify numerals 0-100.</i></p> <p><i>2.NO.1d6 Identify the numeral between 0 and 100 when presented the name.</i></p> <p><i>2.NO.1e3 Write or select the numerals 0-100.</i></p> <p><i>2.NO.1h8 Write or select expanded form for any 2 digit number.</i></p> <p><i>2.NO.1h9 Write or select expanded form for any 3 digit number.</i></p> <p><i>2.NO.1i3 Explain what the zero represents in place value (hundreds, tens, ones) in a number.</i></p> <p><i>3.NO.1j2 Write or select the expanded form for up to 3 digit number.</i></p> <p><i>2.NO.1f6 Compare (greater than, less than, equal to) 2 numbers up to 100.</i></p> <p><i>2.NO.1h6 Compare 2 digit numbers using representations and numbers (e.g., identify more tens, less tens, more ones, less ones, larger number, smaller number).</i></p> <p><i>2.NO.1h7 Compare 3 digit numbers using representations and numbers (e.g., identify more hundreds, less hundreds, more tens, less tens, more ones, less ones, larger number, smaller number).</i></p> <p><i>3.NO.1h1 Compare 3 digit numbers using representations and numbers (e.g., identify more hundreds, less hundreds, more tens, less tens, more ones, less ones, larger number, smaller number).</i></p>	<p>2.NBT.A.1b: 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).</p> <p>2.NBT.A.2: Count within 1000; skip-count by 5s, 10s, and 100s. Identify patterns in skip counting at any number. (For example, 37, 47, 57 or 328, 428, 528, etc.)</p> <p>2.NBT.A.3: Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.</p> <p>2.NBT.A.4: Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using <math>&gt;</math>, <math>=</math>, and <math>&lt;</math> symbols to record the results of comparisons.</p>
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Use place value understanding and properties of operations to add and subtract.	Use place value understanding and properties of operations to add and subtract.	Standard - QR.C.6 Use place value understanding and properties of operations to add and subtract.
<p>5. Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.</p> <p>6. Add up to four two-digit numbers using strategies based on place value and properties of operations.</p> <p>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.</p> <p>8. Mentally add 10 or 100 to a given number 100–900, and mentally subtract 10 or 100 from a given number 100–900.</p> <p>9. Explain why addition and subtraction strategies work, using place value and the properties of operations.<sup>3</sup></p>	<p><i>2.NO.2a12 Model addition and subtraction with base 10 blocks within 20.</i></p> <p><i>2.NO.2a13 Model addition and subtraction with base 10 blocks within 50.</i></p> <p><i>2.NO.2a14 Model addition and subtraction with base 10 blocks within 100.</i></p> <p><i>2.NO.2a19 Combine up to 3 sets of 20 or less.</i></p> <p><i>2.NO.2c3 Decompose tens into ones and/or hundreds into tens in subtraction situations.</i></p> <p><i>2.NO.2c4 Decompose tens into ones and/or hundreds into tens in subtraction situations.</i></p> <p><i>2.NO.2a18 Use diagrams and number lines to solve addition or subtraction problems.</i></p> <p><i>2.NO.1e8 Mentally add or subtract 10 from a given set from the 10s family (e.g., what is 10 more than 50? What is 10 less than 70?).</i></p> <p><i>2.NO.1e9 Mentally add or subtract 100 from a given set from the 100s family (e.g., what is 100 more than 500? What is 100 less than 700?).</i></p> <p><i>3.NO.1e2 Mentally add or subtract 100 from a given set from the 100s family (e.g., what is 100 more than 500? What is 100 less than 700?).</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>2.NBT.B.5: Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.</p> <p>2.NBT.B.6: Add up to four two-digit numbers using strategies based on place value and properties of operations.</p> <p>2.NBT.B.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.</p> <p>2.NBT.B.8: Mentally add 10 or 100 to a given number 100–900, and mentally subtract 10 or 100 from a given number 100–900.</p> <p>2.NBT.B.9: Explain why addition and subtraction strategies work, using place value and the properties of operations. Explanations may be supported by drawings or objects.</p>
<b>Measurement and Data</b> <b>2.MD</b>	<b>Measurement and Data</b> <b>2.MD</b>	<b>Statistical Reasoning</b> <b>SR</b>

Measure and estimate lengths in standard units.	Measure and estimate lengths in standard units.	Standard - SR.C.1 Describe and compare measurable attributes.
<p>1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.</p> <p>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.</p> <p>3. Estimate lengths using units of inches, feet, centimeters, and meters.</p> <p>4. Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.</p>	<p><i>2.ME.1a3 Select appropriate tool and unit of measurement to measure an object (ruler or yard stick; inches or feet).</i></p> <p><i>2.ME.2b2 Select appropriate tools and demonstrate or identify appropriate measuring techniques.</i></p> <p><i>2.ME.1c2 Measure the attributes (length, width, height) of an object using 2 different size units.</i></p> <p><i>2.ME.1c3 Recognize that standard measurement units can be decomposed into smaller units.</i></p> <p><i>2.ME.2a3 Estimate the length of an object using units of feet and inches.</i></p> <p><i>2.ME.1b5 Solve word problems involving the difference in standard length units.</i></p> <p><i>2.ME.2a4 Solve one step subtraction problems involving the difference of the lengths of 2 objects in standard length units.</i></p>	<p>2.MD.A.1: Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.</p> <p>2.MD.A.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.</p> <p>2.MD.A.3: Estimate lengths using units of inches, feet, centimeters, and meters.</p> <p>2.MD.A.4: Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.</p>
Relate addition and subtraction to length.	Relate addition and subtraction to length.	Standard - SR.C.3 Relate addition and subtraction to length.
<p>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.</p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>2.MD.B.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.</p> <p>2.MD.B.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.</p>

<p><b>Work with time and money.</b></p> <p>7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.</p> <p>8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using \$ and ¢ symbols appropriately. <i>Example: If you have 2 dimes and 3 pennies, how many cents do you have?</i></p>	<p><b>Work with time and money.</b></p> <p><i>3.ME.1a1 Tell time to the nearest 5 minutes using a digital clock.</i></p> <p><i>2.ME.1a4 Solve word problems using dollar bills, quarters, dimes, nickels, or pennies.</i></p>	<p><b>Standard - SR.C.4 Work with time and money.</b></p> <p>2.MD.C.7: Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.</p> <p>2.MD.C.8: Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using \$ and ¢ symbols appropriately. <i>Example: If you have 2 dimes and 3 pennies, how many cents do you have?</i></p>
<p><b>Represent and interpret data.</b></p> <p>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.</p> <p>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<sup>4</sup> using information presented in a bar graph.</p>	<p><b>Represent and interpret data.</b></p> <p><i>2.DPS.1c3 Organize data by representing continuous data on a line plot.</i></p> <p><i>2.DPS.1d2 Identify the value of each category represented on picture graph and bar graph or each point on a line plot.</i></p> <p><i>2.DPS.1a7 Analyze data by sorting into categories established by each question</i></p> <p><i>2.DPS.1c2 Organize data by representing categorical data on a pictorial graph or bar graph.</i></p> <p><i>2.DPS.1e2 Compare the information shown in a bar graph or picture graph with up to 4 categories. Solve simple comparisons of how many more or how many less.</i></p>	<p><b>Standard - SR.C.2 Represent and interpret data.</b></p> <p>2.MD.D.9: Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Organize and record data on a line plot, where the horizontal scale is marked off in whole-number units.</p> <p>2.MD.D.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.</p>
<p><b>Geometry</b> <b>2.G</b></p>	<p><b>Geometry</b> <b>2.G</b></p>	<p><b>Geometric Reasoning</b> <b>GR</b></p>
<p><b>Reason with shapes and their attributes.</b></p>	<p><b>Reason with shapes and their attributes.</b></p>	<p><b>Standard - GR.C.1 Identify, describe, analyze, compare, create, and compose shapes based on their attributes. Sizes are compared directly or visually, not compared by measuring.</b></p>
<p>1. Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces.<sup>5</sup> Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.</p>	<p><i>2.GM.1a4 Identify two- dimensional shapes such as rhombus, pentagons, hexagons, octagon, ovals, equilateral, isosceles, and scalene triangles.</i></p> <p><i>2.GM.1b3 Distinguish two- or three- dimensional shapes based upon their attributes (i.e., #of sides,</i></p>	<p>2.G.A.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 (including squares, rectangles, rhombuses, and trapezoids) pentagons,</p>

<p>2. Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.</p> <p>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.</p>	<p><i>equal or different lengths of sides, # of faces, # of corners).</i></p> <p><i>2.GM.1e1 Draw two- dimensional shapes with specific attributes.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>2.GM.1f2 Partition circles and rectangles into 2 and 4 equal parts.</i></p> <p><i>2.GM.1f3 Label a partitioned shape (e.g., one whole rectangle was separated into 2 halves, one whole circle was separated into three thirds).</i></p>	<p>hexagons, and cubes. Sizes are compared directly or visually, not compared by measuring.</p> <p>2.G.A.2: Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.</p> <p>2.G.A.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.</p>
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<sup>1</sup>See Glossary, Table 1.

<sup>2</sup>See standard 1.OA.6 for a list of mental strategies.

<sup>3</sup>Explanations may be supported by drawings or objects.

<sup>4</sup>See Glossary, Table 1.

<sup>5</sup>Sizes are compared directly or visually, not compared by measuring.

## Grade 3 Mathematics

### Operations and Algebraic Thinking

- Represent and solve problems involving multiplication and division.
- Understand properties of multiplication and the relationship between multiplication and division.
- Multiply and divide within 100.
- Solve problems involving the four operations, and identify and explain patterns in arithmetic.

### Number and Operations in Base Ten

- Use place value understanding and properties of operations to perform multi-digit arithmetic.

### Number and Operations—Fractions

- Develop understanding of fractions as numbers.

### Measurement and Data

- Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.
- Represent and interpret data.
- Geometric measurement: understand concepts of area and relate area to multiplication and to addition.
- Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.

## Geometry

- Reason with shapes and their attributes.

Common Core State Standards	Core Content Connectors	Maine Learning Results
<p>In Grade 3, instructional time should focus on four critical areas: (1) developing understanding of multiplication and division and strategies for multiplication and division within 100; (2) developing understanding of fractions, especially unit fractions (fractions with numerator 1); (3) developing understanding of the structure of rectangular arrays and of area; and (4) describing and analyzing two-dimensional shapes.</p> <p>(1) Students develop an understanding of the meanings of multiplication and division of whole numbers through activities and problems involving equal-sized groups, arrays, and area models; multiplication is finding an unknown product, and division is finding an unknown factor in these situations. For equal-sized group situations, division can require finding the unknown number of groups or the unknown group size. Students use properties of operations to calculate products of whole numbers, using increasingly sophisticated strategies based on these properties to solve multiplication and division problems involving single-digit factors. By comparing a variety of solution strategies, students learn the relationship between multiplication and division.</p> <p>(2) Students develop an understanding of fractions, beginning with unit fractions. Students view fractions in general as being built out of unit fractions, and they use fractions along with visual fraction models to represent parts of a whole. Students understand that the size of a fractional part is relative to the size of the whole. For example, <math>\frac{1}{2}</math> of the paint in a small bucket could</p>		

be less paint than  $\frac{1}{3}$  of the paint in a larger bucket, but  $\frac{1}{3}$  of a ribbon is longer than  $\frac{1}{5}$  of the same ribbon because when the ribbon is divided into 3 equal parts, the parts are longer than when the ribbon is divided into 5 equal parts. Students are able to use fractions to represent numbers equal to, less than, and greater than one. They solve problems that involve comparing fractions by using visual fraction models and strategies based on noticing equal numerators or denominators.

(3) Students recognize area as an attribute of two-dimensional regions. They measure the area of a shape by finding the total number of same-size units of area required to cover the shape without gaps or overlaps, a square with sides of unit length being the standard unit for measuring area. Students understand that rectangular arrays can be decomposed into identical rows or into identical columns. By decomposing rectangles into rectangular arrays of squares, students connect area to multiplication, and justify using multiplication to determine the area of a rectangle.

(4) Students describe, analyze, and compare properties of two-dimensional shapes. They compare and classify shapes by their sides and angles, and connect these with definitions of shapes. Students also relate their fraction work to geometry by expressing the area of part of a shape as a unit fraction of the whole.

**Operations and Algebraic Thinking      3.OA**

**Operations and Algebraic Thinking      3.OA**

**Algebraic Reasoning      AR**

**Represent and solve problems involving multiplication and division.**

**Represent and solve problems involving multiplication and division.**

**Standard - AR.C.4 Understand properties of multiplication and the relationship between multiplication and division to represent and solve problems within 100. *Students need not use formal terms for these properties.***

<p>1. Interpret products of whole numbers, e.g., interpret <math>5 \times 7</math> as the total number of objects in 5 groups of 7 objects each. <i>For example, describe a context in which a total number of objects can be expressed as <math>5 \times 7</math>.</i></p>	<p><i>3.NO.2d1 Find the total number of objects when given the number of identical groups and the number of objects in each group neither number larger than 5.</i></p> <p><i>3.NO.2d2 Find total number inside an array with neither number in the columns or rows larger than 5.</i></p> <p><i>3.NO.2d3 Solve multiplication problems with neither number greater than 5.</i></p> <p><i>3.PRF.1d1 Use objects to model multiplication and division situations involving up to 5 groups with up to 5 objects in each group and interpret the results.</i></p> <p><i>4.NO.2d6 Find total number inside an array with neither number in the columns or rows larger than 10.</i></p> <p><i>4.NO.2d8 Match an accurate addition and multiplication equation to a representation.</i></p> <p><i>4.PRF.1d2 Use objects to model multiplication and division situations involving up to 10 groups with up to 5 objects in each group and interpret the results.</i></p>	<p>3.OA.A.1: Interpret products of whole numbers, e.g., interpret <math>5 \times 7</math> as the total number of objects in 5 groups of 7 objects each. <i>For example, describe a context in which a total number of objects can be expressed as <math>5 \times 7</math>.</i></p>
<p>2. Interpret whole-number quotients of whole numbers, e.g., interpret <math>56 \div 8</math> 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. <i>For example, describe a context in which a number of shares or a number of groups can be expressed as <math>56 \div 8</math>.</i></p>	<p><i>3.NO.2d4 Determine how many objects go into each group when given the total number of objects and the number of groups where the number in each group or number of groups is not greater than 5.</i></p> <p><i>3.NO.2d5 Determine the number of groups given the number of total number of objects and the number of objects in each group where the number in each group and the number of groups is not greater than 5.</i></p> <p><i>3.PRF.1d1 Use objects to model multiplication and division situations involving up to 5 groups with up to 5 objects in each group and interpret the results.</i></p>	<p>3.OA.A.2: Interpret whole-number quotients of whole numbers, e.g., interpret <math>56 \div 8</math> 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. <i>For example, describe a context in which a number of shares or a number of groups can be expressed as <math>56 \div 8</math>.</i></p>
<p>3. Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g.,</p>	<p><i>No CCC developed for this standard.</i></p>	<p>3.OA.A.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</p>

<p>by using drawings and equations with a symbol for the unknown number to represent the problem.<sup>1</sup></p> <p>4. Determine the unknown whole number in a multiplication or division equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations <math>8 \times ? = 48</math>, <math>5 = \square \div 3</math>, <math>6 \times 6 = ?</math>.</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>symbol for the unknown number to represent the problem.</p> <p>3.OA.A.4: Determine the unknown whole number in a multiplication or division equation relating three whole numbers. <i>For example, determine the unknown number that makes the equation true in each of the equations <math>8 \times ? = 48</math>, <math>5 = \_ \div 3</math>, <math>6 \times 6 = ?</math>.</i></p>
<p><b>Understand properties of multiplication and the relationship between multiplication and division.</b></p>	<p><b>Understand properties of multiplication and the relationship between multiplication and division.</b></p>	<p><b>(Repeat) Standard - AR.C.4 Understand properties of multiplication and the relationship between multiplication and division to represent and solve problems within 100. Students need not use formal terms for these properties.</b></p>
<p>5. Apply properties of operations as strategies to multiply and divide.<sup>2</sup> <i>Examples: If <math>6 \times 4 = 24</math> is known, then <math>4 \times 6 = 24</math> is also known. (Commutative property of multiplication.) <math>3 \times 5 \times 2</math> can be found by <math>3 \times 5 = 15</math>, then <math>15 \times 2 = 30</math>, or by <math>5 \times 2 = 10</math>, then <math>3 \times 10 = 30</math>. (Associative property of multiplication.) Knowing that <math>8 \times 5 = 40</math> and <math>8 \times 2 = 16</math>, one can find <math>8 \times 7</math> as <math>8 \times (5 + 2) = (8 \times 5) + (8 \times 2) = 40 + 16 = 56</math>. (Distributive property.)</i></p> <p>6. Understand division as an unknown-factor problem. <i>For example, find <math>32 \div 8</math> by finding the number that makes 32 when multiplied by 8.</i></p>	<p><i>3.PRF.2d2 Apply properties of operations as strategies to multiply and divide.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>3.OA.B.5: Apply properties of operations as strategies to multiply. <i>Examples: If <math>6 \times 4 = 24</math> is known, then <math>4 \times 6 = 24</math> is also known. (Commutative property of multiplication.) <math>3 \times 5 \times 2</math> can be found by <math>3 \times 5 = 15</math>, then <math>15 \times 2 = 30</math>, or by <math>5 \times 2 = 10</math>, then <math>3 \times 10 = 30</math>. (Associative property of multiplication.) Knowing that <math>8 \times 5 = 40</math> and <math>8 \times 2 = 16</math>, one can find <math>8 \times 7</math> as <math>8 \times (5 + 2) = (8 \times 5) + (8 \times 2) = 40 + 16 = 56</math>. (Distributive property.)</i></p> <p>3.OA.B.6: Understand division as an unknown-factor problem. <i>For example, find <math>32 \div 8</math> by finding the number that makes 32 when multiplied by 8.</i></p>
<p><b>Multiply and divide within 100.</b></p>	<p><b>Multiply and divide within 100.</b></p>	<p><b>(Repeat) Standard - AR.C.4 Understand properties of multiplication and the relationship between multiplication and division to represent and solve problems within 100. Students need not use formal terms for these properties.</b></p>
<p>7. Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that <math>8 \times 5 = 40</math>, one knows <math>40 \div 5 = 8</math>) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>3.OA.C.7: Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that <math>8 \times 5 = 40</math>, one knows <math>40 \div 5 = 8</math>) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.</p>

Solve problems involving the four operations, and identify and explain patterns in arithmetic.	Solve problems involving the four operations, and identify and explain patterns in arithmetic.	Standard - AR.C.5 Solve problems involving the four operations. <i>This standard is limited to problems posed with whole numbers and having whole-number answers; students should know how to perform operations in conventional order when there are no parentheses to specify a particular order (Order of Operations).</i>
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. <sup>3</sup>	3.NO.2e1 <i>Solve or solve and check one or two step word problems requiring addition, subtraction or multiplication with answers up to 100.</i>	3.OA.D.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.
<b>(Repeat) Solve problems involving the four operations, and identify and explain patterns in arithmetic.</b>	<b>(Repeat) Solve problems involving the four operations, and identify and explain patterns in arithmetic.</b>	<b>Standard - AR.C.8 Identify, explain, generate and analyze patterns.</b>
9. Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. <i>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.</i>	3.PRF.1e1 <i>Describe the rule for a numerical pattern (e.g., increase by 2, 5, or 10).</i> 3.PRF.1e2 <i>Select or name the three next terms in a numerical pattern where numbers increase by 2, 5 or 10.</i> 3.PRF.2d1 <i>Identify multiplication patterns in a real word setting.</i>	3.OA.D.9: Identify arithmetic patterns (including patterns in the addition table or multiplication table) and explain them using properties of operations. <i>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.</i>
<b>Number and Operations in Base Ten      3.NBT</b>	<b>Number and Operations in Base Ten      3.NBT</b>	<b>Quantitative Reasoning      QR</b>
<b>Use place value understanding and properties of operations to perform multi-digit arithmetic.<sup>4</sup></b>	<b>Use place value understanding and properties of operations to perform multi-digit arithmetic.</b>	<b>Standard - QR.C.8 Understand the place value system. <i>A range of algorithms may be used.</i></b>
1. Use place value understanding to round whole numbers to the nearest 10 or 100.	3.NO.1j3 <i>Use place value to round to the nearest 10 or 100.</i> 3.NO.1j4 <i>Use rounding to solve word problems.</i>	3.NBT.A.1: Use place value understanding to round whole numbers to the nearest 10 or 100.
<b>(Repeat) Use place value understanding and properties of operations to perform multi-digit arithmetic.<sup>4</sup></b>	<b>(Repeat) Use place value understanding and properties of operations to perform multi-digit arithmetic.</b>	<b>Standard - QR.C.7 Use place value understanding and properties of operations to perform multi-digit arithmetic with whole numbers and decimals to hundredths. <i>A range of algorithms may be used.</i></b>
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.NO.2c1 <i>Solve multi-step addition and subtraction problems up to 100.</i> 3.NO.2b1 <i>Use the relationships between addition and subtraction to solve problems.</i>	3.NBT.A.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.

<p>3. Multiply one-digit whole numbers by multiples of 10 in the range 10–90 (e.g., <math>9 \times 80</math>, <math>5 \times 60</math>) using strategies based on place value and properties of operations.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>3.NBT.A.3: Multiply one-digit whole numbers by multiples of 10 in the range 10-90 (e.g., <math>9 \times 80</math>, <math>5 \times 60</math>) using strategies based on place value and properties of operations.</p>
<p><b>Number and Operations - Fractions<sup>5</sup> 3.NF</b></p>	<p><b>Number and Operations - Fractions 3.NF</b></p>	<p><b>Quantitative Reasoning QR</b></p>
<p><b>Develop understanding of fractions as numbers.</b></p>	<p><b>Develop understanding of fractions as numbers.</b></p>	<p><b>Standard - QR.C.9 Develop and extend the understanding of fractions as numbers, including equivalence and ordering. Grade 3 expectations in this strand are limited to fractions with denominators 2, 3, 4, 6, and 8.</b></p>
<p>1. Understand a fraction <math>1/b</math> as the quantity formed by 1 part when a whole is partitioned into <math>b</math> equal parts; understand a fraction <math>a/b</math> as the quantity formed by <math>a</math> parts of size <math>1/b</math>.</p> <p>2. Understand a fraction as a number on the number line; represent fractions on a number line diagram.</p> <p>a. Represent a fraction <math>1/b</math> on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into <math>b</math> equal parts. Recognize that each part has size <math>1/b</math> and that the endpoint of the part based at 0 locates the number <math>1/b</math> on the number line.</p> <p>b. Represent a fraction <math>a/b</math> on a number line diagram by marking off <math>a</math> lengths <math>1/b</math> from 0. Recognize that the resulting interval has size <math>a/b</math> and that its endpoint locates the number <math>a/b</math> on the number line.</p> <p>3. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.</p>	<p><i>3.NO.1I1 Identify the number of highlighted parts (numerator) of a given representation (rectangles and circles).</i></p> <p><i>3.NO.1I2 Identify the total number of parts (denominator) of a given representation (rectangles and circles).</i></p> <p><i>3.NO.1I3 Identify the fraction that matches the representation (rectangles and circles; halves, fourths, and thirds, eighths).</i></p> <p><i>3.NO.1I4 Identify that a part of a rectangle can be represented as a fraction that has a value between 0 and 1.</i></p> <p><i>3.NO.1I5 Locate given common unit fractions (i.e., <math>\frac{1}{2}</math>, <math>\frac{1}{4}</math>, <math>\frac{1}{8}</math>,) on a number line or ruler.</i></p> <p><i>4.NO.1I6 Locate fractions on a number line.</i></p> <p><i>4.NO.1I7 Order fractions on a number line.</i></p> <p><i>3.SE.1g1 Use =, &lt;, or &gt; to compare 2 fractions with the same numerator or denominator.</i></p> <p><i>4.SE.1h1 Express whole numbers as fractions.</i></p>	<p>3.NF.A.1: Understand a unit fraction <math>1/b</math> as the quantity formed by 1 part when a whole is partitioned into <math>b</math> equal parts; understand a fraction <math>a/b</math> as the quantity formed by <math>a</math> parts of size <math>1/b</math>.</p> <p>3.NF.A.2: Understand a fraction as a number on the number line; represent fractions on a number line diagram.</p> <p>3.NF.A.2a: Represent a fraction <math>1/b</math> on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into <math>b</math> equal parts. Recognize that each part has size <math>1/b</math> and that the endpoint of the part based at 0 locates the number <math>1/b</math> on the number line.</p> <p>3.NF.A.2b: Represent a fraction <math>a/b</math> on a number line diagram by marking off <math>a</math> lengths <math>1/b</math> from 0. Recognize that the resulting interval has size <math>a/b</math> and that its endpoint locates the number <math>a/b</math> on the number line.</p> <p>3.NF.A.3: Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.</p>

<p>a. Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line.</p> <p>b. Recognize and generate simple equivalent fractions, e.g., <math>1/2 = 2/4</math>, <math>4/6 = 2/3</math>. Explain why the fractions are equivalent, e.g., by using a visual fraction model.</p> <p>c. Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers. <i>Examples: Express 3 in the form <math>3 = 3/1</math>; recognize that <math>6/1 = 6</math>; locate <math>4/4</math> and 1 at the same point of a number line diagram.</i></p> <p>d. Compare two fractions with the same numerator or the same denominator by reasoning about their size. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with the symbols <math>&gt;</math>, <math>=</math>, or <math>&lt;</math>, and justify the conclusions, e.g., by using a visual fraction model.</p>	<p><i>4.NO.1m1 Determine equivalent fractions.</i></p> <p><i>4.NO.2h3 Solve word problems involving addition and subtraction of fractions with like denominators (2, 3, 4, or 8).</i></p>	<p>3.NF.A.3a: Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line.</p> <p>3.NF.A.3b: Recognize and generate simple equivalent fractions, e.g., <math>1/2 = 2/4</math>, <math>4/6 = 2/3</math>. Explain why the fractions are equivalent, e.g., by using a visual fraction model.</p> <p>3.NF.A.3c: Express whole numbers as fractions and recognize fractions that are equivalent to whole numbers. <i>Examples: Express 3 in the form <math>3 = 3/1</math>; recognize that <math>6/1 = 6</math>; locate <math>4/4</math> and 1 at the same point of a number line diagram.</i></p> <p>3.NF.A.3d: Compare two fractions with the same numerator or the same denominator by reasoning about their size. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with the symbols <math>&gt;</math>, <math>=</math>, or <math>&lt;</math>, and justify the conclusions, e.g., by using a visual fraction model.</p>
<p><b>Measurement and Data</b> <b>3.MD</b></p>	<p><b>Measurement and Data</b> <b>3.MD</b></p>	<p><b>Statistical Reasoning</b> <b>SR</b></p>
<p><b>Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.</b></p>	<p><b>Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.</b></p>	<p><b>Standard - SR.C.5 Solve problems involving measurement, conversion of measurement and estimation of intervals of time, liquid volumes, and masses of objects.</b> <i>Excludes compound units such as <math>cm^3</math> and finding the geometric volume of a container. Excludes multiplicative comparison problems (problems involving notions of “times as much”).</i></p>
<p>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.</p>	<p><i>3.ME.1a2 Solve word problems involving the addition and subtraction of time intervals of whole hours or within an hour (whole hours: 5:00 to 8:00, within hours: 7:15 to 7:45).</i></p>	<p>3.MD.A.1: Tell and write time to the nearest minute and measure time intervals in minutes using analog and digital clocks. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.</p>

<p>2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).<sup>6</sup> 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.<sup>7</sup></p>	<p><i>3.PRF.1f1 Determine the equivalence between number of minutes and the fraction of the hour (e.g., 30 minutes = ½ hour).</i>  <i>3.PRF.1f 2 Determine the equivalence between the number of minutes and the number of hours (e.g., 60 minutes = 1 hour).</i></p> <p><i>3.ME.1f1 Select appropriate units for measurement (liquid volume, area, time, money).</i>  <i>3.ME.1f2 Add to solve one step word problems.</i>  <i>3.ME.2e1 Select appropriate tool for measurement: liquid volume, area, time, money.</i>  <i>3.ME.2i1 Estimate liquid volume.</i></p>	<p>3.MD.A.2: Measure and estimate liquid volumes and masses of objects using standard metric 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 metric units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.</p>
<p><b>Represent and interpret data.</b></p>	<p><b>Represent and interpret data.</b></p>	<p><b>Standard - SR.C.6 Represent and interpret data.</b></p>
<p>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. <i>For example, draw a bar graph in which each square in the bar graph might represent 5 pets.</i></p> <p>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.</p>	<p><i>3.DPS.1g1 Collect data, organize into picture or bar graph.</i>  <i>3.DPS.1i1 Select the appropriate statement that describes the data representations based on a given graph (picture, bar, line plots).</i></p> <p><i>3.ME.2e2 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.</i>  <i>3.ME.2e3 Measure to solve problems using number lines and ruler to 1 inch, ½ inch, or ¼ of an inch.</i>  <i>3.DPS.1g2 Organize measurement data into a line plot.</i></p>	<p>3.MD.B.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. <i>For example, draw a bar graph in which each square in the bar graph might represent 5 pets.</i></p> <p>3.MD.B.4: Generate measurement data by measuring lengths of objects using rulers marked with halves and fourths of an inch. Record and show the data by making a line plot, where the horizontal scale is marked off in appropriate units— whole numbers, halves, or fourths.</p>
<p><b>Geometric measurement: understand concepts of area and relate area to multiplication and to addition.</b></p>	<p><b>Geometric measurement: understand concepts of area and relate area to multiplication and to addition.</b></p>	<p><b>Standard - SR.C.7 Understand concepts of Geometric measurement: involving perimeter, area, and volume.</b></p>
<p>5. Recognize area as an attribute of plane figures and understand concepts of area measurement.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>3.MD.C.5: Recognize area as an attribute of plane figures and understand concepts of area measurement.</p>

<p>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.</p> <p>b. A plane figure which can be covered without gaps or overlaps by <math>n</math> unit squares is said to have an area of <math>n</math> square units.</p> <p>6. Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).</p> <p>7. Relate area to the operations of multiplication and addition.</p> <p>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.</p> <p>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.</p> <p>c. Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths <math>a</math> and <math>b + c</math> is the sum of <math>a \times b</math> and <math>a \times c</math>. Use area models to represent the distributive property in mathematical reasoning.</p> <p>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.</p>	<p><i>3.ME.1d2 Measure area of rectangles by counting squares.</i></p> <p><i>3.ME.1d1 Use tiling and addition to determine area.</i></p> <p><i>4.ME.1d3 Use tiling and multiplication to determine area.</i></p> <p><i>4.ME.2h1 Apply the formulas for area and perimeter to solve real world problems.</i></p> <p><i>4.PRF.1f3 Apply the distributive property to solve problems with models.</i></p>	<p>3.MD.C.5a: 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.</p> <p>3.MD.C.5b: A plane figure which can be covered without gaps or overlaps by <math>n</math> unit squares is said to have an area of <math>n</math> square units.</p> <p>3.MD.C.6: Measure areas by counting unit squares (square cm, square m, square in, square ft, and non-standard units).</p> <p>3.MD.C.7: Relate area to the operations of multiplication and addition.</p> <p>3.MD.C.7a: 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.</p> <p>3.MD.C.7b: 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.</p> <p>3.MD.C.7c: Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths <math>a</math> and <math>b + c</math> is the sum of <math>a \times b</math> and <math>a \times c</math>. Use area models to represent the distributive property in mathematical reasoning.</p> <p>3.MD.C.7d: 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,</p>
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		applying this technique to solve real world problems.
<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b>	<b>Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.</b>	<b>(Repeat) Standard - SR.C.7 Understand concepts of Geometric measurement: involving perimeter, area, and volume.</b>
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.	<p><i>3.ME.1g1 Identify a figure as getting larger or smaller when the dimensions of the figure changes</i></p> <p><i>3.ME.2h1 Use addition to find the perimeter of a rectangle</i></p> <p><i>4.ME.2h1 Apply the formulas for area and perimeter to solve real world problems.</i></p>	3.MD.D.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.
<b>Geometry</b> <b>3.G</b>	<b>Geometry</b> <b>3.G</b>	<b>Geometric Reasoning</b> <b>GR</b>
<b>Reason with shapes and their attributes.</b>	<b>Reason with shapes and their attributes.</b>	<b>Standard - GR.C.2 Analyze, compare, create, and compose shapes based on their attributes.</b>
<p>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.</p> <p>2. Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. <i>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.</i></p>	<p><i>3.GM.1h1 Identify shared attributes of shapes.</i></p> <p><i>3.GM.1i1 Partition rectangles into equal parts with equal area.</i></p>	<p>3.G.A.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.</p> <p>3.G.A.2: Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. <i>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.</i></p>

<sup>1</sup>See Glossary, Table 2.

<sup>2</sup>Students need not use formal terms for these properties.

<sup>3</sup>This standard is limited to problems posed with whole numbers and having whole number answers; students should know how to perform operations in the conventional order when there are no parentheses to specify a particular order (Order of Operations).

<sup>4</sup>A range of algorithms may be used.

<sup>5</sup>Grade 3 expectations in this domain are limited to fractions with denominators 2, 3, 4, 6, and 8.

<sup>6</sup>Excludes compound units such as cm<sup>3</sup> and finding the geometric volume of a container.

<sup>7</sup>Excludes multiplicative comparison problems (problems involving notions of “times as much”; see Glossary, Table 2).

## Grade 4 Mathematics

### Operations and Algebraic Thinking

- Use the four operations with whole numbers to solve problems.
- Gain familiarity with factors and multiples.
- Generate and analyze patterns.

### Number and Operations in Base Ten

- Generalize place value understanding for multidigit whole numbers.
- Use place value understanding and properties of operations to perform multi-digit arithmetic.

### Number and Operations—Fractions

- Extend understanding of fraction equivalence and ordering.
- Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.
- Understand decimal notation for fractions, and compare decimal fractions.

### Measurement and Data

- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.
- Represent and interpret data.
- Geometric measurement: understand concepts of angle and measure angles.

### Geometry

- Draw and identify lines and angles, and classify shapes by properties of their lines and angles.

Common Core State Standards	Core Content Connectors	Maine Learning Results
In Grade 4, instructional time should focus on three critical areas: (1) developing understanding and fluency with multi-digit multiplication, and developing understanding of dividing to find quotients involving multi-digit dividends; (2) developing an understanding of fraction equivalence, addition and subtraction of fractions with like denominators, and multiplication of fractions by whole numbers; (3) understanding that geometric figures can be analyzed and classified based on their properties, such as having parallel sides, perpendicular sides, particular angle measures, and symmetry.		

(1) Students generalize their understanding of place value to 1,000,000, understanding the relative sizes of numbers in each place. They apply their understanding of models for multiplication (equal-sized groups, arrays, area models), place value, and properties of operations, in particular the distributive property, as they develop, discuss, and use efficient, accurate, and generalizable methods to compute products of multi-digit whole numbers. Depending on the numbers and the context, they select and accurately apply appropriate methods to estimate or mentally calculate products. They develop fluency with efficient procedures for multiplying whole numbers; understand and explain why the procedures work based on place value and properties of operations; and use them to solve problems. Students apply their understanding of models for division, place value, properties of operations, and the relationship of division to multiplication as they develop, discuss, and use efficient, accurate, and generalizable procedures to find quotients involving multi-digit dividends. They select and accurately apply appropriate methods to estimate and mentally calculate quotients, and interpret remainders based upon the context.

(2) Students develop understanding of fraction equivalence and operations with fractions. They recognize that two different fractions can be equal (e.g.,  $15/9 = 5/3$ ), and they develop methods for generating and recognizing equivalent fractions. Students extend previous understandings about how fractions are built from unit fractions, composing fractions from unit fractions, decomposing fractions into unit fractions, and using the meaning of fractions and the meaning of multiplication to multiply a fraction by a whole number.

<p>(3) Students describe, analyze, compare, and classify two-dimensional shapes. Through building, drawing, and analyzing two-dimensional shapes, students deepen their understanding of properties of two-dimensional objects and the use of them to solve problems involving symmetry.</p>		
<p><b>Operations and Algebraic Thinking</b>      <b>4.OA</b></p>	<p><b>Operations and Algebraic Thinking</b>      <b>4.OA</b></p>	<p><b>Algebraic Reasoning</b>      <b>AR</b></p>
<p><b>Use the four operations with whole numbers to solve problems.</b></p>	<p><b>Use the four operations with whole numbers to solve problems.</b></p>	<p><b>Standard - AR.C.5 Solve problems involving the four operations.</b></p>
<p>1. Interpret a multiplication equation as a comparison, e.g., interpret <math>35 = 5 \times 7</math> 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.</p> <p>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.<sup>1</sup></p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>4.NO.2d7 Determine how many objects go into each group when given the total number of objects and the number of groups where the number in each group or number of groups is not greater than 10.</i></p> <p><i>4.PRF.1e3 Solve multiplicative comparisons with an unknown using up to 2-digit numbers with information presented in a graph or word problem (e.g., an orange hat cost \$3. A purple hat cost 2 times as much. How much does the purple hat cost? [<math>3 \times 2 = p</math>]).</i></p> <p><i>4.NO.2e2 Solve or solve and check one or two step word problems requiring addition, subtraction, or multiplication with answers up to 100.</i></p>	<p>4.OA.A.1: Interpret a multiplication equation as a comparison, e.g., interpret <math>35 = 5 \times 7</math> 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.</p> <p>4.OA.A.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.</p> <p>4.OA.A.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.</p>

<b>Gain familiarity with factors and multiples.</b>	<b>Gain familiarity with factors and multiples.</b>	<b>Standard - AR.C.6 Gain familiarity with factors and multiples.</b>
4. Find all 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.	<i>4.NO.2f1 Identify multiples for a whole number (e.g., <math>2 = 2, 4, 6, 8, 10</math>).</i>	4.OA.B.4: Find all 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.
<b>Generate and analyze patterns.</b>	<b>Generate and analyze patterns.</b>	<b>Standard - AR.C.8 Identify, explain, generate and analyze patterns.</b>
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. <i>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.</i>	<i>4.PRF.2d3 Generate a pattern when given a rule and word problem (I run 3 miles every day, how many miles have I run in 3 days). 4.PRF.2e1 Extend a numerical pattern when the rule is provided. 5.PRF.2a1 Generate a pattern that follows the provided rule.</i>	4.OA.C.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. <i>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.</i>
<b>Number and Operations in Base Ten<sup>2</sup> 4.NBT</b>	<b>Number and Operations in Base Ten 4.NBT</b>	<b>Quantitative Reasoning QR</b>
<b>Generalize place value understanding for multi-digit whole numbers.</b>	<b>Generalize place value understanding for multi-digit whole numbers.</b>	<b>Standard - QR.C.8 Understand the place value system. Grade 4 expectations in this strand are limited to whole numbers less than or equal to 1,000,000.</b>
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. <i>For example, recognize that <math>700 \div 70 = 10</math> by applying concepts of place value and division.</i>  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 in each place, using $>$ , $=$ , and $<$ symbols to record the results of comparisons.	<i>4.NO.1k1 Compare the value of a number when it is represented in different place values of two 3 digit numbers.  4.NO.1j6 Compare multi-digit numbers using representations and numbers. 4.NO.1j7 Write or select the expanded form for a multi-digit number.</i>	4.NBT.A.1: Recognize that in a multi-digit whole number, a digit in any place represents ten times what it represents in the place to its right. <i>For example, recognize that <math>700 \div 70 = 10</math> by applying concepts of place value and division.</i>  4.NBT.A.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 in each place, using $>$ , $=$ , and $<$ symbols to record the results of comparisons.

3. Use place value understanding to round multi-digit whole numbers to any place.	4.NO.1j5 Use place value to round to any place (i.e., ones, tens, hundreds, thousands).	4.NBT.A.3: Use place value understanding to round multi-digit whole numbers to any place.
<b>Use place value understanding and properties of operations to perform multi-digit arithmetic.</b>	<b>Use place value understanding and properties of operations to perform multi-digit arithmetic.</b>	<b>Standard - QR.C.7 Use place value understanding and properties of operations to perform multi-digit arithmetic with whole numbers and decimals to hundredths.</b> Grade 4 expectations in this strand are limited to whole numbers less than or equal to 1,000,000.
4. Fluently add and subtract multi-digit whole numbers using the standard algorithm.  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.  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.NO.2f2 Solve multiplication problems up to two digits by one digit.  4.PRF.1f4 Solve a 2-digit by 1-digit multiplication problem using two different strategies.  5.NO.2a2 Separate a group of objects into equal sets when given the number of sets to find the total in each set with the total number less than 50.	4.NBT.B.4: Fluently add and subtract multi-digit whole numbers using the standard algorithm.  4.NBT.B.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.NBT.B.6: Find whole-number quotients and remainders with up to four-digit dividends and one-digit divisors, using strategies based on place value, 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.
<b>Number and Operations - Fractions<sup>3</sup> 4.NF</b>	<b>Number and Operations - Fractions 4.NF</b>	<b>Quantitative Reasoning QR</b>
<b>Extend understanding of fraction equivalence and ordering.</b>	<b>Extend understanding of fraction equivalence and ordering.</b>	<b>Standard - QR.C.9 Develop and extend the understanding of fractions as numbers, including equivalence and ordering.</b> Grade 4 expectations in this strand are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12, and 100.
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.NO.1m1 Determine equivalent fractions.	4.NF.A.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, including fractions greater than 1.

<p>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 <math>1/2</math>. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols <math>&gt;</math>, <math>=</math>, or <math>&lt;</math>, and justify the conclusions, e.g., by using a visual fraction model.</p>	<p><i>4.SE.1g2 Use =, &lt;, or &gt; to compare 2 fractions (fractions with a denominator or 10 or less).</i>  <i>4.NO.1n2 Compare up to 2 given fractions that have different denominators.</i></p>	<p>4.NF.A.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 <math>1/2</math>. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols <math>&gt;</math>, <math>=</math>, or <math>&lt;</math>, and justify the conclusions, e.g., by using a visual fraction model.</p>
<p><b>Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</b></p>	<p><b>Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</b></p>	<p><b>Standard - QR.C.11 Use equivalent fractions as a strategy to add and subtract fractions.</b> <i>Grade 4 expectations in this strand are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12, and 100. Students who can generate equivalent fractions can develop strategies for adding fractions with unlike denominators in general. But addition and subtraction with unlike denominators in general is not a requirement at this grade.</i></p>
<p>3. Understand a fraction <math>a/b</math> with <math>a &gt; 1</math> as a sum of fractions <math>1/b</math>.</p> <p>a. Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.</p> <p>b. Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model. <i>Examples: <math>3/8 = 1/8 + 1/8 + 1/8</math>; <math>3/8 = 1/8 + 2/8</math>; <math>2\ 1/8 = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8</math>.</i></p> <p>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.</p>	<p><i>4.NO.2g1 Using a representation, decompose a fraction into multiple copies of a unit fraction (e.g., <math>3/4 = 1/4 + 1/4 + 1/4</math>).</i>  <i>4.NO.2h1 Add and subtract fractions with like denominators of (2,3,4, or 8).</i>  <i>4.NO.2h2 Add and subtract fractions with like denominators (2,3,4, or 8) using representations.</i>  <i>4.NO.2h3 Solve word problems involving addition and subtraction of fractions with like denominators (2, 3, 4, or 8).</i></p>	<p>4.NF.B.3: Understand a fraction <math>a/b</math> with <math>a &gt; 1</math> as a sum of fractions <math>1/b</math>.</p> <p>4.NF.B.3a: Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.</p> <p>4.NF.B.3b: Decompose a fraction into a sum of fractions with the same denominator in more than one way, recording each decomposition by an equation. Justify decompositions, e.g., by using a visual fraction model to build fractions from unit fractions. <i>Examples: <math>3/8 = 1/8 + 1/8 + 1/8</math>; <math>3/8 = 1/8 + 2/8</math>; <math>2\ 1/8 = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8</math>.</i></p> <p>4.NF.B.3c: 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.</p>

<p>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.</p>		<p>4.NF.B.3d: 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.</p>
<p><b>(Repeat) Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</b></p>	<p><b>(Repeat) Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.</b></p>	<p><b>Standard - QR.C.12 Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</b></p>
<p>4. Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.</p> <p>a. Understand a fraction <math>a/b</math> as a multiple of <math>1/b</math>. For example, use a visual fraction model to represent <math>5/4</math> as the product <math>5 \times (1/4)</math>, recording the conclusion by the equation <math>5/4 = 5 \times (1/4)</math>.</p> <p>b. Understand a multiple of <math>a/b</math> as a multiple of <math>1/b</math>, and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express <math>3 \times (2/5)</math> as <math>6 \times (1/5)</math>, recognizing this product as <math>6/5</math>. (In general, <math>n \times (a/b) = (n \times a)/b</math>.)</p> <p>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 <math>3/8</math> of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?</p>	<p>No CCCs developed for these standards.</p>	<p>4.NF.B.4: Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.</p> <p>4.NF.B.4a: Understand a fraction <math>a/b</math> as a multiple of <math>1/b</math>. For example, use a visual fraction model to represent <math>5/4</math> as the product <math>5 \times (1/4)</math>, recording the conclusion by the equation <math>5/4 = 5 \times (1/4)</math>.</p> <p>4.NF.B.4b: Understand a multiple of <math>a/b</math> as a multiple of <math>1/b</math> and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express <math>3 \times (2/5)</math> as <math>6 \times (1/5)</math>, recognizing this product as <math>6/5</math>. (In general, <math>n \times (a/b) = (n \times a)/b</math>.)</p> <p>4.NF.B.4c: 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 <math>3/8</math> of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?</p>
<p><b>Understand decimal notation for fractions, and compare decimal fractions.</b></p>	<p><b>Understand decimal notation for fractions, and compare decimal fractions.</b></p>	<p><b>Standard - QR.C.10 Understand decimal notation for fractions, and compare decimal fractions.</b> Grade 4 expectations in this strand are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12,</p>

		<i>and 100. Students who can generate equivalent fractions can develop strategies for adding fractions with unlike denominators in general. But addition and subtraction with unlike denominators in general is not a requirement at this grade.</i>
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. <sup>4</sup> <i>For example, express 3/10 as 30/100, and add <math>3/10 + 4/100 = 34/100</math>.</i>	<i>4.NO.1o2 Find the equivalent decimal for a given fraction.</i>	4.NF.C.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. <i>For example, express 3/10 as 30/100, and add <math>3/10 + 4/100 = 34/100</math>.</i>
6. Use decimal notation for fractions with denominators 10 or 100. <i>For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram.</i>	<i>4.SE.1h2 Identify the equivalent decimal for a fraction</i> <i>4.NO.1o1 Match a fraction with a denominator of 10 or 100 as a decimal (<math>5/10 = .5</math>).</i> <i>4.NO.1p1 Read, write or select decimals to the tenths place.</i> <i>4.NO.1p2 Read, write or select decimals to the hundredths place.</i> <i>5.NO.1c1 Rewrite a fraction as a decimal.</i> <i>5.NO.1c2 Rewrite a decimal as a fraction.</i>	4.NF.C.6: Use decimal notation for fractions with denominators 10 or 100. <i>For example, rewrite 0.62 as 62/100; describe a length as 0.62 meters; locate 0.62 on a number line diagram.</i>
7. Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the 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.	<i>4.SE.1g3 Use =, &lt;, or &gt; to compare 2 decimals (decimals in multiples of .10).</i> <i>4.NO.1q1 Compare two decimals to the tenths place with a value of less than 1.</i> <i>4.NO.1q2 Compare two decimals to the hundredths place with a value of less than 1.</i>	4.NF.C.7: Compare two decimals to hundredths by reasoning about their size. Recognize that comparisons are valid only when the 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.
<b>Measurement and Data</b> <b>4.MD</b>	<b>Measurement and Data</b> <b>4.MD</b>	<b>Statistical Reasoning</b> <b>SR</b>
<b>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</b>	<b>Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</b>	<b>Standard - SR.C.5 Solve problems involving measurement, conversion of measurement and estimation of intervals of time, liquid volumes, and masses of objects.</b>
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 a smaller unit. Record	<i>4.ME.1a1 Identify the appropriate units of measurement for different purposes in a real life context (e.g., measure a wall using feet, not inches).</i>	4.MD.A.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 a smaller unit. Record

<p>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), ...</p> <p>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.</p>	<p>4.ME.2f1 Complete a conversion table for length and mass within a single system.</p> <p>4.ME.1f3 Select appropriate units for measurement: mass, length, angles.</p> <p>4.ME.1g2 Solve word problems using perimeter and area where changes occur to the dimensions of a figure.</p>	<p>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), ...</p> <p>4.MD.A.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.</p>
<p><b>(Repeat) Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</b></p>	<p><b>(Repeat) Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.</b></p>	<p><b>Standard - SR.C.7 Understand concepts of Geometric measurement: involving perimeter, area, and volume.</b></p>
<p>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.</p>	<p>4.ME.1g2 Solve word problems using perimeter and area where changes occur to the dimensions of a figure.</p> <p>4.ME.2h1 Apply the formulas for area and perimeter to solve real world problems.</p>	<p>4.MD.A.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.</p>
<p><b>Represent and interpret data.</b></p>	<p><b>Represent and interpret data.</b></p>	<p><b>Standard - SR.C.6 Represent and interpret data.</b></p>
<p>4. Make a line plot to display a data set of measurements in fractions of a unit (<math>\frac{1}{2}</math>, <math>\frac{1}{4}</math>, <math>\frac{1}{8}</math>). 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.</p>	<p>No CCC developed for this standard.</p>	<p>4.MD.B.4: Make a line plot to display a data set of measurements in fractions of a unit (<math>\frac{1}{2}</math>, <math>\frac{1}{4}</math>, <math>\frac{1}{8}</math>). 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.</p>
<p><b>Geometric measurement: understand concepts of angle and measure angles.</b></p>	<p><b>Geometric measurement: understand concepts of angle and measure angles.</b></p>	<p><b>Standard - SR.C.8 Geometric measurement: understand concept of angle and measure angles.</b></p>
<p>5. Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:</p>	<p>No CCC developed for this standard.</p>	<p>4.MD.C.5: Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:</p>

<p>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 <math>\frac{1}{360}</math> of a circle is called a "one-degree angle," and can be used to measure angles.</p> <p>b. An angle that turns through <math>n</math> one-degree angles is said to have an angle measure of <math>n</math> degrees.</p> <p>6. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.</p> <p>7. Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.</p>	<p><i>4.ME.2e4 Select appropriate tool for measurement: mass, length, angles.</i></p> <p><i>4.ME.2e5 Construct a given angle.</i></p> <p><i>4.ME.2e6 Measure right angles using a tool (e.g., angle ruler, protractor).</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>4.Md.C.5a: 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 <math>\frac{1}{360}</math> of a circle is called a "one-degree angle," and can be used to measure angles.</p> <p>4.MD.C.5b: An angle that turns through <math>n</math> one-degree angles is said to have an angle measure of <math>n</math> degrees.</p> <p>4.MD.C.6: Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.</p> <p>4.MD.C.7: Recognize angle measure as additive. When an angle is decomposed into non-overlapping parts, the angle measure of the whole is the sum of the angle measures of the parts. Solve addition and subtraction problems to find unknown angles on a diagram in real world and mathematical problems, e.g., by using an equation with a symbol for the unknown angle measure.</p>
<p><b>Geometry</b> <span style="float: right;"><b>4.G</b></span></p>	<p><b>Geometry</b> <span style="float: right;"><b>4.G</b></span></p>	<p><b>Geometric Reasoning</b> <span style="float: right;"><b>GR</b></span></p>
<p><b>Draw and identify lines and angles, and classify shapes by properties of their lines and angles.</b></p>	<p><b>Draw and identify lines and angles, and classify shapes by properties of their lines and angles.</b></p>	<p><b>Standard - GR.C.3 Draw and identify lines and angles and classify shapes by properties of their lines and angles.</b></p>
<p>1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.</p>	<p><i>4.GM.1j1 Recognize a point, line and line segment, rays in two-dimensional figures.</i></p> <p><i>4.GM.1j2 Recognize perpendicular and parallel lines in two-dimensional figure.</i></p> <p><i>4.GM.1j3 Recognize an angle in two-dimensional figures.</i></p> <p><i>5.GM.1j1 Recognize parallel and perpendicular lines within the context of two-dimensional figures.</i></p>	<p>4.G.A.1: Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.</p>

<p>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.</p> <p>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.</p>	<p><i>4.GM.1h2 Classify two-dimensional shapes based on attributes (number of angles).</i></p> <p><i>4.GM.1j4 Categorize angles as right, acute, or obtuse.</i></p> <p><i>4.GM.1k1 Recognize a line of symmetry in a figure.</i></p>	<p>4.G.A.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.</p> <p>4.G.A.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.</p>
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<sup>1</sup>See Glossary, Table 2.

<sup>2</sup>Grade 4 expectations in this domain are limited to whole numbers less than or equal to 1,000,000.

<sup>3</sup>Grade 4 expectations in this domain are limited to fractions with denominators 2, 3, 4, 5, 6, 8, 10, 12, and 100.

<sup>4</sup>Students who can generate equivalent fractions can develop strategies for adding fractions with unlike denominators in general. But addition and subtraction with unlike denominators in general is not a requirement at this grade.

## Grade 5 Mathematics

### Operations and Algebraic Thinking

- Write and interpret numerical expressions.
- Analyze patterns and relationships.

### Number and Operations in Base Ten

- Understand the place value system.
- Perform operations with multi-digit whole numbers and with decimals to hundredths.

### Number and Operations—Fractions

- Use equivalent fractions as a strategy to add and subtract fractions.
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

### Measurement and Data

- Convert like measurement units within a given measurement system.
- Represent and interpret data.
- Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

### Geometry

- Graph points on the coordinate plane to solve real-world and mathematical problems.
- Classify two-dimensional figures into categories based on their properties.

Common Core State Standards	Core Content Connectors	Maine Learning Results
<p>In Grade 5, instructional time should focus on three critical areas: (1) developing fluency with addition and subtraction of fractions, and developing understanding of the multiplication of fractions and of division of fractions in limited cases (unit fractions divided by whole numbers and whole numbers divided by unit fractions); (2) extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operations; and (3) developing understanding of volume.</p> <p>(1) Students apply their understanding of fractions and fraction models to represent the addition and subtraction of fractions with unlike denominators as equivalent calculations with like denominators. They develop fluency in calculating sums and differences of fractions, and make reasonable estimates of them. Students also use the meaning of fractions, of multiplication and division, and the relationship between multiplication and division to understand and explain why the procedures for multiplying and dividing fractions make sense. (Note: this is limited to the case of dividing unit fractions by whole numbers and whole numbers by unit fractions.)</p> <p>(2) Students develop understanding of why division procedures work based on the meaning of base-ten numerals and properties of operations. They finalize fluency with multi-digit addition, subtraction, multiplication, and division. They apply their understandings of models for decimals, decimal notation, and properties of operations to add and subtract decimals to hundredths. They develop fluency in these computations, and make reasonable estimates of their results. Students use</p>		

<p>the relationship between decimals and fractions, as well as the relationship between finite decimals and whole numbers (i.e., a finite decimal multiplied by an appropriate power of 10 is a whole number), to understand and explain why the procedures for multiplying and dividing finite decimals make sense. They compute products and quotients of decimals to hundredths efficiently and accurately.</p> <p>(3) Students recognize volume as an attribute of three-dimensional space. They understand that volume can be measured by finding the total number of same-size units of volume required to fill the space without gaps or overlaps. They understand that a 1-unit by 1-unit by 1-unit cube is the standard unit for measuring volume. They select appropriate units, strategies, and tools for solving problems that involve estimating and measuring volume. They decompose three-dimensional shapes and find volumes of right rectangular prisms by viewing them as decomposed into layers of arrays of cubes. They measure necessary attributes of shapes in order to determine volumes to solve real world and mathematical problems.</p>		
<p><b>Operations and Algebraic Thinking</b>      <b>5.OA</b></p>	<p><b>Operations and Algebraic Thinking</b>      <b>5.OA</b></p>	<p><b>Algebraic Reasoning</b>      <b>AR</b></p>
<p><b>Write and interpret numerical expressions.</b></p>	<p><b>Write and interpret numerical expressions.</b></p>	<p><b>Standard - AR.C.7 Write and interpret numerical expressions.</b></p>
<p>1. Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.</p> <p>2. Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. <i>For example, express the calculation “add 8 and 7, then multiply by 2” as <math>2 \times (8 + 7)</math>. Recognize that <math>3 \times (18932 + 921)</math> is three times as large as <math>18932 +</math></i></p>	<p><i>5.SE.1a1 Given a real world problem, write an equation using 1 set of parentheses.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>5.OA.A.1: Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.</p> <p>5.OA.A.2: Write simple expressions that record calculations with numbers and interpret numerical expressions without evaluating them. <i>For example, express the calculation “add 8 and 7, then multiply by 2” as <math>2 \times (8 + 7)</math>. Recognize that <math>3 \times (18932 + 921)</math> is three times as large as <math>18932 +</math></i></p>

921, without having to calculate the indicated sum or product.		without having to calculate the indicated sum or product.
<b>Analyze patterns and relationships.</b>	<b>Analyze patterns and relationships.</b>	<b>Standard - AR.C.8 Identify, explain, generate and analyze patterns.</b>
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.PRF.1b1 Given 2 patterns involving the same context (e.g., collecting marbles) determine the first 5 terms and compare the values. 5.PRF.1b2 When given a line graph representing two arithmetic patterns, identify the relationship between the two. 5.PRF.2b1 Generate or select a comparison between two graphs from a similar situation. 5.NO.3b1 Use up to two rules to verify provided responses or select correct answers (e.g., rules: +3, +2 and table lists pairs, 4:5, 7:7, and 10:9).	5.OA.B.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.
<b>Number and Operations in Base Ten</b> <b>5.NBT</b>	<b>Number and Operations in Base Ten</b> <b>5.NBT</b>	<b>Quantitative Reasoning</b> <b>QR</b>
<b>Understand the place value system.</b>	<b>Understand the place value system.</b>	<b>Standard - QR.C.8 Understand the place value system.</b>
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.  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.  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., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times 1/1000$ .	No CCC developed for this standard.  6.NO.1i1 Identify what an exponent represents (e.g., $8^3 = 8 \times 8 \times 8$ ).  5.NO.1b1 Read, write, or select a decimal to the hundredths place. 5.NO.1b2 Read, write or select a decimal to the thousandths place. 5.NO.1b3 Compare two decimals to the thousandths place with a value of less than 1.	5.NBT.A.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.  5.NBT.A.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.NBT.A.3: Read, write, and compare decimals to thousandths.  5.NBT.A.3a: Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$ .

<p>b. Compare two decimals to thousandths based on meanings of the digits in each place, using <math>&gt;</math>, <math>=</math>, and <math>&lt;</math> symbols to record the results of comparisons.</p> <p>4. Use place value understanding to round decimals to any place.</p>	<p><i>5.NO.1b4 Round decimals to the next whole number.</i></p> <p><i>5.NO.1b5 Round decimals to the tenths place.</i></p> <p><i>5.NO.1b6 Round decimals to the hundredths place.</i></p>	<p>5.NBT.A.3b: Compare two decimals to thousandths based on meanings of the digits in each place, using <math>&gt;</math>, <math>=</math>, and <math>&lt;</math> symbols to record the results of comparisons.</p> <p>5.NBT.A.4: Use place value understanding to round decimals to any place.</p>
<p><b>Perform operations with multi-digit whole numbers and with decimals to hundredths.</b></p>	<p><b>Perform operations with multi-digit whole numbers and with decimals to hundredths.</b></p>	<p><b>Standard - QR.C.7 Use place value understanding and properties of operations to perform multi-digit arithmetic with whole numbers and decimals to hundredths.</b></p>
<p>5. Fluently multiply multi-digit whole numbers using the standard algorithm.</p> <p>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.</p> <p>7. Add, subtract, multiply, and divide decimals to hundredths, 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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>5.NO.2a3 Find whole number quotients up to two dividends and two divisors.</i></p> <p><i>5.NO.2a4 Find whole number quotients up to four dividends and two divisors.</i></p> <p><i>5.NO.2a5 Solve word problems that require multiplication or division.</i></p> <p><i>5.NO.2c1 Solve 1 step problems using decimals.</i></p>	<p>5.NBT.B.5: Fluently multiply multi-digit whole numbers using the standard algorithm.</p> <p>5.NBT.B.6: Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, 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.</p> <p>5.NBT.B.7: Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, money and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.</p>
<p><b>Number and Operations - Fractions</b>      <b>5.NF</b></p>	<p><b>Number and Operations - Fractions</b>      <b>5.NF</b></p>	<p><b>Quantitative Reasoning</b>      <b>QR</b></p>
<p><b>Use equivalent fractions as a strategy to add and subtract fractions.</b></p>	<p><b>Use equivalent fractions as a strategy to add and subtract fractions.</b></p>	<p><b>Standard - QR.C.11 Use equivalent fractions as a strategy to add and subtract fractions.</b></p>
<p>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</p>	<p><i>5.NO.2b1 Add and subtract fractions with unlike denominators by replacing fractions with equivalent fractions (identical denominators).</i></p>	<p>5.NF.A.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</p>

<p>difference of fractions with like denominators. <i>For example, <math>2/3 + 5/4 = 8/12 + 15/12 = 23/12</math>. (In general, <math>a/b + c/d = (ad + bc)/bd</math>.)</i></p> <p>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. <i>For example, recognize an incorrect result <math>2/5 + 1/2 = 3/7</math>, by observing that <math>3/7 &lt; 1/2</math>.</i></p>	<p><i>5.NO.2b2 Add or subtract fractions with unlike denominators.</i></p> <p><i>5.NO.2c2 Solve word problems involving the addition, subtraction, multiplication or division of fractions.</i></p>	<p>difference of fractions with like denominators. <i>For example, <math>2/3 + 5/4 = 8/12 + 15/12 = 23/12</math>. (In general, <math>a/b + c/d = (ad + bc)/bd</math>.)</i></p> <p>5.NF.A.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. <i>For example, recognize an incorrect result <math>2/5 + 1/2 = 3/7</math>, by observing that <math>3/7 &lt; 1/2</math>.</i></p>
<p><b>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</b></p>	<p><b>Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</b></p>	<p><b>Standard - QR.C.12 Apply and extend previous understandings of multiplication and division to multiply and divide fractions.</b> <i>Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But division of a fraction by a fraction is not a requirement at this grade.</i></p>
<p>3. Interpret a fraction as division of the numerator by the denominator (<math>a/b = a \div b</math>). 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. <i>For example, interpret <math>3/4</math> as the result of dividing 3 by 4, noting that <math>3/4</math> multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size <math>3/4</math>. 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?</i></p> <p>4. Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>5.NO.2b3 Multiply or divide fractions.</i></p>	<p>5.NF.B.3: Interpret a fraction as division of the numerator by the denominator (<math>a/b = a \div b</math>). 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. <i>For example, interpret <math>3/4</math> as the result of dividing 3 by 4, noting that <math>3/4</math> multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size <math>3/4</math>. 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?</i></p> <p>5.NF.B.4: Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.</p>

<p>a. Interpret the product <math>(a/b) \times q</math> as <math>a</math> parts of a partition of <math>q</math> into <math>b</math> equal parts; equivalently, as the result of a sequence of operations <math>a \times q \div b</math>. For example, use a visual fraction model to show <math>(2/3) \times 4 = 8/3</math>, and create a story context for this equation. Do the same with <math>(2/3) \times (4/5) = 8/15</math>. (In general, <math>(a/b) \times (c/d) = ac/bd</math>.)</p> <p>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.</p> <p>5. Interpret multiplication as scaling (resizing), by:</p> <p>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.</p> <p>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 than the given number; and relating the principle of fraction equivalence <math>a/b = (n \times a)/(n \times b)</math> to the effect of multiplying <math>a/b</math> by 1.</p> <p>6. Solve real world problems involving multiplication of fractions and mixed numbers,</p>	<p><i>5.PRF.1a1 Determine whether the product will increase or decrease based on the multiplier.</i></p> <p><i>5.PRF.1a2 Determine whether or not the quotient will increase or decrease based on the divisor.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>5.NF.B.4a: Interpret the product <math>(a/b) \times q</math> as <math>a</math> parts of a partition of <math>q</math> into <math>b</math> equal parts; equivalently, as the result of a sequence of operations <math>a \times q \div b</math>. For example, use a visual fraction model to show <math>(2/3) \times 4 = 8/3</math>, and create a story context for this equation. Do the same with <math>(2/3) \times (4/5) = 8/15</math>. (In general, <math>(a/b) \times (c/d) = (ac)/(bd)</math>.)</p> <p>5.NF.B.4b: 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.</p> <p>5.NF.B.5: Interpret multiplication scaling (resizing), by:</p> <p>5.NF.B.5a: 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.</p> <p>5.NF.B.5b: 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 than the given number; and relating the principle of fraction equivalence <math>a/b = (n \times a)/(n \times b)</math> to the effect of multiplying <math>a/b</math> by 1.</p> <p>5.NF.B.6: Solve real world problems involving multiplication of fractions and mixed numbers,</p>
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<p>e.g., by using visual fraction models or equations to represent the problem.</p> <p>7. Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.<sup>1</sup></p> <p>a. Interpret division of a unit fraction by a non-zero whole number and compute such quotients. <i>For example, create a story context for <math>(1/3) \div 4</math>, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that <math>(1/3) \div 4 = 1/12</math> because <math>(1/12) \times 4 = 1/3</math>.</i></p> <p>b. Interpret division of a whole number by a unit fraction, and compute such quotients. <i>For example, create a story context for <math>4 \div (1/5)</math>, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that <math>4 \div (1/5) = 20</math> because <math>20 \times (1/5) = 4</math>.</i></p> <p>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. <i>For example, how much chocolate will each person get if 3 people share <math>1/2</math> lb of chocolate equally? How many <math>1/3</math>-cup servings are in 2 cups of raisins?</i></p>	<p><i>6.NO.2c4 Solve word problems involving the addition, subtraction, multiplication or division of fractions.</i></p>	<p>e.g., by using visual fraction models or equations to represent the problem.</p> <p>5.NF.B.7: Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.</p> <p>5.NF.B.7a: Interpret division of a unit fraction by a non-zero whole number and compute such quotients. <i>For example, create a story context for <math>(1/3) \div 4</math>, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that <math>(1/3) \div 4 = 1/12</math> because <math>(1/12) \times 4 = 1/3</math>.</i></p> <p>5.NF.B.7b: Interpret division of a whole number by a unit fraction and compute such quotients. <i>For example, create a story context for <math>4 \div (1/5)</math>, and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that <math>4 \div (1/5) = 20</math> because <math>20 \times (1/5) = 4</math>.</i></p> <p>5.NF.B.7c: 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. <i>For example, how much chocolate will each person get if 3 people share <math>1/2</math> lb of chocolate equally? How many <math>1/3</math>-cup servings are in 2 cups of raisins?</i></p>
<p><b>Measurement and Data</b> <b>5.MD</b></p>	<p><b>Measurement and Data</b> <b>5.MD</b></p>	<p><b>Statistical Reasoning</b> <b>SR</b></p>
<p><b>Convert like measurement units within a given measurement system.</b></p>	<p><b>Convert like measurement units within a given measurement system.</b></p>	<p><b>Standard - SR.C.5 Solve problems involving measurement, conversion of measurement and estimation of intervals of time, liquid volumes, and masses of objects.</b></p>
<p>1. Convert among different-sized standard measurement units within a given measurement</p>	<p><i>5.ME.1b1 Convert measurements of time.</i></p>	<p>5.MD.A.1: Convert among different-sized standard measurement units within a given measurement</p>

<p>system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.</p>	<p><i>5.ME.1b2 Convert standard measurements of length.</i>  <i>5.ME.1b3 Convert standard measurements of mass.</i>  <i>5.ME.2a1 Solve problems involving conversions of standard measurement units when finding area, volume, time lapse, or mass.</i></p>	<p>system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.</p>
<p><b>Represent and interpret data.</b></p>	<p><b>Represent and interpret data.</b></p>	<p><b>Standard - SR.C.6 Represent and interpret data.</b></p>
<p>2. Make a line plot to display a data set of measurements in fractions of a unit (<math>\frac{1}{2}</math>, <math>\frac{1}{4}</math>, <math>\frac{1}{8}</math>). Use operations on fractions for this grade to solve problems involving information presented in line plots. <i>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.</i></p>	<p><i>5.DPS.1c1 Collect and graph data: bar graph, line plots, picture graph (e.g., average height among 3 classrooms, # of boys and girls).</i></p>	<p>5.MD.B.2: Make a line plot to display a data set of measurements in fractions of a unit (<math>\frac{1}{2}</math>, <math>\frac{1}{4}</math>, <math>\frac{1}{8}</math>). Use operations on fractions for this grade to solve problems involving information presented in line plots. <i>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.</i></p>
<p><b>Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.</b></p>	<p><b>Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.</b></p>	<p><b>Standard - SR.C.7 Understand concepts of Geometric measurement: involving perimeter, area, and volume.</b></p>
<p>3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement.</p> <p>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.</p> <p>b. A solid figure which can be packed without gaps or overlaps using <math>n</math> unit cubes is said to have a volume of <math>n</math> cubic units.</p> <p>4. Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>5.ME.2b1 Use filling and multiplication to determine volume.</i></p>	<p>5.MD.C.3: Recognize volume as an attribute of solid figures and understand concepts of volume measurement.</p> <p>5.MD.C.3a: 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.</p> <p>5.MD.C.3b: A solid figure which can be packed without gaps or overlaps using <math>n</math> unit cubes is said to have a volume of <math>n</math> cubic units.</p> <p>5.MD.C.4: Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and non-standard units.</p>

<p>5. Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.</p> <p>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.</p> <p>b. Apply the formulas <math>V = l \times w \times h</math> and <math>V = b \times h</math> 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.</p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>5.ME.2b2 Apply formula to solve one step problems involving volume.</i></p>	<p>5.MD.C.5: Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume. When finding volumes of objects answers will be in cubic units.</p> <p>5.MD.C.5a: Find the volume of a right rectangular prism with whole-number edge 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.</p> <p>5.MD.C.5b: Apply the formulas <math>V = l \times w \times h</math> and <math>V = B \times h</math> (where <math>B</math> stands for the area of the base) 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.</p> <p>5.MD.C.5c: 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.</p>
<p><b>Geometry</b> <b>5.G</b></p>	<p><b>Geometry</b> <b>5.G</b></p>	<p><b>Geometric Reasoning</b> <b>GR</b></p>
<p><b>Graph points on the coordinate plane to solve real-world and mathematical problems.</b></p>	<p><b>Graph points on the coordinate plane to solve real-world and mathematical problems.</b></p>	<p><b>Standard - GR.C.4 Graph points on the coordinate plane to solve real-world and mathematical problems.</b></p>
<p>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</p>	<p><i>5.GM.1c1 Locate the x and y axis on a graph.</i>  <i>5.GM.1c2 Locate points on a graph.</i>  <i>5.GM.1c3 Use order pairs to graph given points.</i></p>	<p>5.G.A.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</p>

<p>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., <math>x</math>-axis and <math>x</math>-coordinate, <math>y</math>-axis and <math>y</math>-coordinate).</p> <p>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.</p>	<p><i>6.GM.1c6 Find coordinate values of points in the context of a situation.</i></p>	<p>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., <math>x</math>-axis and <math>x</math>-coordinate, <math>y</math>-axis and <math>y</math>-coordinate).</p> <p>5.G.A.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.</p>
<p><b>Classify two-dimensional figures into categories based on their properties.</b></p>	<p><b>Classify two-dimensional figures into categories based on their properties.</b></p>	<p><b>Standard - GR.C.2 Analyze, compare, create, and compose shapes based on their attributes.</b></p>
<p>3. Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. <i>For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.</i></p> <p>4. Classify two-dimensional figures in a hierarchy based on properties.</p>	<p><i>5.GM.1a1 Recognize properties of simple plane figures.</i></p> <p><i>5.GM.1b1 Distinguish plane figures by their properties.</i></p>	<p>5.G.B.3: Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. <i>For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.</i></p> <p>5.G.B.4: Classify two-dimensional figures in a hierarchy based on properties. (e.g., all rectangles are parallelograms, because they are all quadrilaterals with two pairs of opposite sides parallel.)</p>

<sup>1</sup>Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But division of a fraction by a fraction is not a requirement at this grade.

### Grade Span 6-8 Mathematics

**\*Mathematics in grades 6-8 have been consolidated into a grade span. While the CCSS and CCC break standards out into grade levels, the MLR focus on a grade span. Due to courses and the structure of teaching mathematics, the Maine Learning Results do not designate the grade at which the standard is taught, rather performance expectations show what the standard looks like across the grade span.**

#### Grade 6 Overview

##### Ratios and Proportional Relationships

- Understand ratio concepts and use ratio reasoning to solve problems.

##### The Number System

- Apply and extend previous understandings of multiplication and division to divide fractions by fractions.

- Compute fluently with multi-digit numbers and find common factors and multiples.
- Apply and extend previous understandings of numbers to the system of rational numbers.

#### **Expressions and Equations**

- Apply and extend previous understandings of arithmetic to algebraic expressions.
- Reason about and solve one-variable equations and inequalities.
- Represent and analyze quantitative relationships between dependent and independent variables.

#### **Geometry**

- Solve real-world and mathematical problems involving area, surface area, and volume.

#### **Statistics and Probability**

- Develop understanding of statistical variability.
- Summarize and describe distributions.

### **Grade 7 Overview**

#### **Ratios and Proportional Relationships**

- Analyze proportional relationships and use them to solve real-world and mathematical problems.

#### **The Number System**

- Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.

#### **Expressions and Equations**

- Use properties of operations to generate equivalent expressions.
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

#### **Geometry**

- Draw, construct and describe geometrical figures and describe the relationships between them.
- Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.

#### **Statistics and Probability**

- Use random sampling to draw inferences about a population.
- Draw informal comparative inferences about two populations.
- Investigate chance processes and develop, use, and evaluate probability models.

### **Grade 8 Overview**

#### **The Number System**

- Know that there are numbers that are not rational, and approximate them by rational numbers.

#### **Expressions and Equations**

- Work with radicals and integer exponents.
- Understand the connections between proportional relationships, lines, and linear equations.
- Analyze and solve linear equations and pairs of simultaneous linear equations.

#### **Functions**

- Define, evaluate, and compare functions.
- Use functions to model relationships between quantities.

**Geometry**

- Understand congruence and similarity using physical models, transparencies, or geometry software.
- Understand and apply the Pythagorean Theorem.
- Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.

**Statistics and Probability**

- Investigate patterns of association in bivariate data.

Common Core State Standards	Core Content Connectors	Maine Learning Results
<p><b>Mathematics   Grade 6</b></p> <p>In Grade 6, instructional time should focus on four critical areas: (1) connecting ratio and rate to whole number multiplication and division and using concepts of ratio and rate to solve problems; (2) completing understanding of division of fractions and extending the notion of number to the system of rational numbers, which includes negative numbers; (3) writing, interpreting, and using expressions and equations; and (4) developing understanding of statistical thinking.</p> <p>(1) Students use reasoning about multiplication and division to solve ratio and rate problems about quantities. By viewing equivalent ratios and rates as deriving from, and extending, pairs of rows (or columns) in the multiplication table, and by analyzing simple drawings that indicate the relative size of quantities, students connect their understanding of multiplication and division with ratios and rates. Thus students expand the scope of problems for which they can use multiplication and division to solve problems, and they connect ratios and fractions. Students solve a wide variety of problems involving ratios and rates.</p> <p>(2) Students use the meaning of fractions, the meanings of multiplication and division, and the relationship between multiplication and division to</p>		

understand and explain why the procedures for dividing fractions make sense. Students use these operations to solve problems. Students extend their previous understandings of number and the ordering of numbers to the full system of rational numbers, which includes negative rational numbers, and in particular negative integers. They reason about the order and absolute value of rational numbers and about the location of points in all four quadrants of the coordinate plane.

(3) Students understand the use of variables in mathematical expressions. They write expressions and equations that correspond to given situations, evaluate expressions, and use expressions and formulas to solve problems. Students understand that expressions in different forms can be equivalent, and they use the properties of operations to rewrite expressions in equivalent forms. Students know that the solutions of an equation are the values of the variables that make the equation true. Students use properties of operations and the idea of maintaining the equality of both sides of an equation to solve simple one-step equations. Students construct and analyze tables, such as tables of quantities that are in equivalent ratios, and they use equations (such as  $3x = y$ ) to describe relationships between quantities.

(4) Building on and reinforcing their understanding of number, students begin to develop their ability to think statistically. Students recognize that a data distribution may not have a definite center and that different ways to measure center yield different values. The median measures center in the sense that it is roughly the middle value. The mean measures center in the sense that it is the value that each data point would take on if the total of the data values were redistributed equally,

and also in the sense that it is a balance point. Students recognize that a measure of variability (interquartile range or mean absolute deviation) can also be useful for summarizing data because two very different sets of data can have the same mean and median yet be distinguished by their variability. Students learn to describe and summarize numerical data sets, identifying clusters, peaks, gaps, and symmetry, considering the context in which the data were collected. Students in Grade 6 also build on their work with area in elementary school by reasoning about relationships among shapes to determine area, surface area, and volume. They find areas of right triangles, other triangles, and special quadrilaterals by decomposing these shapes, rearranging or removing pieces, and relating the shapes to rectangles. Using these methods, students discuss, develop, and justify formulas for areas of triangles and parallelograms. Students find areas of polygons and surface areas of prisms and pyramids by decomposing them into pieces whose area they can determine. They reason about right rectangular prisms with fractional side lengths to extend formulas for the volume of a right rectangular prism to fractional side lengths. They prepare for work on scale drawings and constructions in Grade 7 by drawing polygons in the coordinate plane.

### **Mathematics | Grade 7**

In Grade 7, instructional time should focus on four critical areas: (1) developing understanding of and applying proportional relationships; (2) developing understanding of operations with rational numbers and working with expressions and linear equations; (3) solving problems involving scale drawings and informal geometric constructions, and working with two- and three-dimensional shapes to solve problems involving area, surface

area, and volume; and (4) drawing inferences about populations based on samples.

(1) Students extend their understanding of ratios and develop understanding of proportionality to solve single- and multi-step problems. Students use their understanding of ratios and proportionality to solve a wide variety of percent problems, including those involving discounts, interest, taxes, tips, and percent increase or decrease. Students solve problems about scale drawings by relating corresponding lengths between the objects or by using the fact that relationships of lengths within an object are preserved in similar objects. Students graph proportional relationships and understand the unit rate informally as a measure of the steepness of the related line, called the slope. They distinguish proportional relationships from other relationships.

(2) Students develop a unified understanding of number, recognizing fractions, decimals (that have a finite or a repeating decimal representation), and percents as different representations of rational numbers. Students extend addition, subtraction, multiplication, and division to all rational numbers, maintaining the properties of operations and the relationships between addition and subtraction, and multiplication and division. By applying these properties, and by viewing negative numbers in terms of everyday contexts (e.g., amounts owed or temperatures below zero), students explain and interpret the rules for adding, subtracting, multiplying, and dividing with negative numbers. They use the arithmetic of rational numbers as they formulate expressions and equations in one variable and use these equations to solve problems.

(3) Students continue their work with area from Grade 6, solving problems involving the area and circumference of a circle and surface area of three-dimensional objects. In preparation for work on congruence and similarity in Grade 8 they reason about relationships among two-dimensional figures using scale drawings and informal geometric constructions, and they gain familiarity with the relationships between angles formed by intersecting lines. Students work with three-dimensional figures, relating them to two-dimensional figures by examining cross-sections. They solve real-world and mathematical problems involving area, surface area, and volume of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes and right prisms.

(4) Students build on their previous work with single data distributions to compare two data distributions and address questions about differences between populations. They begin informal work with random sampling to generate data sets and learn about the importance of representative samples for drawing inferences.

### **Mathematics | Grade 8**

In Grade 8, instructional time should focus on three critical areas: (1) formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations; (2) grasping the concept of a function and using functions to describe quantitative relationships; (3) analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.

(1) Students use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. Students recognize equations for proportions ( $y/x = m$  or  $y = mx$ ) as special linear equations ( $y = mx + b$ ), understanding that the constant of proportionality ( $m$ ) is the slope, and the graphs are lines through the origin. They understand that the slope ( $m$ ) of a line is a constant rate of change, so that if the input or  $x$ -coordinate changes by an amount  $A$ , the output or  $y$ -coordinate changes by the amount  $m \cdot A$ . Students also use a linear equation to describe the association between two quantities in bivariate data (such as arm span vs. height for students in a classroom). At this grade, fitting the model, and assessing its fit to the data are done informally. Interpreting the model in the context of the data requires students to express a relationship between the two quantities in question and to interpret components of the relationship (such as slope and  $y$ -intercept) in terms of the situation. Students strategically choose and efficiently implement procedures to solve linear equations in one variable, understanding that when they use the properties of equality and the concept of logical equivalence, they maintain the solutions of the original equation. Students solve systems of two linear equations in two variables and relate the systems to pairs of lines in the plane; these intersect, are parallel, or are the same line. Students use linear equations, systems of linear equations, linear functions, and their understanding of slope of a line to analyze situations and solve problems.

(2) Students grasp the concept of a function as a rule that assigns to each input exactly one output. They understand that functions describe situations where one quantity determines another. They can translate among representations and partial

<p>representations of functions (noting that tabular and graphical representations may be partial representations), and they describe how aspects of the function are reflected in the different representations.</p> <p>(3) Students use ideas about distance and angles, how they behave under translations, rotations, reflections, and dilations, and ideas about congruence and similarity to describe and analyze two-dimensional figures and to solve problems. Students show that the sum of the angles in a triangle is the angle formed by a straight line, and that various configurations of lines give rise to similar triangles because of the angles created when a transversal cuts parallel lines. Students understand the statement of the Pythagorean Theorem and its converse, and can explain why the Pythagorean Theorem holds, for example, by decomposing a square in two different ways. They apply the Pythagorean Theorem to find distances between points on the coordinate plane, to find lengths, and to analyze polygons. Students complete their work on volume by solving problems involving cones, cylinders, and spheres.</p>		
<p><b>Ratios and Proportional Relationships</b>      <b>RP</b></p>	<p><b>Ratios and Proportional Relationships</b>      <b>RP</b></p>	<p><b>Quantitative Reasoning</b>      <b>QR</b></p>
<p><b>Understand ratio concepts and use ratio reasoning to solve problems.</b></p>	<p><b>Understand ratio concepts and use ratio reasoning to solve problems.</b></p>	<p><b>Standard - QR.EA.1 Understand ratio and rate concepts and use ratio and rate reasoning to solve problems.</b></p>
<p>6.RP.1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. <i>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."</i></p> <p>6.RP.2. Understand the concept of a unit rate <math>a/b</math> associated with a ratio <math>a:b</math> with <math>b \neq 0</math>, and use rate</p>	<p><i>6.NO.1f2 Write or select a ratio to match a given statement and representation.</i></p> <p><i>6.NO.1f31 Select or make a statement to interpret a given ratio.</i></p> <p><i>6.PRF.1c1 Describe the ratio relationship between two quantities for a given situation.</i></p> <p><i>6.PRF.2b3 Complete a statement that describes the ratio relationship between two quantities.</i></p> <p><i>6.PRF.1c2 Represent proportional relationships on a line graph.</i></p>	<p>6.RP.A.1: Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. <i>For example, "The ratio of wings to beaks of the chickadees in the pine tree was 2:1, because for every 2 wings there was 1 beak." "For every vote candidate A received, candidate C received nearly three votes."</i></p> <p>6.RP.A.2: Understand the concept of a unit rate <math>a/b</math> associated with a ratio <math>a:b</math> with <math>b \neq 0</math> and use</p>

<p>language in the context of a ratio relationship. <i>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."</i><sup>1</sup></p> <p>6.RP.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.</p> <p>6.RP.3.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.</p> <p>6.RP.3.b. Solve unit rate problems including those involving unit pricing and constant speed. <i>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?</i></p> <p>6.RP.3.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.</p> <p>6.RP.3.d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.</p>	<p>6.PRF.2b4 <i>Determine the unit rate in a variety of contextual situations.</i></p> <p>6.NO.1f4 <i>Find a missing value (representations, whole numbers, common fractions, decimals to hundredths place, percent) for a given ratio.</i></p> <p>6.PRF.2b5 <i>Use ratios and reasoning to solve real-world mathematical problems (e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations).</i></p> <p>6.NO.1f5 <i>Solve unit rate problems involving unit pricing.</i></p> <p>6.ME.2a2 <i>Solve one-step real world measurement problems involving unit rates with ratios of whole numbers when given the unit rate (3 inches of snow falls per hour, how much in 6 hours).</i></p> <p>6.NO.1f1 <i>Calculate a percent of a quantity as rate per 100.</i></p> <p>6.ME.1b4 <i>Complete a conversion table for length, mass, time, volume.</i></p> <p>6.ME.1b5 <i>Analyze table to answer questions.</i></p>	<p>rate language in the context of a ratio relationship. <i>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 5 lobsters, which is a rate of \$15 per lobster." Expectations for unit rates in this grade are limited to non-complex fractions.</i></p> <p>6.RP.A.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.</p> <p>6.RP.A.3a: 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.</p> <p>6.RP.A.3b: Solve unit rate problems including those involving unit pricing and constant speed. <i>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?</i></p> <p>6.RP.A.3c: 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.</p> <p>6.RP.A.3d: Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.</p>
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Analyze proportional relationships and use them to solve real-world and mathematical problems.	Analyze proportional relationships and use them to solve real-world and mathematical problems.	Standard - QR.EA.2 Analyze proportional relationships and use them to solve real-world and mathematical problems.
<p>7.RP.1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. <i>For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction <math>\frac{1/2}{1/4}</math> miles per hour, equivalently 2 miles per hour.</i></p> <p>7.RP.2. Recognize and represent proportional relationships between quantities.</p> <p>7.RP.2.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.</p> <p>7.RP.2.b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.</p> <p>7.RP.2.c. Represent proportional relationships by equations. <i>For example, if total cost <math>t</math> is proportional to the number <math>n</math> of items purchased at a constant price <math>p</math>, the relationship between the total cost and the number of items can be expressed as <math>t = pn</math>.</i></p> <p>7.RP.2.d. Explain what a point <math>(x, y)</math> on the graph of a proportional relationship means in terms of the situation, with special attention to the points <math>(0, 0)</math> and <math>(1, r)</math> where <math>r</math> is the unit rate.</p> <p>7.RP.3. Use proportional relationships to solve multistep ratio and percent problems. Examples:</p>	<p>7.NO.2f3 <i>Find unit rates given a ratio.</i></p> <p>7.PRF.1e1 <i>Determine unit rates associated with ratios of lengths, areas, and other quantities measured in like units.</i></p> <p>7.ME.2e2 <i>Solve one step problems involving unit rates associated with ratios of fractions.</i></p> <p>7.NO.2f1 <i>Identify the proportional relationship between two quantities.</i></p> <p>7.NO.2f2 <i>Determine if two quantities are in a proportional relationship using a table of equivalent ratios or points graphed on a coordinate plane.</i></p> <p>7.PRF.1e2 <i>Represent proportional relationships on a line graph.</i></p> <p>7.NO.2f4 <i>Use a rate of change or proportional relationship to determine the points on a coordinate plane.</i></p> <p>7.NO.2f5 <i>Use proportions to solve ratio problems.</i></p> <p>7.NO.2f6 <i>Solve word problems involving ratios.</i></p>	<p>7.RP.A.1: Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. <i>For example, if a person walks 1/2 mile in each 1/4 hour, compute the unit rate as the complex fraction <math>\frac{1/2}{1/4}</math> miles per hour, equivalently 2 miles per hour.</i></p> <p>7.RP.A.2: Recognize and represent proportional relationships between quantities.</p> <p>7.RP.A.2a: 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.</p> <p>7.RP.A.2b: Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.</p> <p>7.RP.A.2c: Represent proportional relationships by equations. <i>For example, if the total cost <math>t</math> is proportional to the number <math>n</math> of items purchased at a constant price <math>p</math>, the relationship between the total cost and the number of items can be expressed as <math>t = pn</math>.</i></p> <p>7.RP.A.2d: Explain what a point <math>(x, y)</math> on the graph of a proportional relationship means in terms of the situation, with special attention to the points <math>(0, 0)</math> and <math>(1, r)</math> where <math>r</math> is the unit rate.</p> <p>7.RP.A.3: Use proportional relationships to solve multistep ratio, rate, and percent problems.</p>

<p>simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.</p>	<p>7.NO.2h 1 Find percents in real world contexts. 7.NO.2h2 Solve one step percentage increase and decrease problems 7.PRF.1f1 Use proportional relationships to solve multistep percent problems.</p>	<p>Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.</p>
<p><b>The Number System</b> <span style="float: right;">NS</span></p>	<p><b>The Number System</b> <span style="float: right;">NS</span></p>	<p><b>Quantitative Reasoning</b> <span style="float: right;">QR</span></p>
<p><b>Apply and extend previous understandings of multiplication and division to divide fractions by fractions.</b></p>	<p><b>Apply and extend previous understandings of multiplication and division to divide fractions by fractions.</b></p>	<p><b>Standard - QR.EA.3 Apply and extend previous understandings of operations with whole numbers to rational numbers.</b></p>
<p>6.NS.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. <i>For example, create a story context for <math>(2/3) \div (3/4)</math> and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that <math>(2/3) \div (3/4) = 8/9</math> because <math>3/4</math> of <math>8/9</math> is <math>2/3</math>. (In general, <math>(a/b) \div (c/d) = ad/bc</math>.) How much chocolate will each person get if 3 people share <math>1/2</math> lb of chocolate equally? How many <math>3/4</math>-cup servings are in <math>2/3</math> of a cup of yogurt? How wide is a rectangular strip of land with length <math>3/4</math> mi and area <math>1/2</math> square mi?</i></p>	<p>6.NO.2c3 Solve one step, addition, subtraction, multiplication, or division problems with fractions or decimals.</p>	<p>6.NS.A.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/or equations to represent the problem. <i>For example, create a story context for <math>(2/3) \div (3/4)</math> and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that <math>(2/3) \div (3/4) = 8/9</math> because <math>3/4</math> of <math>8/9</math> is <math>2/3</math>. (In general, <math>(a/b) \div (c/d) = ad/bc</math>.)</i></p>
<p><b>Compute fluently with multi-digit numbers and find common factors and multiples.</b></p>	<p><b>Compute fluently with multi-digit numbers and find common factors and multiples.</b></p>	<p><b>Standard - QR.EA.4 Compute fluently with multi-digit whole numbers and find common factors and multiples.</b></p>
<p>6.NS.2. Fluently divide multi-digit numbers using the standard algorithm.</p> <p>6.NS.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. <i>For example, express <math>36 + 8</math> as <math>4(9 + 2)</math>.</i></p>	<p>No CCC developed for this standard.</p> <p>No CCC developed for this standard.</p>	<p>6.NS.B.2: Fluently divide multi-digit numbers using the standard algorithm.</p> <p>6.NS.B.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. <i>(For example: Use prime factorization to find the greatest common factor); 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 relatively prime numbers. For example, express <math>36 + 8</math> as <math>4(9 + 2)</math>.</i></p>

<b>(Repeat) Compute fluently with multi-digit numbers and find common factors and multiples.</b>	<b>(Repeat) Compute fluently with multi-digit numbers and find common factors and multiples.</b>	<b>(Repeat) Standard - QR.EA.3 Apply and extend previous understandings of operations with whole numbers to rational numbers.</b>
6.NS.3. Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.	<i>No CCC developed for this standard.</i>	6.NS.B.3: Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.
<b>Apply and extend previous understandings of numbers to the system of rational numbers.</b>	<b>Apply and extend previous understandings of numbers to the system of rational numbers.</b>	<b>Standard - QR.EA.5 Apply and extend previous understandings of numbers to the system of rational numbers.</b>
<p>6.NS.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.</p> <p>6.NS.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 with negative number coordinates.</p> <p>6.NS.6.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., <math>-(-3) = 3</math>, and that 0 is its own opposite.</p> <p>6.NS.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.</p>	<p><i>6.NO.1d4 Select the appropriate meaning of a negative number in a real world situation.</i></p> <p><i>6.NO.1d1 Identify numbers as positive or negative.</i></p> <p><i>6.NO.1d2 Locate and plot positive and negative numbers on a number line.</i></p> <p><i>6.NO.2e1 Determine the difference between two integers using a number line.</i></p> <p><i>6.NO.1d5 Find given points between -10 and 10 on both axis of a coordinate plane.</i></p> <p><i>6.NO.1d6 Label points between -10 and 10 on both axis of a coordinate plane.</i></p>	<p>6.NS.C.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 rational numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.</p> <p>6.NS.C.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 with negative number coordinates.</p> <p>6.NS.C.6a: 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., <math>-(-3) = 3</math>, and that 0 is its own opposite.</p> <p>6.NS.C.6b: 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.</p>

<p>6.NS.6.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.</p> <p>6.NS.7. Understand ordering and absolute value of rational numbers.</p> <p>6.NS.7.a. Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. <i>For example, interpret <math>-3 &gt; -7</math> as a statement that <math>-3</math> is located to the right of <math>-7</math> on a number line oriented from left to right.</i></p> <p>6.NS.7.b. Write, interpret, and explain statements of order for rational numbers in real-world contexts. <i>For example, write <math>-3^{\circ}\text{C} &gt; -7^{\circ}\text{C}</math> to express the fact that <math>-3^{\circ}\text{C}</math> is warmer than <math>-7^{\circ}\text{C}</math>.</i></p> <p>6.NS.7.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 situation. <i>For example, for an account balance of <math>-30</math> dollars, write <math> -30  = 30</math> to describe the size of the debt in dollars.</i></p> <p>6.NS.7.d. Distinguish comparisons of absolute value from statements about order. <i>For example, recognize that an account balance less than <math>-30</math> dollars represents a debt greater than 30 dollars.</i></p> <p>6.NS.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</p>	<p>6.NO.2e2 Compare two numbers on a number line (e.g., <math>-2 &gt; -9</math>).</p> <p>6.NO.1e1 Determine the absolute value of a rational number.</p> <p>No CCC developed for this standard.</p>	<p>6.NS.C.6c: 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.</p> <p>6.NS.C.7: Understand ordering and absolute value of rational numbers.</p> <p>6.NS.C.7a: Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. <i>For example, interpret <math>-3 &gt; -7</math> as a statement that <math>-3</math> is located to the right of <math>-7</math> on a number line oriented from left to right.</i></p> <p>6.NS.C.7b: Write, interpret, and explain statements of order for rational numbers in real-world contexts. <i>For example, write <math>-3^{\circ}\text{C} &gt; -7^{\circ}\text{C}</math> to express the fact that <math>-3^{\circ}\text{C}</math> is warmer than <math>-7^{\circ}\text{C}</math>.</i></p> <p>6.NS.C.7c: 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 situation. <i>For example, for an account balance of <math>-30</math> dollars, write <math> -30  = 30</math> to describe the size of the debt in dollars.</i></p> <p>6.NS.C.7d: Distinguish comparisons of absolute value from statements about order. <i>For example, recognize that an account balance less than <math>-30</math> dollars represents a debt greater than 30 dollars.</i></p> <p>6.NS.C.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</p>
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points with the same first coordinate or the same second coordinate.		points with the same first coordinate or the same second coordinate.
<b>Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.</b>	<b>Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.</b>	<b>(Repeat) Standard - QR.EA.3 Apply and extend previous understandings of operations with whole numbers to rational numbers.</b>
<p>7.NS.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.</p> <p>7.NS.1.a. Describe situations in which opposite quantities combine to make 0. <i>For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.</i></p> <p>7.NS.1.b. Understand <math>p + q</math> as the number located a distance <math> q </math> from <math>p</math>, in the positive or negative direction depending on whether <math>q</math> 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.</p> <p>7.NS.1.c. Understand subtraction of rational numbers as adding the additive inverse, <math>p - q = p + (-q)</math>. 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.</p> <p>7.NS.1.d. Apply properties of operations as strategies to add and subtract rational numbers.</p> <p>7.NS.2. Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.</p>	<p><i>7.NO.1g1 Identify the additive inverse of a number (e.g., -3 and +3).</i></p> <p><i>7.NO.1g2 Identify the difference between two given numbers on a number line using absolute value.</i></p> <p><i>7.NO.2i1 Solve multiplication problems with positive/negative numbers.</i></p> <p><i>7.NO.2i2 Solve division problems with positive/negative numbers.</i></p>	<p>7.NS.A.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.</p> <p>7.NS.A.1a: Describe situations in which opposite quantities combine to make 0. <i>For example, a hydrogen atom has a zero charge because its two constituents are oppositely charged.</i></p> <p>7.NS.A.1b: Understand <math>p + q</math> as the number located a distance <math> q </math> from <math>p</math>, in the positive or negative direction depending on whether <math>q</math> 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.</p> <p>7.NS.A.1c: Understand subtraction of rational numbers as adding the additive inverse, <math>p - q = p + (-q)</math>. 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.</p> <p>7.NS.A.1d: Apply properties of operations as strategies to add and subtract rational numbers.</p> <p>7.NS.A.2: Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.</p>

<p>7.NS.2.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 <math>(-1)(-1) = 1</math> and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.</p> <p>7.NS.2.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 <math>p</math> and <math>q</math> are integers, then <math>-(p/q) = (-p)/q = p/(-q)</math>. Interpret quotients of rational numbers by describing real-world contexts.</p> <p>7.NS.2.c. Apply properties of operations as strategies to multiply and divide rational numbers.</p> <p>7.NS.2.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.</p> <p>7.NS.3. Solve real-world and mathematical problems involving the four operations with rational numbers.<sup>2</sup></p>	<p><i>No CCC developed for this standard.</i></p>	<p>7.NS.A.2a: 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 <math>(-1)(-1) = 1</math> and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.</p> <p>7.NS.A.2b: 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 <math>p</math> and <math>q</math> are integers, then <math>-(p/q) = (-p)/q = p/(-q)</math>. Interpret quotients of rational numbers by describing real-world contexts.</p> <p>7.NS.A.2c: Apply properties of operations as strategies to multiply and divide rational numbers.</p> <p>7.NS.A.2d: 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.</p> <p>7.NS.A.3: Solve real-world and mathematical problems involving the four operations with rational numbers. <i>Computations with rational numbers extend the rules for manipulating fractions to complex fractions.</i></p>
<p><b>Know that there are numbers that are not rational, and approximate them by rational numbers.</b></p>	<p><b>Know that there are numbers that are not rational, and approximate them by rational numbers.</b></p>	<p><b>Standard - QR.EA.6 Know that there are numbers that are not rational, and approximate them by rational numbers.</b></p>
<p>8.NS.1. Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal</p>	<p><i>No CCC developed for this standard.</i></p>	<p>8.NS.A.1: Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansions terminate in 0s or eventually repeats</p>

<p>expansion which repeats eventually into a rational number.</p> <p>8.NS.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., <math>\pi^2</math>). For example, by truncating the decimal expansion of <math>\sqrt{2}</math>, show that <math>\sqrt{2}</math> is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.</p>	<p><i>8.NO.1k1 Identify <math>\pi</math> as an irrational number.</i></p> <p><i>8.NO.1k2 Round irrational numbers to the hundredths place.</i></p> <p><i>8.NO.1k3 Use approximations of irrational numbers to locate them on a number line.</i></p>	<p>and convert a decimal expansion into a rational number.</p> <p>8.NS.A.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., <math>\pi^2</math>). For example, by truncating the decimal expansion of <math>\sqrt{2}</math>, show that <math>\sqrt{2}</math> is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.</p>
<p><b>Expressions and Equations</b> <span style="float: right;"><b>EE</b></span></p>	<p><b>Expressions and Equations</b> <span style="float: right;"><b>EE</b></span></p>	<p><b>Algebraic Reasoning</b> <span style="float: right;"><b>AR</b></span></p>
<p><b>Apply and extend previous understandings of arithmetic to algebraic expressions.</b></p>	<p><b>Apply and extend previous understandings of arithmetic to algebraic expressions.</b></p>	<p><b>Standard - AR.EA.1 Apply and extend previous understandings of arithmetic to algebraic expressions.</b></p>
<p>6.EE.1. Write and evaluate numerical expressions involving whole-number exponents.</p> <p>6.EE.2. Write, read, and evaluate expressions in which letters stand for numbers.</p> <p>6.EE.2.a. Write expressions that record operations with numbers and with letters standing for numbers. For example, express the calculation "Subtract <math>y</math> from 5" as <math>5 - y</math>.</p> <p>6.EE.2.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 <math>2(8 + 7)</math> as a product of two factors; view <math>(8 + 7)</math> as both a single entity and a sum of two terms.</p> <p>6.EE.2.c. Evaluate expressions at specific values of their variables. Include expressions that</p>	<p><i>6.NO.1i1 Identify what an exponent represents (e.g., <math>8^3 = 8 \times 8 \times 8</math>).</i></p> <p><i>6.NO.1i2 Solve numerical expressions involving whole number exponents.</i></p> <p><i>6.SE.1a2 Given a real world problem, write an equation using 1 set of parentheses.</i></p>	<p>6.EE.A.1: Write and evaluate numerical expressions involving whole-number exponents.</p> <p>6.EE.A.2: Write, read, and evaluate expressions in which letters represent numbers.</p> <p>6.EE.A.2a: Write expressions that record operations with numbers and with letters representing numbers. For example, express the calculation "Subtract <math>y</math> from 5" as <math>5 - y</math>.</p> <p>6.EE.A.2b: Identify parts of an expression using mathematical terms (including but not limited to: sum, term, product, factor, quotient, coefficient, variable, constant); view one or more parts of an expression as a single entity. For example, describe the expression <math>2(x + 7)</math> as a product of two factors; view <math>(x + 7)</math> as both a single entity and a sum of two terms.</p> <p>6.EE.A.2c: Evaluate expressions at specific values of their variables. Include expressions</p>

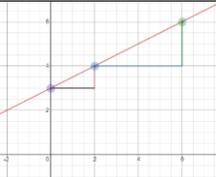
<p>arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). <i>For example, use the formulas <math>V = s^3</math> and <math>A = 6s^2</math> to find the volume and surface area of a cube with sides of length <math>s = 1/2</math>.</i></p> <p>6.EE.3. Apply the properties of operations to generate equivalent expressions. <i>For example, apply the distributive property to the expression <math>3(2 + x)</math> to produce the equivalent expression <math>6 + 3x</math>; apply the distributive property to the expression <math>24x + 18y</math> to produce the equivalent expression <math>6(4x + 3y)</math>; apply properties of operations to <math>y + y + y</math> to produce the equivalent expression <math>3y</math>.</i></p> <p>6.EE.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). <i>For example, the expressions <math>y + y + y</math> and <math>3y</math> are equivalent because they name the same number regardless of which number <math>y</math> stands for.</i></p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole-number exponents, using the order of operations. <i>For example, use the formulas <math>V = s^3</math> and <math>A = 6s^2</math> to find the volume and surface area of a cube with sides of length <math>s = 1/2</math>.</i></p> <p>6.EE.A.3: Apply the properties of operations to generate equivalent expressions. <i>For example, apply the distributive property to the expression <math>3(2 + x)</math> to produce the equivalent expression <math>6 + 3x</math>; apply the distributive property to factor the expression <math>24x + 18y</math> to produce the equivalent expression <math>6(4x + 3y)</math>; apply properties of operations to <math>y + y + y</math> to produce the equivalent expression <math>3y</math>.</i></p> <p>6.EE.A.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). <i>For example, the expressions <math>y + y + y</math> and <math>3y</math> are equivalent because they name the same number regardless of which number <math>y</math> stands for.</i></p>
<p><b>Reason about and solve one-variable equations and inequalities.</b></p>	<p><b>Reason about and solve one-variable equations and inequalities.</b></p>	<p><b>Standard - AR.EA.2 Reason about and solve one-variable equations and inequalities.</b></p>
<p>6.EE.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.</p> <p>6.EE.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</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>6.PRF.2a2 Use a variable to represent numbers and write expressions when solving real world problems.</i></p>	<p>6.EE.B.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.</p> <p>6.EE.B.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</p>

<p>on the purpose at hand, any number in a specified set.</p> <p>6.EE.7. Solve real-world and mathematical problems by writing and solving equations of the form <math>x + p = q</math> and <math>px = q</math> for cases in which <math>p</math>, <math>q</math> and <math>x</math> are all nonnegative rational numbers.</p> <p>6.EE.8. Write an inequality of the form <math>x &gt; c</math> or <math>x &lt; c</math> to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form <math>x &gt; c</math> or <math>x &lt; c</math> have infinitely many solutions; represent solutions of such inequalities on number line diagrams.</p>	<p><i>6.SE.1a3 Write expressions for real-world problems involving one unknown number.</i></p> <p><i>6.NO.2a6 Solve problems or word problems using up to three digit numbers and any of the four operations.</i></p> <p><i>6.PRF.1d1 Solve real world, single step linear equations.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>on the purpose at hand, any number in a specified set.</p> <p>6.EE.B.7: Solve real-world and mathematical problems by writing and solving equations of the form <math>x + p = q</math> and <math>px = q</math> for cases in which <math>p</math>, <math>q</math> and <math>x</math> are all nonnegative rational numbers. <i>For example, Sal is paid \$0.50 per pound of blueberries that she rakes. If she rakes <math>x</math> pounds, and earns \$17.25, write and solve an equation that determines how many pounds she raked.</i></p> <p>6.EE.B.8: Write an inequality of the form <math>x &gt; c</math> or <math>x &lt; c</math> to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form <math>x &gt; c</math> or <math>x &lt; c</math> have infinitely many solutions; represent solutions of such inequalities on number line diagrams.</p>
<p><b>Represent and analyze quantitative relationships between dependent and independent variables.</b></p>	<p><b>Represent and analyze quantitative relationships between dependent and independent variables.</b></p>	<p><b>Standard - AR.EA.3 Represent and analyze quantitative relationships between dependent and independent variables.</b></p>
<p>6.EE.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. <i>For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation <math>d = 65t</math> to represent the relationship between distance and time.</i></p>	<p><i>6.PRF.2a3 Use variables to represent two quantities in a real-world problem that change in relationship to one another.</i></p> <p><i>6.PRF.2a4 Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.</i></p>	<p>6.EE.C.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. <i>For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation <math>d = 65t</math> to represent the relationship between distance and time.</i></p>
<p><b>Use properties of operations to generate equivalent expressions.</b></p>	<p><b>Use properties of operations to generate equivalent expressions.</b></p>	<p><b>Standard - AR.EA.4 Use properties of operations to generate equivalent expressions.</b></p>

<p>7.EE.1. Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.</p> <p>7.EE.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. <i>For example, <math>a + 0.05a = 1.05a</math> means that "increase by 5%" is the same as "multiply by 1.05."</i></p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>7.EE.A.1: Apply properties of operations to add, subtract, factor, and expand linear expressions with rational coefficients. <i>For example, <math>4x + 2 = 2(2x+1)</math> and <math>-3(x-5/3) = -3x + 5</math>.</i></p> <p>7.EE.A.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. <i>For example, A shirt is on sale for 20% off the regular price, <math>p</math>. The discount can be expressed as <math>0.2p</math>. The new price for the shirt can be expressed as <math>p - 0.2p</math> or <math>0.8p</math>.</i></p>
<p><b>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b></p>	<p><b>Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b></p>	<p><b>Standard - AR.EA.5 Solve real-life and mathematical problems using numerical and algebraic expressions and equations.</b></p>
<p>7.EE.3. Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole 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. <i>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.</i></p> <p>7.EE.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.</p>	<p><i>7.PRF.1g1 Solve real world multi step problems using whole numbers.</i></p> <p><i>7.SE.1f1 Set up equations with 1 variable based on real world problems.</i></p> <p><i>7.SE.1f2 Solve equations with 1 variable based on real world problems.</i></p> <p><i>7.PRF.1g2 Use variables to represent quantities in a real-world or mathematical problem, and</i></p>	<p>7.EE.B.3: Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole 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. <i>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.</i></p> <p>7.EE.B.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.</p>

<p>7.EE.4.a. Solve word problems leading to equations of the form <math>px + q = r</math> and <math>p(x + q) = r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> 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. <i>For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?</i></p> <p>7.EE.4.b. Solve word problems leading to inequalities of the form <math>px + q &gt; r</math> or <math>px + q &lt; r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. <i>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.</i></p>	<p><i>construct simple equations and inequalities to solve problems by reasoning about the quantities.</i></p> <p><i>7.PRF.2d Use a calculator to solve word problems leading to inequalities of the form <math>px + q &gt; r</math> or <math>px + q &lt; r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers.</i></p> <p><i>7.NO.3c5 Explain how to solve a multi-step equation.</i></p>	<p>7.EE.B.4a: Solve word problems leading to equations of the form <math>px + q = r</math> and <math>p(x + q) = r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> 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. <i>For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?</i></p> <p>7.EE.B.4b: Solve word problems leading to inequalities of the form <math>px + q &gt; r</math> or <math>px + q &lt; r</math>, where <math>p</math>, <math>q</math>, and <math>r</math> are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. <i>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.</i></p>
<p><b>Work with radicals and integer exponents.</b></p>	<p><b>Work with radicals and integer exponents.</b></p>	<p><b>Standard - AR.EA.6 Work with radicals and integer exponents.</b></p>
<p>8.EE.1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. <i>For example, <math>3^2 \times 3^{-5} = 3^{-3} = (1/3)^3 = 1/27</math>.</i></p> <p>8.EE.2. Use square root and cube root symbols to represent solutions to equations of the form <math>x^2 = p</math> and <math>x^3 = p</math>, where <math>p</math> is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that <math>\sqrt{2}</math> is irrational.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>8.EE.A.1: Know and apply the properties of integer exponents to generate equivalent numerical expressions. <i>For example, <math>3^2 \times 3^{-5} = 3^{-3} = (1/3)^3 = 1/27</math>.</i></p> <p>8.EE.A.2: Use square root and cube root symbols to represent solutions to equations of the form <math>x^2 = p</math> and <math>x^3 = p</math>, where <math>p</math> is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that <math>\sqrt{2}</math> is irrational.</p>

<p>8.EE.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. <i>For example, estimate the population of the United States as <math>3 \times 10^8</math> and the population of the world as <math>7 \times 10^9</math>, and determine that the world population is more than 20 times larger.</i></p> <p>8.EE.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.</p>	<p><i>8.NO.1i1 Convert a number expressed in scientific notation up to 10,000.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>8.EE.A.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. <i>For example, estimate the population of the United States as 3 times <math>10^8</math> and the population of the world as 7 times <math>10^9</math>, and determine that the world population is more than 20 times larger.</i></p> <p>8.EE.A.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.</p>
<p><b>Understand the connections between proportional relationships, lines, and linear equations.</b></p>	<p><b>Understand the connections between proportional relationships, lines, and linear equations.</b></p>	<p><b>Standard - AR.EA.7 Understand the connections between proportional relationships, lines, and linear equations.</b></p>
<p>8.EE.5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. <i>For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.</i></p> <p>8.EE.6. Use similar triangles to explain why the slope <math>m</math> is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation <math>y = mx</math> for a line through the origin and the equation <math>y = mx + b</math> for a line intercepting the vertical axis at <math>b</math>.</p>	<p><i>8.PRF.1e2 Represent proportional relationships on a line graph.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>8.EE.B.5: Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. <i>For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.</i></p> <p>8.EE.B.6: Use similar triangles to explain why the slope <math>m</math> is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation <math>y = mx</math> for a line through the origin and the equation <math>y = mx + b</math> for a line intercepting the vertical axis at <math>b</math>. <i>For example, given the line <math>y = 0.5x + 3</math> explain why the similar triangles have the same slope.</i></p>

		
<b>Analyze and solve linear equations and pairs of simultaneous linear equations.</b>	<b>Analyze and solve linear equations and pairs of simultaneous linear equations.</b>	<b>Standard - AR.EA.8 Analyze and solve linear equations and pairs of simultaneous linear equations.</b>
<p>8.EE.7. Solve linear equations in one variable.</p> <p>8.EE.7.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 <math>x = a</math>, <math>a = a</math>, or <math>a = b</math> results (where <math>a</math> and <math>b</math> are different numbers).</p> <p>8.EE.7.b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.</p> <p>8.EE.8. Analyze and solve pairs of simultaneous linear equations.</p> <p>8.EE.8.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.</p> <p>8.EE.8.b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. <i>For example, <math>3x + 2y = 5</math> and <math>3x + 2y = 6</math> have no solution because <math>3x + 2y</math> cannot simultaneously be 5 and 6.</i></p>	<p><i>8.PRF.1g3 Solve linear equations with 1 variable.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>8.EE.C.7: Solve linear equations in one variable.</p> <p>8.EE.C.7a: 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 <math>x = a</math>, <math>a = a</math>, or <math>a = b</math> results (where <math>a</math> and <math>b</math> are different numbers).</p> <p>8.EE.C.7b: Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.</p> <p>8.EE.C.8: Analyze and solve pairs of simultaneous linear equations.</p> <p>8.EE.C.8a: 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.</p> <p>8.EE.C.8b: Solve systems of two linear equations in two variables algebraically (i.e. by substitution or elimination) and estimate solutions by graphing the equations. Solve simple cases by inspection. <i>For example, <math>3x + 2y</math></i></p>

<p>8.EE.8.c. Solve real-world and mathematical problems leading to two linear equations in two variables. <i>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.</i></p>		<p><math>= 5</math> and <math>3x + 2y = 6</math> have no solution because <math>3x + 2y</math> cannot simultaneously be 5 and 6.</p> <p>8.EE.C.8c: Solve real-world and mathematical problems leading to two linear equations in two variables. <i>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.</i></p>
<p><b>Functions</b> <b>F</b></p>	<p><b>Functions</b> <b>F</b></p>	<p><b>Algebraic Reasoning</b> <b>AR</b></p>
<p><b>Define, evaluate, and compare functions.</b></p>	<p><b>Define, evaluate, and compare functions.</b></p>	<p><b>Standard - AR.EA.9 Define, evaluate, and compare functions in order to model relationships between quantities. Function notation is not required for Grade 8.</b></p>
<p>8.F.1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.<sup>3</sup></p> <p>8.F.2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>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.</i></p> <p>8.F.3. Interpret the equation <math>y = mx + b</math> as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. <i>For example, the function <math>A = s^2</math> 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.</i></p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>8.PRF.2c1 Given two graphs, describe the function as linear and not linear.</i></p>	<p>8.F.A.1: Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.</p> <p>8.F.A.2: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>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.</i></p> <p>8.F.A.3: Interpret the equation <math>y = mx + b</math> as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. <i>For example, the function <math>A = s^2</math> 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.</i></p>
<p><b>Use functions to model relationships between quantities.</b></p>	<p><b>Use functions to model relationships between quantities.</b></p>	<p><b>(Repeat) Standard - AR.EA.9 Define, evaluate, and compare functions in order to model</b></p>

		<b>relationships between quantities. Function notation is not required for Grade 8.</b>
<p>8.F.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.</p> <p>8.F.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.</p>	<p><i>8.PRF.2e2 Identify the rate of change (slope) and initial value (y-intercept) from graphs.</i></p> <p><i>8.PRF.2c1 Given two graphs, describe the function as linear and not linear.</i></p> <p><i>8.PRF.2e3 Given a verbal description of a situation, create or identify a graph to model the situation.</i></p> <p><i>8.PRF.2e4 Given a graph of a situation, generate a description of the situation.</i></p> <p><i>8.PRF.1f2 describe or select the relationship between the two quantities given a line graph of a situation.</i></p> <p><i>8.NO.3c3 Analyze provided information (e.g., a graph) to describe the relationship between two quantities.</i></p>	<p>8.F.B.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.</p> <p>8.F.B.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.</p>
<b>Geometry</b> <b>G</b>	<b>Geometry</b> <b>G</b>	<b>Geometric Reasoning</b> <b>GR</b>
<b>Solve real-world and mathematical problems involving area, surface area, and volume.</b>	<b>Solve real-world and mathematical problems involving area, surface area, and volume.</b>	<b>Standard - GR.EA.1 Solve real-world and mathematical problems involving angle measure, area, surface area, and volume.</b>
<p>6.G.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.</p>	<p><i>6.ME.1a2 Identify the appropriate formula (i.e., perimeter, area, volume) to use when measuring for different purposes in a real life context.</i></p> <p><i>6.ME.2a3 Apply the formula to find the area of triangles.</i></p> <p><i>6.ME.2b3 Decompose complex shapes (polygon, trapezoid, pentagon) into simple shapes (rectangles, squares, triangles) to measure area.</i></p> <p><i>6.GM.1d1 Find area of quadrilaterals.</i></p> <p><i>6.GM.1d2 Find area of triangles.</i></p>	<p>6.G.A.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.</p>

<p>6.G.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 <math>V = l w h</math> and <math>V = b h</math> to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.</p> <p>6.G.3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.</p> <p>6.G.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.</p>	<p><i>6.ME.1a2 Identify the appropriate formula (i.e., perimeter, area, volume) to use when measuring for different purposes in a real life context.</i></p> <p><i>6.ME.1c1 Find the area of a 2-dimensional figure and the volume of a 3-dimensional figure.</i></p> <p><i>6.GM.1c7 Use coordinate points to draw polygons.</i></p> <p><i>6.GM.1c8 Use coordinate points to find the side lengths of polygons that are horizontal or vertical.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>6.G.A.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 <math>V = l w h</math> and <math>V = B h</math> (where <math>B</math> stands for the area of the base) to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.</p> <p>6.G.A.3: Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.</p> <p>6.G.A.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.</p>
<p><b>Draw, construct, and describe geometrical figures and describe the relationships between them.</b></p>	<p><b>Draw, construct, and describe geometrical figures and describe the relationships between them.</b></p>	<p><b>Standard - GR.EA.2 Draw, construct, and describe geometrical figures and describe the relationships between them.</b></p>
<p>7.G.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.</p> <p>7.G.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, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.</p>	<p><i>7.ME.1d1 Solve problems that use proportional reasoning with ratios of length and area.</i></p> <p><i>7.ME2e1 Solve one step real world problems related to scaling.</i></p> <p><i>7.GM.1e1 Construct or draw plane figures using properties.</i></p>	<p>7.G.A.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.</p> <p>7.G.A.2: Draw (freehand, with ruler and protractor, and with technology) two-dimensional geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.</p>

<p>7.G.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.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>7.G.A.3: Describe the shape of the cross-section two-dimensional face of the figures that results from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.</p>
<p><b>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</b></p>	<p><b>Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.</b></p>	<p><b>(Repeat) Standard - GR.EA.1 Solve real-world and mathematical problems involving angle measure, area, surface area, and volume.</b></p>
<p>7.G.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.</p> <p>7.G.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.</p> <p>7.G.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.</p>	<p><i>7.ME.2d1 Apply formula to measure area and circumference of circles.</i></p> <p><i>8.GM.1i1 Identify supplementary angles</i>  <i>8.GM.1i2 Identify complimentary angles.</i>  <i>8.GM.1i3 Identify adjacent angles.</i>  <i>8.GM.1i4 Use angle relationships to find the value of a missing angle.</i></p> <p><i>7.GM.1h1 Add the area of each face of a prism to find surface area of three dimensional objects.</i>  <i>7.GM.1h2 Find the surface area of three-dimensional figures using nets of rectangles or triangles.</i>  <i>7.GM.1h3 Find area of plane figures and surface area of solid figures (quadrilaterals).</i>  <i>7.GM.1h4 Find area of an equilateral, isosceles, and scalene triangle.</i>  <i>7.ME.2c 1 Solve one step real world measurement problems involving area, volume, or surface area of two- and three-dimensional objects.</i></p>	<p>7.G.B.4: Know that a circle is a two-dimensional shape created by connecting all the points equidistant from a fixed point called the center of the circle. Understand and describe the relationships among the radius, diameter, circumference and area of a circle. 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.</p> <p>7.G.B.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.</p> <p>7.G.B.6: Solve real-world and mathematical problems involving area, volume and surface area of two- and/or three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.</p>
<p><b>Understand congruence and similarity using physical models, transparencies, or geometry software.</b></p>	<p><b>Understand congruence and similarity using physical models, transparencies, or geometry software.</b></p>	<p><b>Standard - GR.EA.3 Understand congruence and similarity using physical models, transparencies, or geometry software.</b></p>

<p>8.G.1. Verify experimentally the properties of rotations, reflections, and translations:</p> <p>8.G.1.a. Lines are taken to lines, and line segments to line segments of the same length.</p> <p>8.G.1.b. Angles are taken to angles of the same measure.</p> <p>8.G.1.c. Parallel lines are taken to parallel lines.</p> <p>8.G.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.</p> <p>8.G.3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.</p> <p>8.G.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.</p> <p>8.G.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. <i>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.</i></p>	<p><i>8.GM.1f1 Recognize a rotation, reflection, or translation of a figure.</i></p> <p><i>H.GM.1d1 Use the reflections, rotations, or translations in the coordinate plane to solve problems with right angles.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>8.GM.1f2 Identify a rotation, reflection, or translation of a plane figure when given coordinates.</i></p> <p><i>8.GM.1g1 Recognize congruent and similar figures.</i></p> <p><i>8.ME.1e1 Describe the changes in surface area, area, and volume when the figure is changed in some way (e.g., scale drawings).</i></p> <p><i>8.ME.1e2 Compare area and volume of similar figures.</i></p> <p><i>8.GM.1i4 Use angle relationships to find the value of a missing angle.</i></p>	<p>8.G.A.1: Verify experimentally the properties of rotations, reflections, and translations:</p> <p>8.G.A.1a: Lines are taken to lines, and line segments to line segments of the same length.</p> <p>8.G.A.1b: Angles are taken to angles of the same measure.</p> <p>8.G.A.1c: Parallel lines are taken to parallel lines.</p> <p>8.G.A.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.</p> <p>8.G.A.3: Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.</p> <p>8.G.A.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.</p> <p>8.G.A.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. <i>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.</i></p>
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Understand and apply the Pythagorean Theorem.	Understand and apply the Pythagorean Theorem.	Standard - GR.EA.4 Understand and apply the Pythagorean Theorem.
<p>8.G.6. Explain a proof of the Pythagorean Theorem and its converse.</p> <p>8.G.7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p> <p>8.G.8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>8.ME.2f1 Apply the Pythagorean theorem to determine lengths/distances in real-world situations.</i></p> <p><i>8.GM.1j1 Find the hypotenuse of a two-dimensional right triangle (Pythagorean Theorem).</i></p> <p><i>8.GM.1j2 Find the missing side lengths of a two-dimensional right triangle (Pythagorean Theorem).</i></p> <p><i>H.GM.1a1 Find the hypotenuse of a two-dimensional right triangle (Pythagorean Theorem).</i></p> <p><i>H.GM.1a2 Find the missing side lengths of a two-dimensional right triangle (Pythagorean Theorem).</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>8.G.B.6: Explain a proof of the Pythagorean Theorem and its converse using pictures, diagrams, narratives or models.</p> <p>8.G.B.7: Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</p> <p>8.G.B.8: Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.</p>
<p><b>Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.</b></p>	<p><b>Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.</b></p>	<p><b>(Repeat) Standard - GR.EA.1 Solve real-world and mathematical problems involving angle measure, area, surface area, and volume.</b></p>
<p>8.G.9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.</p>	<p><i>8.ME2d2 Apply the formula to find the volume of 3 dimensional shapes (i.e., cubes, spheres, and cylinders).</i></p>	<p>8.G.C.9: Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.</p>
<p><b>Statistics and Probability</b> <span style="float: right;"><b>SP</b></span></p>	<p><b>Statistics and Probability</b> <span style="float: right;"><b>SP</b></span></p>	<p><b>Statistical Reasoning</b> <span style="float: right;"><b>SR</b></span></p>
<p><b>Develop understanding of statistical variability.</b></p>	<p><b>Develop understanding of statistical variability.</b></p>	<p><b>Standard - SR.EA.1 Summarize distribution using measures of center, variability, and graphical displays.</b></p>
<p>6.SP.1. Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. <i>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.</i></p>	<p><i>6.DPS.1a2 Identify statistical questions and make a plan for data collection.</i></p>	<p>6.SP.A.1: Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. <i>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.</i></p>

<p>6.SP.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.</p> <p>6.SP.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.</p>	<p><i>6.DPS.1d4 Find the range of a given data set.</i>  <i>6.DPS.1d6 Explain or identify what the mode represents in a set of data.</i></p> <p><i>5.DPS.1d1 Select an appropriate statement about the range of the data for a given graph (bar graph, line plot) (i.e. range of data) up to 10 points.</i>  <i>5.DPS.1e1 Use measures of central tendency to interpret data including overall patterns in the data.</i>  <i>6.DPS.1d2 Solve for mean of a given data set.</i>  <i>6.DPS.1d5 Explain or identify what the mean represents in a set of data.</i></p>	<p>6.SP.A.2: Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center (mean, median and/or mode), spread (range and/or interquartile range), and overall shape.</p> <p>6.SP.A.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.</p>
<p><b>Summarize and describe distributions.</b></p>	<p><b>Summarize and describe distributions.</b></p>	<p><b>(Repeat) Standard - SR.EA.1 Summarize distribution using measures of center, variability, and graphical displays.</b></p>
<p>6.SP.4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.</p> <p>6.SP.5. Summarize numerical data sets in relation to their context, such as by:</p> <p>6.SP.5.a. Reporting the number of observations.</p> <p>6.SP.5.b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.</p> <p>6.SP.5.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.</p>	<p><i>6.DPS.1c2 Collect and graph data: bar graph, line plots, dot plots, histograms.</i></p> <p><i>6.DPS.1d3 Select statement that matches mean, mode, and spread of data for 1 measure of central tendency for a given data set.</i>  <i>6.DPS.1d7 Explain or identify what the median represents in a set of data.</i>  <i>6.DPS.1e2 Use measures of central tendency to interpret data including overall patterns in the data.</i></p>	<p>6.SP.B.4: Display numerical data in plots on a number line, including dot plots, histograms, and box plots.</p> <p>6.SP.B.5: Summarize numerical data sets in relation to their context, such as by:</p> <p>6.SP.B.5a: Reporting the number of observations.</p> <p>6.SP.B.5b: Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.</p> <p>6.SP.B.5c: Calculating quantitative measures of center (median and/or mean) and variability (range and/or 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.</p>

<p>6.SP.5.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.</p>		<p>6.SP.B.5d: 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.</p>
<p><b>Use random sampling to draw inferences about a population.</b></p>	<p><b>Use random sampling to draw inferences about a population.</b></p>	<p><b>Standard - SR.EA.2 Use random sampling, visual representations, and measures of center and variability to draw inferences about one or more populations.</b></p>
<p>7.SP.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 that random sampling tends to produce representative samples and support valid inferences.</p> <p>7.SP.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. <i>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.</i></p>	<p><i>7.DPS.1b1 Determine sample size to answer a given question.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>7.SP.A.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 that random sampling tends to produce representative samples and support valid inferences.</p> <p>7.SP.A.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. <i>For example, estimate the mean length of a largemouth bass in a lake by randomly sampling largemouth bass from the lake; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.</i></p>
<p><b>Draw informal comparative inferences about two populations.</b></p>	<p><b>Draw informal comparative inferences about two populations.</b></p>	<p><b>(Repeat) Standard - SR.EA.2 Use random sampling, visual representations, and measures of center and variability to draw inferences about one or more populations.</b></p>
<p>7.SP.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. <i>For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the</i></p>	<p><i>7.DPS.1j1 Make or select a statement to compare the distribution of 2 data sets.</i></p>	<p>7.SP.B.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. <i>For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the</i></p>

<p>soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.</p> <p>7.SP.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.</p>	<p>7.DPS.1i2 Identify the range (high/low), median(middle), mean, or mode of a given data set.</p> <p>7.DPS.1k1 Analyze graphs to determine or select appropriate comparative inferences about two samples or populations.</p> <p>8.DPS.1j2 Make or select an appropriate statements based upon two unequal data sets using measure of central tendency and shape.</p>	<p>soccer team and both distributions have similar variability (mean absolute deviation) of about 5 cm. The difference between the mean heights of the two teams (10 cm) is about twice the variability (5 cm mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.</p> <p>7.SP.B.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.</p>
<p><b>Investigate chance processes and develop, use, and evaluate probability models.</b></p>	<p><b>Investigate chance processes and develop, use, and evaluate probability models.</b></p>	<p><b>Standard - SR.EA.3 Investigate chance processes and develop, use, and evaluate probability models.</b></p>
<p>7.SP.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.</p> <p>7.SP.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.</p>	<p>7.DPS.2d1 Describe the probability of events as being certain or impossible, likely, less likely or equally likely.</p> <p>7.DPS.2d2 State the theoretical probability of events occurring in terms of ratios(words, percentages, decimals).</p> <p>7.DPS.2a1 Conduct simple probability experiments</p> <p>7.DPS.2d4 Make a prediction regarding the probability of an event occurring; conduct simple probability experiments.</p>	<p>7.SP.C.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.</p> <p>7.SP.C.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.</p>

7.SP.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 sources of the discrepancy.

7.SP.7.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.SP.7.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.SP.8. Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

7.SP.8.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.

7.SP.8.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.

*7.DPS.2d3 Using an appropriate graphic or tactile representation, find all possible outcomes for a compound event.*

*7.DPS.2d5 Compare actual results of simple experiment with theoretical probabilities.*

*7.DPS.2b1 Identify sample space for a single event (coin, spinner, die).*

*7.DPS.2e1 Determine the theoretical probability of multistage probability experiments (2 coins, 2 dice).*

*7.DPS.2e2 Collect data from multistage probability experiments (2 coins, 2 dice).*

*7.DPS.2e3 Compare actual results of multistage experiment with theoretical probabilities.*

7.SP.C.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 sources of the discrepancy.

7.SP.C.7a: 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.SP.C.7b: 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.SP.C.8: Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

7.SP.C.8a: 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.

7.SP.C.8b: 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.

<p>7.SP.8.c. Design and use a simulation to generate frequencies for compound events. <i>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?</i></p>		<p>7.SP.C.8c: Design and use a simulation to generate frequencies for compound events. <i>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?</i></p>
<p><b>Investigate patterns of association in bivariate data.</b></p>	<p><b>Investigate patterns of association in bivariate data.</b></p>	<p><b>Standard - SR.EA.4 Investigate patterns of association in bivariate data.</b></p>
<p>8.SP.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.</p> <p>8.SP.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.</p> <p>8.SP.3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. <i>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.</i></p> <p>8.SP.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</p>	<p><i>8.SP.1a Recognize a pattern of association using existing data.</i></p> <p><i>8.DPS.1g2 Graph data using line graphs, histograms, or box plots.</i></p> <p><i>8.DPS.1h1 Graph bivariate data using scatter plots and identify possible associations between the variables.</i></p> <p><i>8.DPS.1i3 using box plots and scatter plots, identify data points that appear to be outliers.</i></p> <p><i>8.DPS.2g1 Distinguish between a linear and non-linear association when analyzing bivariate data on a scatter plot.</i></p> <p><i>8.DPS.2g2 Interpret the slope and the y-intercept of a line in the context of a problem.</i></p> <p><i>8.DPS.1k2 Analyze displays of bivariate data to develop or select appropriate claims about those data.</i></p> <p><i>8.DPS.1f3 Construct a two-way table summarizing data on two categorical variables collected from</i></p>	<p>8.SP.A.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.</p> <p>8.SP.A.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.</p> <p>8.SP.A.3: Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. <i>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.</i></p> <p>8.SP.A.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</p>

<p>variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. <i>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?</i></p>	<p><i>the same subjects; identify possible association between the two variables.</i></p>	<p>variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. <i>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?</i></p>
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<sup>1</sup>Expectations for unit rates in this grade are limited to non-complex fractions.

<sup>2</sup>Computations with rational numbers extend the rules for manipulating fractions to complex fractions.

<sup>3</sup>Function notation is not required in Grade 8.

### Grade Span 9-Diploma Mathematics

**\*Mathematics in grades 9-diploma have been consolidated into a grade span rather than broken out into conceptual categories. While the CCSS and CCC focuses on conceptual categories, the MLR focus on a grade span. Due to courses and the structure of teaching mathematics, the Maine Learning Results do not designate the grade or course at which the standard is taught, rather performance expectations show what the standard looks like across the grade span.**

#### Number and Quantity Overview

##### The Real Number System

- Extend the properties of exponents to rational exponents
- Use properties of rational and irrational numbers

##### Quantities

- Reason quantitatively and use units to solve problems

##### The Complex Number System

- Perform arithmetic operations with complex numbers
- Represent complex numbers and their operations on the complex plane
- Use complex numbers in polynomial identities and equations

##### Vector and Matrix Quantities

- Represent and model with vector quantities
- Perform operations on vectors
- Perform operations on matrices and use matrices in applications

#### Algebra Overview

##### Seeing Structure in Expressions

- Interpret the structure of expressions
- Write expressions in equivalent forms to solve problems

### **Arithmetic with Polynomials and Rational Expressions**

- Perform arithmetic operations on polynomials
- Understand the relationship between zeros and factors of polynomials
- Use polynomial identities to solve problems
- Rewrite rational expressions

### **Creating Equations**

- Create equations that describe numbers or relationships

### **Reasoning with Equations and Inequalities**

- Understand solving equations as a process of reasoning and explain the reasoning
- Solve equations and inequalities in one variable
- Solve systems of equations
- Represent and solve equations and inequalities graphically

### **Functions Overview**

#### **Interpreting Functions**

- Understand the concept of a function and use function notation
- Interpret functions that arise in applications in terms of the context
- Analyze functions using different representations

#### **Building Functions**

- Build a function that models a relationship between two quantities
- Build new functions from existing functions

### **Linear, Quadratic, and Exponential Models**

- Construct and compare linear, quadratic, and exponential models and solve problems
- Interpret expressions for functions in terms of the situation they model

### **Trigonometric Functions**

- Extend the domain of trigonometric functions using the unit circle
- Model periodic phenomena with trigonometric functions
- Prove and apply trigonometric identities

### **Geometry Overview**

#### **Congruence**

- Experiment with transformations in the plane
- Understand congruence in terms of rigid motions
- Prove geometric theorems
- Make geometric constructions

#### **Similarity, Right Triangles, and Trigonometry**

- Understand similarity in terms of similarity transformations
- Prove theorems involving similarity
- Define trigonometric ratios and solve problems involving right triangles
- Apply trigonometry to general triangles

#### **Circles**

- Understand and apply theorems about circles
- Find arc lengths and areas of sectors of circles

#### **Expressing Geometric Properties with Equations**

- Translate between the geometric description and the equation for a conic section
- Use coordinates to prove simple geometric theorems algebraically

#### **Geometric Measurement and Dimension**

- Explain volume formulas and use them to solve problems
- Visualize relationships between two-dimensional and three-dimensional objects

#### **Modeling with Geometry**

- Apply geometric concepts in modeling situations

#### **Statistics and Probability Overview**

##### **Interpreting Categorical and Quantitative Data**

- Summarize, represent, and interpret data on a single count or measurement variable
- Summarize, represent, and interpret data on two categorical and quantitative variables
- Interpret linear models

##### **Making Inferences and Justifying Conclusions**

- Understand and evaluate random processes underlying statistical experiments
- Make inferences and justify conclusions from sample surveys, experiments and observational studies

##### **Conditional Probability and the Rules of Probability**

- Understand independence and conditional probability and use them to interpret data
- Use the rules of probability to compute probabilities of compound events in a uniform probability model

##### **Using Probability to Make Decisions**

- Calculate expected values and use them to solve problems
- Use probability to evaluate outcomes of decisions

Common Core State Standards	Core Content Connectors	Maine Learning Results
<b>Mathematics Standards for High School</b> The high school standards specify the mathematics that all students should study in order to be college and career ready. Additional mathematics		Modeling Standards: Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice,

that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics is indicated by (+), as in this example:

(+) Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers).

All standards without a (+) symbol should be in the common mathematics curriculum for all college and career ready students. Standards with a (+) symbol may also appear in courses intended for all students.

The high school standards are listed in conceptual categories:

- Number and Quantity
- Algebra
- Functions
- Modeling
- Geometry
- Statistics and Probability

Conceptual categories portray a coherent view of high school mathematics; a student's work with functions, for example, crosses a number of traditional course boundaries, potentially up through and including calculus.

Modeling is best interpreted not as a collection of isolated topics but in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★). The star symbol sometimes appears on the heading for a

and specific modeling standards appears throughout the high school standards indicated by a star symbol (★).

The high school standards also contain some performance expectations which are denoted by a plus (+). These performance expectations are intended to be extensions of learning. All students should be given opportunities to explore this content, but mastery is not expected.

group of standards; in that case, it should be understood to apply to all standards in that group.

**Mathematics | High School—Number and Quantity**

Numbers and Number Systems. During the years from kindergarten to eighth grade, students must repeatedly extend their conception of number. At first, “number” means “counting number”: 1, 2, 3... Soon after that, 0 is used to represent “none” and the whole numbers are formed by the counting numbers together with zero. The next extension is fractions. At first, fractions are barely numbers and tied strongly to pictorial representations. Yet by the time students understand division of fractions, they have a strong concept of fractions as numbers and have connected them, via their decimal representations, with the base-ten system used to represent the whole numbers. During middle school, fractions are augmented by negative fractions to form the rational numbers. In Grade 8, students extend this system once more, augmenting the rational numbers with the irrational numbers to form the real numbers. In high school, students will be exposed to yet another extension of number, when the real numbers are augmented by the imaginary numbers to form the complex numbers.

With each extension of number, the meanings of addition, subtraction, multiplication, and division are extended. In each new number system—integers, rational numbers, real numbers, and complex numbers—the four operations stay the same in two important ways: They have the commutative, associative, and distributive properties and their new meanings are consistent with their previous meanings.

Extending the properties of whole-number exponents leads to new and productive notation. For example, properties of whole-number exponents suggest that  $(5^{1/3})^3$  should be  $5^{(1/3)3} = 5^1 = 5$  and that  $5^{1/3}$  should be the cube root of 5.

Calculators, spreadsheets, and computer algebra systems can provide ways for students to become better acquainted with these new number systems and their notation. They can be used to generate data for numerical experiments, to help understand the workings of matrix, vector, and complex number algebra, and to experiment with non-integer exponents.

Quantities. In real world problems, the answers are usually not numbers but quantities: numbers with units, which involves measurement. In their work in measurement up through Grade 8, students primarily measure commonly used attributes such as length, area, and volume. In high school, students encounter a wider variety of units in modeling, e.g., acceleration, currency conversions, derived quantities such as person-hours and heating degree days, social science rates such as per-capita income, and rates in everyday life such as points scored per game or batting averages. They also encounter novel situations in which they themselves must conceive the attributes of interest. For example, to find a good measure of overall highway safety, they might propose measures such as fatalities per year, fatalities per year per driver, or fatalities per vehicle-mile traveled. Such a conceptual process is sometimes called quantification. Quantification is important for science, as when surface area suddenly “stands out” as an important variable in evaporation. Quantification is also important for companies, which must conceptualize relevant

attributes and create or choose suitable measures for them.

**Mathematics | High School—Algebra**

Expressions. An expression is a record of a computation with numbers, symbols that represent numbers, arithmetic operations, exponentiation, and, at more advanced levels, the operation of evaluating a function. Conventions about the use of parentheses and the order of operations assure that each expression is unambiguous. Creating an expression that describes a computation involving a general quantity requires the ability to express the computation in general terms, abstracting from specific instances.

Reading an expression with comprehension involves analysis of its underlying structure. This may suggest a different but equivalent way of writing the expression that exhibits some different aspect of its meaning. For example,  $p + 0.05p$  can be interpreted as the addition of a 5% tax to a price  $p$ . Rewriting  $p + 0.05p$  as  $1.05p$  shows that adding a tax is the same as multiplying the price by a constant factor.

Algebraic manipulations are governed by the properties of operations and exponents, and the conventions of algebraic notation. At times, an expression is the result of applying operations to simpler expressions. For example,  $p + 0.05p$  is the sum of the simpler expressions  $p$  and  $0.05p$ . Viewing an expression as the result of operation on simpler expressions can sometimes clarify its underlying structure.

A spreadsheet or a computer algebra system (CAS) can be used to experiment with algebraic expressions, perform complicated algebraic

manipulations, and understand how algebraic manipulations behave.

Equations and inequalities. An equation is a statement of equality between two expressions, often viewed as a question asking for which values of the variables the expressions on either side are in fact equal. These values are the solutions to the equation. An identity, in contrast, is true for all values of the variables; identities are often developed by rewriting an expression in an equivalent form.

The solutions of an equation in one variable form a set of numbers; the solutions of an equation in two variables form a set of ordered pairs of numbers, which can be plotted in the coordinate plane. Two or more equations and/or inequalities form a system. A solution for such a system must satisfy every equation and inequality in the system.

An equation can often be solved by successively deducing from it one or more simpler equations. For example, one can add the same constant to both sides without changing the solutions, but squaring both sides might lead to extraneous solutions. Strategic competence in solving includes looking ahead for productive manipulations and anticipating the nature and number of solutions.

Some equations have no solutions in a given number system, but have a solution in a larger system. For example, the solution of  $x + 1 = 0$  is an integer, not a whole number; the solution of  $2x + 1 = 0$  is a rational number, not an integer; the solutions of  $x^2 - 2 = 0$  are real numbers, not rational numbers; and the solutions of  $x^2 + 2 = 0$  are complex numbers, not real numbers.

The same solution techniques used to solve equations can be used to rearrange formulas. For example, the formula for the area of a trapezoid,  $A = ((b_1+b_2)/2)h$ , can be solved for  $h$  using the same deductive process.

Inequalities can be solved by reasoning about the properties of inequality. Many, but not all, of the properties of equality continue to hold for inequalities and can be useful in solving them.

Connections to Functions and Modeling.

Expressions can define functions, and equivalent expressions define the same function. Asking when two functions have the same value for the same input leads to an equation; graphing the two functions allows for finding approximate solutions of the equation. Converting a verbal description to an equation, inequality, or system of these is an essential skill in modeling.

### **Mathematics | High School—Functions**

Functions describe situations where one quantity determines another. For example, the return on \$10,000 invested at an annualized percentage rate of 4.25% is a function of the length of time the money is invested. Because we continually make theories about dependencies between quantities in nature and society, functions are important tools in the construction of mathematical models.

In school mathematics, functions usually have numerical inputs and outputs and are often defined by an algebraic expression. For example, the time in hours it takes for a car to drive 100 miles is a function of the car's speed in miles per hour,  $v$ ; the rule  $T(v) = 100/v$  expresses this relationship algebraically and defines a function whose name is  $T$ .

The set of inputs to a function is called its domain. We often infer the domain to be all inputs for which the expression defining a function has a value, or for which the function makes sense in a given context.

A function can be described in various ways, such as by a graph (e.g., the trace of a seismograph); by a verbal rule, as in, "I'll give you a state, you give me the capital city;" by an algebraic expression like  $f(x) = a + bx$ ; or by a recursive rule. The graph of a function is often a useful way of visualizing the relationship of the function models, and manipulating a mathematical expression for a function can throw light on the function's properties.

Functions presented as expressions can model many important phenomena. Two important families of functions characterized by laws of growth are linear functions, which grow at a constant rate, and exponential functions, which grow at a constant percent rate. Linear functions with a constant term of zero describe proportional relationships.

A graphing utility or a computer algebra system can be used to experiment with properties of these functions and their graphs and to build computational models of functions, including recursively defined functions.

Connections to Expressions, Equations, Modeling, and Coordinates. Determining an output value for a particular input involves evaluating an expression; finding inputs that yield a given output involves solving an equation. Questions about when two functions have the same value for the same input lead to equations, whose solutions can be visualized from the intersection of their graphs.

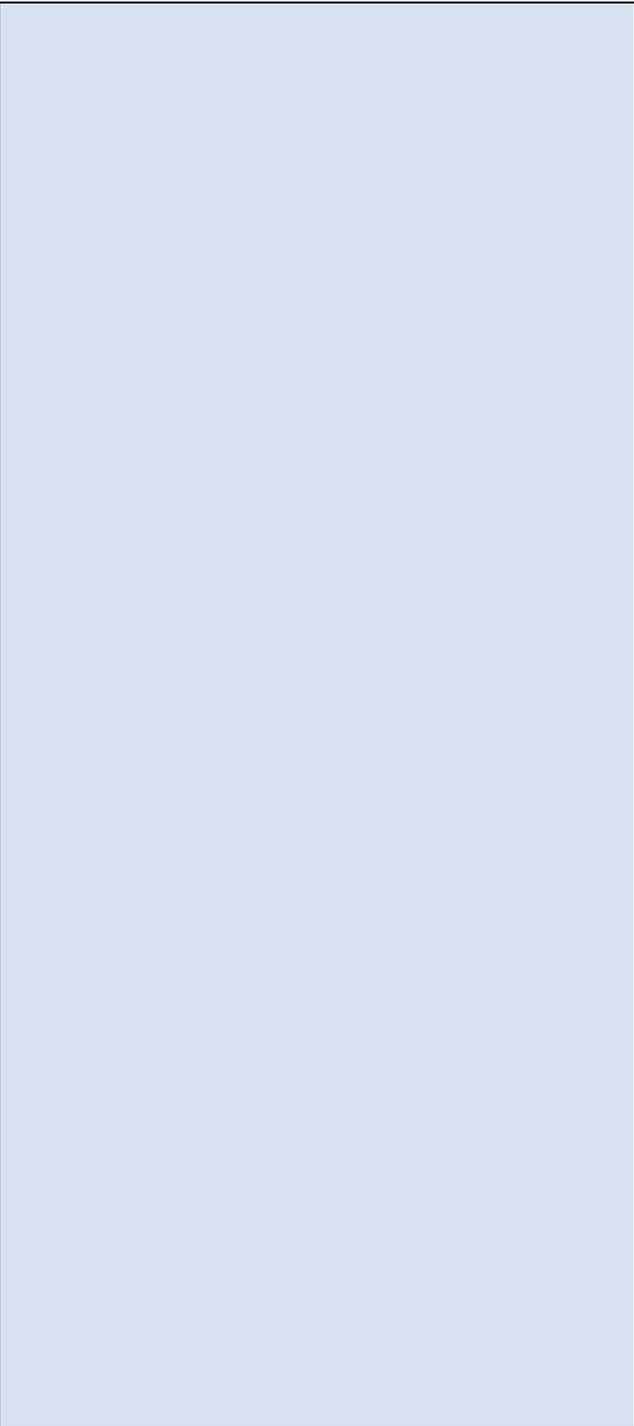
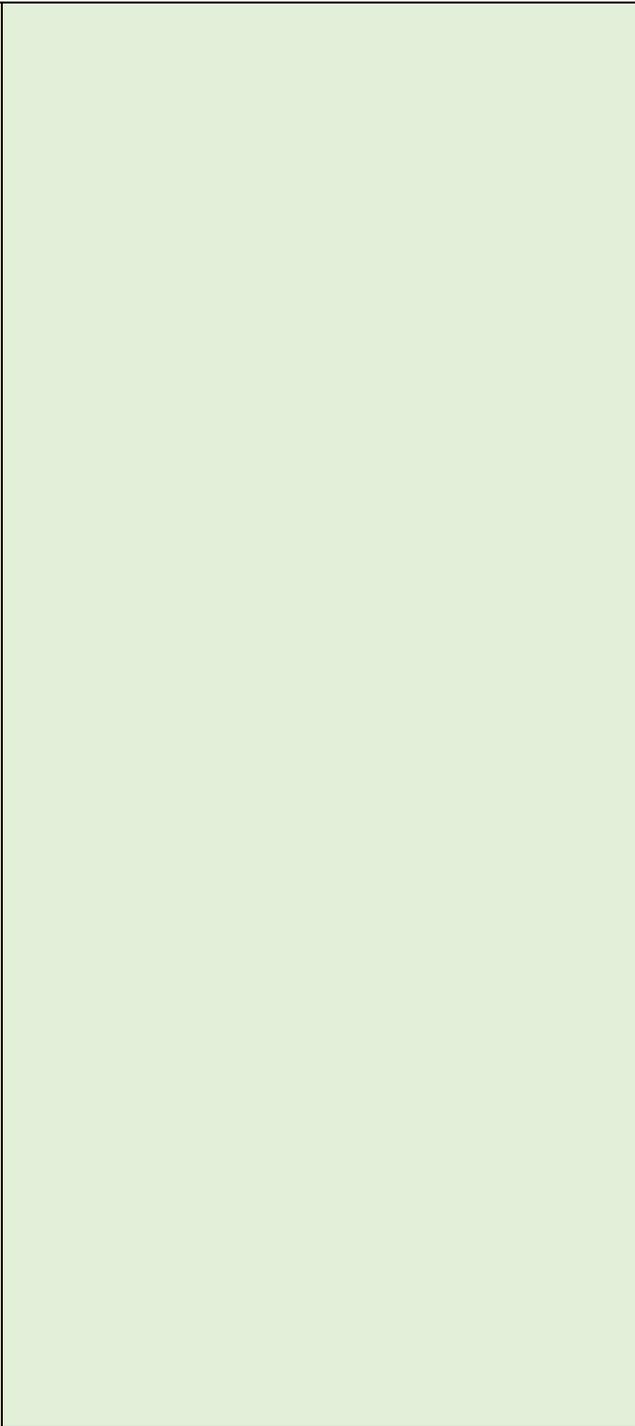
Because functions describe relationships between quantities, they are frequently used in modeling. Sometimes functions are defined by a recursive process, which can be displayed effectively using a spreadsheet or other technology.

**Mathematics | High School—Modeling**

Modeling links classroom mathematics and statistics to everyday life, work, and decision-making. Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve decisions. Quantities and their relationships in physical, economic, public policy, social, and everyday situations can be modeled using mathematical and statistical methods. When making mathematical models, technology is valuable for varying assumptions, exploring consequences, and comparing predictions with data.

A model can be very simple, such as writing total cost as a product of unit price and number bought, or using a geometric shape to describe a physical object like a coin. Even such simple models involve making choices. It is up to us whether to model a coin as a three-dimensional cylinder, or whether a two-dimensional disk works well enough for our purposes. Other situations—modeling a delivery route, a production schedule, or a comparison of loan amortizations—need more elaborate models that use other tools from the mathematical sciences. Real-world situations are not organized and labeled for analysis; formulating tractable models, representing such models, and analyzing them is appropriately a creative process. Like every such process, this depends on acquired expertise as well as creativity.

Some examples of such situations might include:

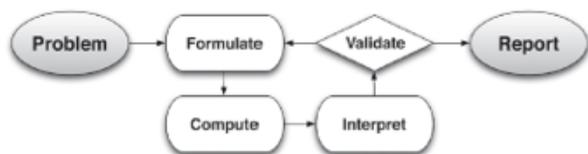


- Estimating how much water and food is needed for emergency relief in a devastated city of 3 million people, and how it might be distributed.
- Planning a table tennis tournament for 7 players at a club with 4 tables, where each player plays against each other player.
- Designing the layout of the stalls in a school fair so as to raise as much money as possible.
- Analyzing stopping distance for a car.
- Modeling savings account balance, bacterial colony growth, or investment growth.
- Engaging in critical path analysis, e.g., applied to turnaround of an aircraft at an airport.
- Analyzing risk in situations such as extreme sports, pandemics, and terrorism.
- Relating population statistics to individual predictions.

In situations like these, the models devised depend on a number of factors: How precise an answer do we want or need? What aspects of the situation do we most need to understand, control, or optimize? What resources of time and tools do we have? The range of models that we can create and analyze is also constrained by the limitations of our mathematical, statistical, and technical skills, and our ability to recognize significant variables and relationships among them. Diagrams of various kinds, spreadsheets and other technology, and algebra are powerful tools for understanding and solving problems drawn from different types of real-world situations.

One of the insights provided by mathematical modeling is that essentially the same mathematical or statistical structure can sometimes model seemingly different situations.

Models can also shed light on the mathematical structures themselves, for example, as when a model of bacterial growth makes more vivid the explosive growth of the exponential function.



The basic modeling cycle is summarized in the diagram. It involves (1) identifying variables in the situation and selecting those that represent essential features, (2) formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables, (3) analyzing and performing operations on these relationships to draw conclusions, (4) interpreting the results of the mathematics in terms of the original situation, (5) validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable, (6) reporting on the conclusions and the reasoning behind them. Choices, assumptions, and approximations are present throughout this cycle.

In descriptive modeling, a model simply describes the phenomena or summarizes them in a compact form. Graphs of observations are a familiar descriptive model— for example, graphs of global temperature and atmospheric CO<sub>2</sub> over time.

Analytic modeling seeks to explain data on the basis of deeper theoretical ideas, albeit with parameters that are empirically based; for example, exponential growth of bacterial colonies (until cut-off mechanisms such as pollution or starvation intervene) follows from a constant reproduction rate. Functions are an important tool for analyzing such problems.

Graphing utilities, spreadsheets, computer algebra systems, and dynamic geometry software are powerful tools that can be used to model purely mathematical phenomena (e.g., the behavior of polynomials) as well as physical phenomena.

*Modeling Standards Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice, and specific modeling standards appear throughout the high school standards indicated by a star symbol (★).*

### **Mathematics | High School—Geometry**

An understanding of the attributes and relationships of geometric objects can be applied in diverse contexts—interpreting a schematic drawing, estimating the amount of wood needed to frame a sloping roof, rendering computer graphics, or designing a sewing pattern for the most efficient use of material.

Although there are many types of geometry, school mathematics is devoted primarily to plane Euclidean geometry, studied both synthetically (without coordinates) and analytically (with coordinates). Euclidean geometry is characterized most importantly by the Parallel Postulate, that through a point not on a given line there is exactly one parallel line. (Spherical geometry, in contrast, has no parallel lines.)

During high school, students begin to formalize their geometry experiences from elementary and middle school, using more precise definitions and developing careful proofs. Later in college some students develop Euclidean and other geometries carefully from a small set of axioms.

The concepts of congruence, similarity, and symmetry can be understood from the perspective of geometric transformation. Fundamental are the rigid motions: translations, rotations, reflections, and combinations of these, all of which are here assumed to preserve distance and angles (and therefore shapes generally). Reflections and rotations each explain a particular type of symmetry, and the symmetries of an object offer insight into its attributes—as when the reflective symmetry of an isosceles triangle assures that its base angles are congruent.

In the approach taken here, two geometric figures are defined to be congruent if there is a sequence of rigid motions that carries one onto the other. This is the principle of superposition. For triangles, congruence means the equality of all corresponding pairs of sides and all corresponding pairs of angles. During the middle grades, through experiences drawing triangles from given conditions, students notice ways to specify enough measures in a triangle to ensure that all triangles drawn with those measures are congruent. Once these triangle congruence criteria (ASA, SAS, and SSS) are established using rigid motions, they can be used to prove theorems about triangles, quadrilaterals, and other geometric figures.

Similarity transformations (rigid motions followed by dilations) define similarity in the same way that rigid motions define congruence, thereby formalizing the similarity ideas of "same shape" and "scale factor" developed in the middle grades. These transformations lead to the criterion for triangle similarity that two pairs of corresponding angles are congruent.

The definitions of sine, cosine, and tangent for acute angles are founded on right triangles and similarity, and, with the Pythagorean Theorem, are fundamental in many real-world and theoretical situations. The Pythagorean Theorem is generalized to non-right triangles by the Law of Cosines. Together, the Laws of Sines and Cosines embody the triangle congruence criteria for the cases where three pieces of information suffice to completely solve a triangle. Furthermore, these laws yield two possible solutions in the ambiguous case, illustrating that Side-Side-Angle is not a congruence criterion.

Analytic geometry connects algebra and geometry, resulting in powerful methods of analysis and problem solving. Just as the number line associates numbers with locations in one dimension, a pair of perpendicular axes associates pairs of numbers with locations in two dimensions. This correspondence between numerical coordinates and geometric points allows methods from algebra to be applied to geometry and vice versa. The solution set of an equation becomes a geometric curve, making visualization a tool for doing and understanding algebra. Geometric shapes can be described by equations, making algebraic manipulation into a tool for geometric understanding, modeling, and proof. Geometric transformations of the graphs of equations correspond to algebraic changes in their equations.

Dynamic geometry environments provide students with experimental and modeling tools that allow them to investigate geometric phenomena in much the same way as computer algebra systems allow them to experiment with algebraic phenomena.

Connections to Equations. The correspondence between numerical coordinates and geometric points allows methods from algebra to be applied to geometry and vice versa. The solution set of an equation becomes a geometric curve, making visualization a tool for doing and understanding algebra. Geometric shapes can be described by equations, making algebraic manipulation into a tool for geometric understanding, modeling, and proof.

**Mathematics | High School—Statistics and Probability★**

Decisions or predictions are often based on data—numbers in context. These decisions or predictions would be easy if the data always sent a clear message, but the message is often obscured by variability. Statistics provides tools for describing variability in data and for making informed decisions that take it into account.

Data are gathered, displayed, summarized, examined, and interpreted to discover patterns and deviations from patterns. Quantitative data can be described in terms of key characteristics: measures of shape, center, and spread. The shape of a data distribution might be described as symmetric, skewed, flat, or bell shaped, and it might be summarized by a statistic measuring center (such as mean or median) and a statistic measuring spread (such as standard deviation or interquartile range). Different distributions can be compared numerically using these statistics or compared visually using plots. Knowledge of center and spread are not enough to describe a distribution. Which statistics to compare, which plots to use, and what the results of a comparison might mean, depend on the question to be investigated and the real-life actions to be taken.

Randomization has two important uses in drawing statistical conclusions. First, collecting data from a random sample of a population makes it possible to draw valid conclusions about the whole population, taking variability into account. Second, randomly assigning individuals to different treatments allows a fair comparison of the effectiveness of those treatments. A statistically significant outcome is one that is unlikely to be due to chance alone, and this can be evaluated only under the condition of randomness. The conditions under which data are collected are important in drawing conclusions from the data; in critically reviewing uses of statistics in public media and other reports, it is important to consider the study design, how the data were gathered, and the analyses employed as well as the data summaries and the conclusions drawn.

Random processes can be described mathematically by using a probability model: a list or description of the possible outcomes (the sample space), each of which is assigned a probability. In situations such as flipping a coin, rolling a number cube, or drawing a card, it might be reasonable to assume various outcomes are equally likely. In a probability model, sample points represent outcomes and combine to make up events; probabilities of events can be computed by applying the Addition and Multiplication Rules. Interpreting these probabilities relies on an understanding of independence and conditional probability, which can be approached through the analysis of two-way tables.

Technology plays an important role in statistics and probability by making it possible to generate plots, regression functions, and correlation coefficients, and to simulate many possible outcomes in a short amount of time.

Connections to Functions and Modeling. Functions may be used to describe data; if the data suggest a linear relationship, the relationship can be modeled with a regression line, and its strength and direction can be expressed through a correlation coefficient.

**Notes on Course Transitions**

The high school portion of the Standards for Mathematical Content specifies the mathematics all students should study for college and career readiness. These standards do not mandate the sequence of high school courses. However, the organization of high school courses is a critical component to implementation of the standards. To that end, sample high school pathways for mathematics – in both a traditional course sequence (Algebra I, Geometry, and Algebra II) as well as an integrated course sequence (Mathematics 1, Mathematics 2, Mathematics 3) – will be made available shortly after the release of the final Common Core State Standards. It is expected that additional model pathways based on these standards will become available as well.

The standards themselves do not dictate curriculum, pedagogy, or delivery of content. In particular, states may handle the transition to high school in different ways. For example, many students in the U.S. today take Algebra I in the 8<sup>th</sup> grade, and in some states this is a requirement. The K-7 standards contain the prerequisites to prepare students for Algebra I by 8<sup>th</sup> grade, and the standards are designed to permit states to continue existing policies concerning Algebra I in 8<sup>th</sup> grade.

A second major transition is the transition from high school to post-secondary education for

<p>college and careers. The evidence concerning college and career readiness shows clearly that the knowledge, skills, and practices important for readiness include a great deal of mathematics prior to the boundary defined by (+) symbols in these standards. Indeed, some of the highest priority content for college and career readiness comes from Grades 6-8. This body of material includes powerfully useful proficiencies such as applying ratio reasoning in real-world and mathematical problems, computing fluently with positive and negative fractions and decimals, and solving real-world and mathematical problems involving angle measure, area, surface area, and volume. Because important standards for college and career readiness are distributed across grades and courses, systems for evaluating college and career readiness should reach as far back in the standards as Grades 6-8. It is important to note as well that cut scores or other information generated by assessment systems for college and career readiness should be developed in collaboration with representatives from higher education and workforce development programs, and should be validated by subsequent performance of students in college and the workforce.</p>		
<p><b>The Real Number System</b>                      <b>HSN-RN</b></p>	<p><b>The Real Number System</b>                      <b>HSN-RN</b></p>	<p><b>Quantitative Reasoning</b>                      <b>QR</b></p>
<p><b>Extend the properties of exponents to rational exponents.</b></p>	<p><b>Extend the properties of exponents to rational exponents.</b></p>	<p><b>Standard - QR.A.1 Extend the properties of exponents to rational exponents.</b></p>
<p>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. <i>For example, we define <math>5^{1/3}</math> to be the cube root of 5 because we want <math>(5^{1/3})^3 = 5^{(1/3)3}</math> to hold, so <math>(5^{1/3})^3</math> must equal 5.</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSN.RN.A.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. <i>For example, we define <math>5^{1/3}</math> to be the cube root of 5 because we want <math>(5^{1/3})^3 = 5^{(1/3)3}</math> to hold, so <math>(5^{1/3})^3</math> must equal 5.</i></p>

<p>2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p>	<p><i>HS.NO.1a1 Simplify expressions that include exponents.</i>  <i>HS.NO.1a2 Explain the influence of an exponent on the location of a decimal point in a given number.</i>  <i>HS.NO.1a3 Convert a number expressed in scientific notation.</i>  <i>HS.NO.2c2 Rewrite expressions that include rational exponents.</i></p>	<p>HSN.RN.A.2: Rewrite expressions involving radicals and rational exponents using the properties of exponents.</p>
<p><b>Use properties of rational and irrational numbers.</b></p>	<p><b>Use properties of rational and irrational numbers.</b></p>	<p><b>Standard - QR.A.2 Use properties of rational and irrational numbers.</b></p>
<p>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.</p>	<p><i>HS.NO.2b1 Explain the pattern for the sum or product for combinations of rational and irrational numbers.</i></p>	<p>HSN.RN.B.3: Explain when and why the sum or product of two rational and/or irrational numbers is rational or irrational.</p>
<p><b>Quantities<sup>★</sup></b> <b>HSN-Q</b></p>	<p><b>Quantities<sup>★</sup></b> <b>HSN-Q</b></p>	<p><b>Quantitative Reasoning</b> <b>QR</b></p>
<p><b>Reason quantitatively and use units to solve problems.</b></p>	<p><b>Reason quantitatively and use units to solve problems.</b></p>	<p><b>Standard - QR.A.3 Reason quantitatively and use units to solve problems.<sup>★</sup></b></p>
<p>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.</p> <p>2. Define appropriate quantities for the purpose of descriptive modeling.</p> <p>3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.</p>	<p><i>H.ME.1a1 Determine the necessary unit(s) to use to solve real world problems.</i>  <i>H.ME.1a2 Solve real world problems involving units of measurement.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>H.ME.2a1 Describe the accuracy of measurement when reporting quantity (you can lessen your limitations by measuring precisely).</i></p>	<p>HSN.Q.A.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. <i>Example: Marlena made a scale drawing of the sand volleyball court at her summer camp. The drawing of the volleyball court is 6 cm long by 3 cm wide. The actual volleyball court is 18 meters long. What scale did Marlena use for the drawing?<sup>★</sup></i></p> <p>HSN.Q.A.2: Define appropriate quantities for the purpose of descriptive modeling. <i>Example: If a town in Aroostook county with a population of 1254 people is projected to double in size every 105 years, what will the population be 315 years from now?<sup>★</sup></i></p> <p>HSN.Q.A.3: Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. <i>Example: The label on a ½ - liter bottle</i></p>

		of flavored water bottled in Maine indicates that one serving of 8 ounce contains 60 calories. The label also says that the full bottle contains 130 calories. Is this the actual amount or the estimated amount of calories in this bottle? How would you explain any discrepancy?★
<b>The Complex Number System</b>	<b>HSN-CN</b>	<b>The Complex Number System</b>
<b>Perform arithmetic operations with complex numbers.</b>	<b>Perform arithmetic operations with complex numbers.</b>	<b>Quantitative Reasoning</b>
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.	<i>No CCC developed for this standard.</i>	<b>QR</b>
2. Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.	<i>No CCC developed for this standard.</i>	<b>Standard - QR.A.4 (+) Perform arithmetic operations with complex numbers.</b>
3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.	<i>No CCC developed for this standard.</i>	(+) HSN.CN.A.1: Know there is a complex number $i$ (which is a non-real number) such that $i^2 = -1$ , and every complex number has the form $a + bi$ with $a$ and $b$ real.
<b>Represent complex numbers and their operations on the complex plane.</b>	<b>Represent complex numbers and their operations on the complex plane.</b>	(+) HSN.CN.A.2: Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.
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.	<i>No CCC developed for this standard.</i>	(+) HSN.CN.A.3: Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
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 $120^\circ$ .	<i>No CCC developed for this standard.</i>	<b>Standard - QR.A.5 (+) Represent complex numbers and their operations on the complex plane.</b>
		(+) HSN.CN.B.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.
		(+) HSN.CN.B.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 $120^\circ$ .

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.	<i>No CCC developed for this standard.</i>	(+) HSN.CN.B.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.
<b>Use complex numbers in polynomial identities and equations.</b>	<b>Use complex numbers in polynomial identities and equations.</b>	<b>Standard - QR.A.6 (+) Use complex numbers in polynomial identities and equations.</b>
7. Solve quadratic equations with real coefficients that have complex solutions.	<i>No CCC developed for this standard.</i>	(+) HSN.CN.C.7: Solve quadratic equations with real coefficients that have complex solutions.
8. (+) Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$ .	<i>No CCC developed for this standard.</i>	(+) HSN.CN.C.8: Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$ .
9. (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.	<i>No CCC developed for this standard.</i>	(+) HSN.CN.C.9: Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.
<b>Vector and Matrix Quantities</b> HSN-VM	<b>Vector and Matrix Quantities</b> HSN-VM	<b>Quantitative Reasoning</b> QR
<b>Represent and model with vector quantities.</b>	<b>Represent and model with vector quantities.</b>	<b>Standard - QR.A.7 (+) Represent and model with vector quantities.</b>
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  $ , $v$ ).	<i>No CCC developed for this standard.</i>	(+) HSN.VM.A.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  $ , $v$ ).
2. (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.	<i>No CCC developed for this standard.</i>	(+) HSN.VM.A.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.	<i>No CCC developed for this standard.</i>	(+) HSN.VM.A.3: Solve problems involving velocity and other quantities that can be represented by vectors.
<b>Perform operations on vectors.</b>	<b>Perform operations on vectors.</b>	<b>Standard - QR.A.8 (+) Perform operations on vectors.</b>
4. (+) Add and subtract vectors.  a. Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that	<i>No CCC developed for this standard.</i>	(+) HSN.VM.B.4: Add and subtract vectors.  (+) HSN.VM.B4a: Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum

<p>the magnitude of a sum of two vectors is typically not the sum of the magnitudes.</p> <p>b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.</p> <p>c. Understand vector subtraction <math>v - w</math> as <math>v + (-w)</math>, where <math>-w</math> is the additive inverse of <math>w</math>, with the same magnitude as <math>w</math> and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.</p> <p>5. (+) Multiply a vector by a scalar.</p> <p>a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as <math>c(v_x, v_y) = (cv_x, cv_y)</math>.</p> <p>b. Compute the magnitude of a scalar multiple <math>cv</math> using <math>  cv   =  c v</math>. Compute the direction of <math>cv</math> knowing that when <math> c v \neq 0</math>, the direction of <math>cv</math> is either along <math>v</math> (for <math>c &gt; 0</math>) or against <math>v</math> (for <math>c &lt; 0</math>).</p>	<p><i>No CCC developed for this standard.</i></p>	<p>of two vectors is typically not the sum of the magnitudes.</p> <p>(+) HSN.VM.B4b: Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.</p> <p>(+) HSN.VM.B4c: Understand vector subtraction <math>v - w</math> as <math>v + (-w)</math>, where <math>-w</math> is the additive inverse of <math>w</math>, with the same magnitude as <math>w</math> and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.</p> <p>(+) HSN.VM.B.5: Multiply a vector by a scalar.</p> <p>(+) HSN.VM.B5a: Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as <math>c(v_x, v_y) = (cv_x, cv_y)</math>.</p> <p>(+) HSN.VM.B5b: Compute the magnitude of a scalar multiple <math>cv</math> using <math>  cv   =  c v</math>. Compute the direction of <math>cv</math> knowing that when <math> c v \neq 0</math>, the direction of <math>cv</math> is either along <math>v</math> (for <math>c &gt; 0</math>) or against <math>v</math> (for <math>c &lt; 0</math>).</p>
<p><b>Perform operations on matrices and use matrices in applications.</b></p>	<p><b>Perform operations on matrices and use matrices in applications.</b></p>	<p><b>Standard - QR.A.9 (+) Perform operations on matrices and use matrices in applications.</b></p>
<p>6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.</p> <p>7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>(+) HSN.VM.C.6: Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.</p> <p>(+) HSN.VM.C.7: Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.</p>

<p>8. (+) Add, subtract, and multiply matrices of appropriate dimensions.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>12. (+) Work with <math>2 \times 2</math> matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>(+) HSN.VM.C.8: Add, subtract, and multiply matrices of appropriate dimensions.</p> <p>(+) HSN.VM.C.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.</p> <p>(+) HSN.VM.C.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.</p> <p>(+) HSN.VM.C.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.</p> <p>(+) HSN.VM.C.12: Work with <math>2 \times 2</math> matrices as a transformations of the plane, and interpret the absolute value of the determinant in terms of area.</p>
<p><b>Seeing Structure in Expressions</b>      <b>HSA-SSE</b></p>	<p><b>Seeing Structure in Expressions</b>      <b>HSA-SSE</b></p>	<p><b>Algebraic Reasoning</b>      <b>AR</b></p>
<p><b>Interpret the structure of expressions</b></p>	<p><b>Interpret the structure of expressions</b></p>	<p><b>Standard - AR.A.1 Interpret the structure of expressions.</b></p>
<p>1. Interpret expressions that represent a quantity in terms of its context.*</p> <p>a. Interpret parts of an expression, such as terms, factors, and coefficients.</p> <p>b. Interpret complicated expressions by viewing one or more of their parts as a single entity. <i>For example, interpret <math>P(1+r)^n</math> as the product of <math>P</math> and a factor not depending on <math>P</math>.</i></p>	<p><i>H.PRF.2a1 Translate an algebraic expression into a word problem.</i></p>	<p>HSA.SSE.A.1: Interpret expressions that represent a quantity in terms of its context.*</p> <p>SSE.A.1a: Interpret parts of an expression, such as terms, factors, and coefficients.*</p> <p>SSE.A.1b: Interpret multi-part expressions by viewing one or more of their parts as a single entity. <i>For example, view <math>P(1+r)^n</math> as the product of <math>P</math> and a factor not depending on <math>P</math> and interpret the parts.*</i></p>

<p>2. Use the structure of an expression to identify ways to rewrite it. For example, see <math>x^4 - y^4</math> as <math>(x^2)^2 - (y^2)^2</math>, thus recognizing it as a difference of squares that can be factored as <math>(x^2 - y^2)(x^2 + y^2)</math>.</p>	<p><i>H.NO.2c1 Simplify expressions that include exponents.</i>  <i>H.NO.2c2 Rewrite expressions that include rational exponents.</i></p>	<p>HSA.SSE.A.2: Use the structure of an expression to identify ways to rewrite it. For example, see <math>x^4 - y^4</math> as <math>(x^2)^2 - (y^2)^2</math>, thus recognizing it as a difference of squares that can be factored as <math>(x^2 - y^2)(x^2 + y^2)</math>.</p>
<p><b>Write expressions in equivalent forms to solve problems</b></p>	<p><b>Write expressions in equivalent forms to solve problems</b></p>	<p><b>Standard - AR.A.2 Write expressions in equivalent forms to reveal information and to solve problems.*</b></p>
<p>3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*</p> <p>a. Factor a quadratic expression to reveal the zeros of the function it defines.</p> <p>b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.</p> <p>c. Use the properties of exponents to transform expressions for exponential functions. For example the expression <math>1.15^t</math> can be rewritten as <math>(1.15^{1/12})^{12t} \approx 1.012^{12t}</math> to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.</p> <p>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.*</p>	<p><i>H.NO.1a1 Simplify expressions that include exponents.</i></p> <p><i>H.NO.3a2 Rewrite mathematical statements (e.g., an expression) in multiple forms.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSA.SSE.B.3: Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.*</p> <p>HSA.SSE.B.3a: Rewrite a quadratic expression (such as by factoring) to reveal the zeros of the function it defines.*</p> <p>HSA.SSE.B.3b: Rewrite a quadratic expression (such as by completing the square) to reveal the maximum or minimum value of the function it defines.*</p> <p>HSA.SSE.B.3c: Use the properties of exponents to transform expressions for exponential functions. For example the expression <math>1.15^t</math> can be rewritten as <math>(1.15^{1/12})^{12t} \approx 1.012^{12t}</math> to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.*</p> <p>HSA.SSE.B.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, Watermilfoil in one Maine lake triples in the number of plants each week during the summer when boat propellers are not cleared when exiting the lake. If the lake has 20 plants at the beginning of the season, how many plants will exist at the end of the 12-week summer season? What is the general formula for Watermilfoil growth for this lake?*</p>

Arithmetic with Polynomials and Rational Expressions HSA-APR	Arithmetic with Polynomials and Rational Expressions HSA-APR	Algebraic Reasoning AR
<b>Perform arithmetic operations on polynomials</b>	<b>Perform arithmetic operations on polynomials</b>	<b>Standard - AR.A.3 Perform arithmetic operations on polynomials.</b>
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.	<i>No CCC developed for this standard.</i>	<p>HSA.APR.A.1: Understand that polynomials form a system analogous to the integers, namely, they are closed under certain operations.</p> <p>HSA.APR.A.1a: Perform operations on polynomial expressions (addition, subtraction, multiplication, and division), and compare the system of polynomials to the system of integers.</p> <p>HSA.APR.A.1b: Factor and/or expand polynomial expressions, identify and combine like terms, and apply the Distributive Property.</p>
<b>Understand the relationship between zeros and factors of polynomials</b>	<b>Understand the relationship between zeros and factors of polynomials</b>	<b>Standard - AR.A.4 Understand the relationship between zeros and factors of polynomials.</b>
<p>2. Know and apply the Remainder Theorem: For a polynomial <math>p(x)</math> and a number <math>a</math>, the remainder on division by <math>x - a</math> is <math>p(a)</math>, so <math>p(a) = 0</math> if and only if <math>(x - a)</math> is a factor of <math>p(x)</math>.</p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSA.APR.B.2: Know and apply the Remainder Theorem: For a polynomial <math>p(x)</math> and a number <math>a</math>, the remainder on division by <math>x - a</math> is <math>p(a)</math>, so <math>p(a) = 0</math> if and only if <math>(x - a)</math> is a factor of <math>p(x)</math>. <i>For example, consider the polynomial function <math>P(x) = x^4 - 2x^3 + ax^2 + 8x + 12</math>, where <math>a</math> is an unknown real number. If <math>(x-3)</math> is a factor of this polynomial, what is the value of <math>a</math>?</i></p> <p>(+) HSA.APR.B.3: Identify zeros of polynomials of degree three or higher when suitable factorizations (in factored form or easily factorable) are available, and use the zeros to construct a rough graph of the function defined by the polynomial.</p>
<b>Use polynomial identities to solve problems</b>	<b>Use polynomial identities to solve problems</b>	<b>Standard - AR.A.5 (+) Use polynomial identities to solve problems.</b>
4. Prove polynomial identities and use them to describe numerical relationships. <i>For example, the</i>	<i>No CCC developed for this standard.</i>	(+) HSA.APR.C.4: Prove polynomial identities and use them to describe numerical relationships. <i>For example, the polynomial identity <math>(x^2 + y^2)^2 = (x^2 -</math></i>

<p><i>polynomial identity <math>(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2</math> can be used to generate Pythagorean triples.</i></p> <p>5. (+) Know and apply the Binomial Theorem for the expansion of <math>(x + y)^n</math> in powers of <math>x</math> and <math>y</math> for a positive integer <math>n</math>, where <math>x</math> and <math>y</math> are any numbers, with coefficients determined for example by Pascal's Triangle.<sup>1</sup></p>	<p><i>No CCC developed for this standard.</i></p>	<p><i><math>y^2)^2 + (2xy)^2</math> can be used to generate Pythagorean triples.</i></p> <p>(+) HSA.APR.C.5: Know and apply the Binomial Theorem for the expansion of <math>(x + y)^n</math> in powers of <math>x</math> and <math>y</math> for a positive integer <math>n</math>, where <math>x</math> and <math>y</math> are any numbers, with coefficients determined for example by Pascal's Triangle. <i>The Binomial Theorem can be proved by mathematical induction or by a combinatorial argument.</i></p>
<p><b>Rewrite rational expressions</b></p>	<p><b>Rewrite rational expressions</b></p>	<p><b>Standard - AR.A.6 Rewrite rational expressions.</b></p>
<p>6. Rewrite simple rational expressions in different forms; write <math>a(x)/b(x)</math> in the form <math>q(x) + r(x)/b(x)</math>, where <math>a(x)</math>, <math>b(x)</math>, <math>q(x)</math>, and <math>r(x)</math> are polynomials with the degree of <math>r(x)</math> less than the degree of <math>b(x)</math>, using inspection, long division, or, for the more complicated examples, a computer algebra system.</p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSA.APR.D.6: Rewrite simple rational expressions in different forms; write <math>a(x)/b(x)</math> in the form <math>q(x) + r(x)/b(x)</math>, where <math>a(x)</math>, <math>b(x)</math>, <math>q(x)</math>, and <math>r(x)</math> are polynomials with the degree of <math>r(x)</math> less than the degree of <math>b(x)</math>, using inspection, long division, or, for the more complicated examples, a computer algebra system.</p> <p>(+) HSA.APR.D.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.</p>
<p><b>Creating Equations★</b>      <b>HSA-CED</b></p>	<p><b>Creating Equations★</b>      <b>HSA-CED</b></p>	<p><b>Algebraic Reasoning</b>      <b>AR</b></p>
<p><b>Create equations that describe numbers or relationships</b></p>	<p><b>Create equations that describe numbers or relationships</b></p>	<p><b>Standard - AR.A.7 Create equations and/or inequalities that describe numbers or relationships.★</b></p>
<p>1. Create equations and inequalities in one variable and use them to solve problems. <i>Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</i></p> <p>2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p>	<p><i>H.PRF.2b1 Translate a real-world problem into a one variable linear equation.</i></p> <p><i>H.PRF.2b2 Solve equations with one or two variables using equations or graphs.</i></p>	<p>HSA.CED.A.1: Create equations and inequalities in one variable and use them to solve problems. <i>Include equations arising from linear and quadratic functions, and simple rational and exponential functions.★</i></p> <p>HSA.CED.A.2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.★</p>

<p>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. <i>For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.</i></p> <p>4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.</i></p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSA.CED.A.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. <i>For example, represent inequalities describing nutritional and cost constraints on combinations of different foods such as lobsters, blueberries, and potatoes.*</i></p> <p>HSA.CED.A.4: Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. <i>For example, rearrange Ohm's law <math>V = IR</math> to highlight resistance <math>R</math>.*</i></p>
<p><b>Reasoning with Equations and Inequalities</b> HSA-REI</p>	<p><b>Reasoning with Equations and Inequalities</b> HSA-REI</p>	<p><b>Algebraic Reasoning</b> AR</p>
<p><b>Understand solving equations as a process of reasoning and explain the reasoning</b></p>	<p><b>Understand solving equations as a process of reasoning and explain the reasoning</b></p>	<p><b>Standard - AR.A.8 Understand solving equations as a process of reasoning and explain the reasoning.</b></p>
<p>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.</p> <p>2. Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p>	<p><i>H.PRF.2b2 Solve equations with one or two variables using equations or graphs.</i></p> <p><i>H.NO.2a1 Solve simple equations using rational numbers with one or more variables.</i></p>	<p>HSA.REI.A.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 or refute a solution method.</p> <p>HSA.REI.A.2: Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.</p>
<p><b>Solve equations and inequalities in one variable</b></p>	<p><b>Solve equations and inequalities in one variable</b></p>	<p><b>Standard - AR.A.9 Solve equations and inequalities in one variable.</b></p>
<p>3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>4. Solve quadratic equations in one variable.</p>	<p><i>H.PRF.2b2 Solve equations with one or two variables using equations or graphs.</i> <i>H.ME.1b2 Solve a linear equation to find a missing attribute given the area, surface area, or volume and the other attribute.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSA.REI.B.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</p> <p>HSA.REI.B.4: Solve quadratic equations in one variable.</p>

<p>a. Use the method of completing the square to transform any quadratic equation in <math>x</math> into an equation of the form <math>(x - p)^2 = q</math> that has the same solutions. Derive the quadratic formula from this form.</p> <p>b. Solve quadratic equations by inspection (e.g., for <math>x^2 = 49</math>), 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 <math>a \pm bi</math> for real numbers <math>a</math> and <math>b</math>.</p>		<p>HSA.REI.B.4a: Use the method of completing the square to transform any quadratic equation in <math>x</math> into an equation of the form <math>(x - p)^2 = q</math> that has the same solutions. Derive the quadratic formula from this form.</p> <p>HSA.REI.B.4b: i) Solve quadratic equations by inspection (e.g., for <math>x^2 = 49</math>), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation.</p> <p>(+) HSA.REI.B.4b: ii) Recognize when the quadratic formula gives complex solutions and write them as <math>a \pm bi</math> for real numbers <math>a</math> and <math>b</math>.</p>
<p><b>Solve systems of equations</b></p>	<p><b>Solve systems of equations</b></p>	<p><b>Standard - AR.A.10 Solve systems of equations.</b></p>
<p>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.</p> <p>6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p> <p>7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. <i>For example, find the points of intersection between the line <math>y = -3x</math> and the circle <math>x^2 + y^2 = 3</math>.</i></p> <p>8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.</p> <p>9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSA.REI.C.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.</p> <p>HSA.REI.C.6: Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</p> <p>HSA.REI.C.7: Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. <i>For example, find the point(s) of intersection between the line <math>y = -3x</math> and the circle <math>x^2 + y^2 = 3</math>.</i></p> <p>(+) HSA.REI.C.8: Represent a system of linear equations as a single matrix equation in a vector variable.</p> <p>(+) HSA.REI.C.9: Find the inverse of a matrix if it exists and use it to solve systems of linear</p>

technology for matrices of dimension $3 \times 3$ or greater).		equations (using technology for matrices of dimension $3 \times 3$ or greater).
<b>Represent and solve equations and inequalities graphically</b>	<b>Represent and solve equations and inequalities graphically</b>	<b>Standard - AR.A.11 Represent and solve equations and inequalities graphically.</b>
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).	<i>No CCC developed for this standard.</i>	HSA.REI.D.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). Show that any point on the graph of an equation in two variables is a solution to the equation.
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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*	<i>No CCC developed for this standard.</i>	HSA.REI.D.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. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
12. Graph the solutions to a linear inequality in two variables as a halfplane (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.	<i>No CCC developed for this standard.</i>	HSA.REI.D.12: Graph the solutions of 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 of a system of linear inequalities in two variables as the intersection of the corresponding half-planes.
<b>Interpreting Functions</b> <b>HSF-IF</b>	<b>Interpreting Functions</b> <b>HSF-IF</b>	<b>Algebraic Reasoning</b> <b>AR</b>
<b>Understand the concept of a function and use function notation</b>	<b>Understand the concept of a function and use function notation</b>	<b>Standard - AR.A.12 Understand the concept of a function and use function notation.</b>
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 $y = f(x)$ .	<i>No CCC developed for this standard.</i>	HSF.IF.A.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 $y = f(x)$ .

<p>2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.IF.A.2: Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.</p>
<p>3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. <i>For example, the Fibonacci sequence is defined recursively by <math>f(0) = f(1) = 1</math>, <math>f(n+1) = f(n) + f(n-1)</math> for <math>n \geq 1</math>.</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.IF.A.3: Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. <i>For example, the Fibonacci sequence is defined recursively by <math>f(0) = f(1) = 1</math>, <math>f(n+1) = f(n) + f(n-1)</math> for <math>n \geq 1</math>.</i></p>
<p><b>Interpret functions that arise in applications in terms of the context</b></p>	<p><b>Interpret functions that arise in applications in terms of the context</b></p>	<p><b>Standard - AR.A.13 Interpret functions that arise in applications in terms of the context.*</b></p>
<p>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. <i>Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.IF.B.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. <i>Key features may include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative and absolute maximums and minimums; symmetries; end behavior; and periodicity.*</i></p>
<p>5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. <i>For example, if the function <math>h(n)</math> gives the number of person-hours it takes to assemble <math>n</math> engines in a factory, then the positive integers would be an appropriate domain for the function.*</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.IF.B.5: Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. <i>For example, if the function <math>h(n)</math> gives the number of person-hours it takes to assemble <math>n</math> engines in a factory, then the positive integers would be an appropriate domain for the function.*</i></p>
<p>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.*</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.IF.B.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.*</p>
<p><b>Analyze functions using different representations</b></p>	<p><b>Analyze functions using different representations</b></p>	<p><b>Standard - AR.A.14 Analyze functions using different representations.</b></p>
<p>7. Graph functions expressed symbolically and show key features of the graph, by hand in simple</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.IF.C.7: Graph functions expressed symbolically as well as show and describe key features of the</p>

<p>cases and using technology for more complicated cases.*</p> <p>a. Graph linear and quadratic functions and show intercepts, maxima, and minima.</p> <p>b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.</p> <p>c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.</p> <p>d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.</p> <p>e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.</p> <p>8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>graph, by hand in simple cases and using technology for more complicated cases.*</p> <p>HSF.IF.C.7a: Graph linear and quadratic functions and show intercepts, maxima, and minima.</p> <p>HSF.IF.C.7b: i) Graph square root and piecewise-defined functions, (including step functions and absolute value functions), as well as show and describe key features of the graph.</p> <p>(+) HSF.IF.C.7b: ii) Graph cube root functions, as well as show and describe key features of the graph.</p> <p>(+) HSF.IF.C.7c: Graph polynomial functions of degree three or higher, identifying zeros when suitable factorizations (in factored form or easily factorable) are available, and showing end behavior.</p> <p>(+) HSF.IF.C.7d: Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.</p> <p>HSF.IF.C.7e: i) Graph exponential functions, showing intercepts and end behavior, and</p> <p>(+) HSF.IF.C.7e: ii) Graph logarithmic functions, showing intercepts and end behavior and trigonometric functions, showing period, midline, and amplitude.</p> <p>HSF.IF.C.8: Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</p>
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<p>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.</p> <p>b. Use the properties of exponents to interpret expressions for exponential functions. <i>For example, identify percent rate of change in functions such as <math>y = (1.02)^t</math>, <math>y = (0.97)^t</math>, <math>y = (1.01)^{12t}</math>, <math>y = (1.2)^{t/10}</math>, and classify them as representing exponential growth or decay.</i></p> <p>9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.</i></p>	<p>No CCC developed for this standard.</p>	<p>HSF.IF.C.8a: Use the process of factoring and completing the square in a quadratic function to show zeros, maximum and minimum values, and symmetry of the graph, and interpret these in terms of a context.</p> <p>HSF.IF.C.8b: Use the properties of exponents to interpret expressions for exponential functions. <i>For example, apply the properties to financial situations such as identifying appreciation and depreciation rate for the value of a house or car sometime after its initial purchase: <math>V_n = P(1 + r)^n</math>.</i></p> <p>HSF.IF.C.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). <i>For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.</i></p>
<p><b>Building Functions</b> <b>HSF-BF</b></p>	<p><b>Building Functions</b> <b>HSF-BF</b></p>	<p><b>Algebraic Reasoning</b> <b>AR</b></p>
<p><b>Build a function that models a relationship between two quantities</b></p>	<p><b>Build a function that models a relationship between two quantities</b></p>	<p><b>Standard - AR.A.15 Build a function that models a relationship between two quantities.*</b></p>
<p>1. Write a function that describes a relationship between two quantities.*</p> <p>a. Determine an explicit expression, a recursive process, or steps for calculation from a context.</p> <p>b. Combine standard function types using arithmetic operations. <i>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.</i></p>	<p>No CCC developed for this standard.</p>	<p>HSF.BF.A.1: Write a function that describes a relationship between two quantities.*</p> <p>HSF.BF.A.1a: Determine an explicit expression, a recursive process, or steps for calculation from a context.</p> <p>HSF.BF.A.1b: Combine standard function types using arithmetic operations. <i>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.</i></p>

<p>c. (+) Compose functions. <i>For example, if <math>T(y)</math> is the temperature in the atmosphere as a function of height, and <math>h(t)</math> is the height of a weather balloon as a function of time, then <math>T(h(t))</math> is the temperature at the location of the weather balloon as a function of time.</i></p> <p>2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*</p>	<p><i>No CCC developed for this standard.</i></p>	<p>(+) HSF.BF.A.1c: Compose functions. <i>For example, if <math>T(y)</math> is the temperature in the atmosphere as a function of height, and <math>h(t)</math> is the height of a weather balloon as a function of time, then <math>T(h(t))</math> is the temperature at the location of the weather balloon as a function of time.</i></p> <p>HSF.BF.A.2: Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.*</p>
<p><b>Build new functions from existing functions</b></p>	<p><b>Build new functions from existing functions</b></p>	<p><b>Standard - AR.A.16 Build new functions from existing functions.</b></p>
<p>3. Identify the effect on the graph of replacing <math>f(x)</math> by <math>f(x) + k</math>, <math>k f(x)</math>, <math>f(kx)</math>, and <math>f(x + k)</math> for specific values of <math>k</math> (both positive and negative); find the value of <math>k</math> given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. <i>Include recognizing even and odd functions from their graphs and algebraic expressions for them.</i></p> <p>4. Find inverse functions.</p> <p>a. Solve an equation of the form <math>f(x) = c</math> for a simple function <math>f</math> that has an inverse and write an expression for the inverse. <i>For example, <math>f(x) = 2x^3</math> or <math>f(x) = (x+1)/(x-1)</math> for <math>x \neq 1</math>.</i></p> <p>b. (+) Verify by composition that one function is the inverse of another.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSF.BF.B.3: Identify the effect on the graph of replacing <math>f(x)</math> by <math>f(x) + k</math>, <math>k f(x)</math>, <math>f(kx)</math>, and <math>f(x + k)</math> for specific values of <math>k</math> (both positive and negative); find the value of <math>k</math> given the graphs. Experiment with 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.</p> <p>HSF.BF.B.4: Find inverse functions.</p> <p>HSF.BF.B.4a: Solve an equation of the form <math>f(x) = c</math> (where <math>c</math> represents the output value of the function) for a simple function <math>f</math> that has an inverse and write an expression for the inverse. <i>For example, if <math>f(x) = 2x^3</math>, then solving <math>f(x) = c</math> leads to <math>x = (c/2)^{1/3}</math>, which is the general formula for finding an input from a specific output, <math>c</math>, for this function.</i></p> <p>(+) HSF.BF.B.4b: Verify by composition that one function is the inverse of another.</p>

<p>c. (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.</p> <p>d. (+) Produce an invertible function from a non-invertible function by restricting the domain.</p> <p>5. (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>(+) HSF.BF.B.4c: Read values of an inverse function from a graph or a table, given that the function has an inverse.</p> <p>(+) HSF.BF.B.4d: Produce an invertible function from a non-invertible function by restricting the domain.</p> <p>(+) HSF.BF.B.5: Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.</p>
<p><b>Linear, Quadratic, and Exponential Models<sup>★</sup></b> HSF-LE</p>	<p><b>Linear, Quadratic, and Exponential Models<sup>★</sup></b> HSF-LE</p>	<p><b>Algebraic Reasoning</b> <span style="float: right;"><b>AR</b></span></p>
<p><b>Construct and compare linear, quadratic, and exponential models and solve problems</b></p>	<p><b>Construct and compare linear, quadratic, and exponential models and solve problems</b></p>	<p><b>Standard - AR.A.17 Construct and compare linear, quadratic, and exponential models and solve problems.<sup>★</sup></b></p>
<p>1. Distinguish between situations that can be modeled with linear functions and with exponential functions.</p> <p>a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.</p> <p>b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.</p> <p>c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.</p> <p>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).</p>	<p><i>H.PRF.1c1 Select the appropriate graphical representation of a linear model based on real world events.</i></p> <p><i>H.PRF.1b1 In a linear situation using graphs or numbers, predicts the change in rate based on a given change in one variable (e.g., If I have been adding sugar at a rate of 1T per cup of water. What happens to my rate if I switch to 2T of sugar for every cup of water?).</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSF.LE.A.1: Distinguish between situations that can be modeled with linear functions and with exponential functions.<sup>★</sup></p> <p>HSF.LE.A.1a: Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.</p> <p>HSF.LE.A.1b: Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.</p> <p>HSF.LE.A.1c: Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.</p> <p>HSF.LE.A.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).<sup>★</sup></p>

<p>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.</p> <p>4. For exponential models, express as a logarithm the solution to <math>ab^{ct} = d</math> where <math>a</math>, <math>c</math>, and <math>d</math> are numbers and the base <math>b</math> is 2, 10, or <math>e</math>; evaluate the logarithm using technology.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSF.LE.A.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.*</p> <p>(+) HSF.LE.A.4: For exponential models, express as a logarithm the solution to <math>ab^{ct} = d</math> where <math>a</math>, <math>c</math>, and <math>d</math> are numbers and the base <math>b</math> is 2, 10, or <math>e</math>; evaluate the logarithm using technology.*</p>
<p><b>Interpret expressions for functions in terms of the situation they model</b></p>	<p><b>Interpret expressions for functions in terms of the situation they model</b></p>	<p><b>Standard - AR.A.18 Interpret expressions for function in terms of the situation they model.*</b></p>
<p>5. Interpret the parameters in a linear or exponential function in terms of a context.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.LE.B.5: Interpret the parameters in a linear or exponential function in terms of a context.*</p>
<p><b>Trigonometric Functions</b> <span style="float: right;"><b>HSF-TF</b></span></p>	<p><b>Trigonometric Functions</b> <span style="float: right;"><b>HSF-TF</b></span></p>	<p><b>Algebraic Reasoning</b> <span style="float: right;"><b>AR</b></span></p>
<p><b>Extend the domain of trigonometric functions using the unit circle</b></p>	<p><b>Extend the domain of trigonometric functions using the unit circle</b></p>	<p><b>Standard - AR.A.19 Extend the domain of trigonometric functions using the unit circle.</b></p>
<p>1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</p> <p>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.</p> <p>3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for <math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>, and use the unit circle to express the values of sine, cosine, and tangent for <math>\pi-x</math>, <math>\pi+x</math>, and <math>2\pi-x</math> in terms of their values for <math>x</math>, where <math>x</math> is any real number.</p> <p>4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSF.TF.A.1: Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</p> <p>HSF.TF.A.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.</p> <p>(+) HSF.TF.A.3: Use special triangles to determine geometrically the values of sine, cosine, tangent for <math>\pi/3</math>, <math>\pi/4</math> and <math>\pi/6</math>, and use the unit circle to express the values of sine, cosine, and tangent for <math>\pi-x</math>, <math>\pi+x</math>, and <math>2\pi-x</math> in terms of their values for <math>x</math>, where <math>x</math> is any real number.</p> <p>(+) HSF.TF.A.4: Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.</p>

<b>Model periodic phenomena with trigonometric functions</b>	<b>Model periodic phenomena with trigonometric functions</b>	<b>Standard - AR.A.20 (+) Model periodic phenomena with trigonometric functions.</b>
<p>5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*</p> <p>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.</p> <p>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.*</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>(+) HSF.TF.B.5: Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*</p> <p>(+) HSF.TF.B.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.</p> <p>(+) HSF.TF.B.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.*</p>
<b>Prove and apply trigonometric identities</b>	<b>Prove and apply trigonometric identities</b>	<b>Standard - AR.A.21 (+) Prove and apply trigonometric identities.</b>
<p>8. Prove the Pythagorean identity <math>\sin^2(\theta) + \cos^2(\theta) = 1</math> and use it to find <math>\sin(\theta)</math>, <math>\cos(\theta)</math>, or <math>\tan(\theta)</math> given <math>\sin(\theta)</math>, <math>\cos(\theta)</math>, or <math>\tan(\theta)</math> and the quadrant of the angle.</p> <p>9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>(+) HSF.TF.C.8: Prove the Pythagorean identity <math>\sin^2(\theta) + \cos^2(\theta) = 1</math> and use it to find <math>\sin(\theta)</math>, <math>\cos(\theta)</math>, or <math>\tan(\theta)</math> given <math>\sin(\theta)</math>, <math>\cos(\theta)</math>, or <math>\tan(\theta)</math> and the quadrant of the angle.</p> <p>(+) HSF.TF.C.9: Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.</p>
<b>Congruence</b> <span style="float: right;"><b>HSG-CO</b></span>	<b>Congruence</b> <span style="float: right;"><b>HSG-CO</b></span>	<b>Geometric Reasoning</b> <span style="float: right;"><b>GR</b></span>
<b>Experiment with transformations in the plane</b>	<b>Experiment with transformations in the plane</b>	<b>Standard - GR.A.1 Experiment with transformations in the plane.</b>
<p>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.</p> <p>2. Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.CO.A.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.</p> <p>HSG.CO.A.2: Represent transformations in the plane using, e.g., transparencies and/or geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations</p>

<p>preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).</p> <p>3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.</p> <p>4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.</p> <p>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.</p>	<p><i>H.GM.1c1 Construct, draw or recognize a figure after its rotation, reflection, or translation.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>H.GM.1c1 Construct, draw or recognize a figure after its rotation, reflection, or translation.</i></p>	<p>that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).</p> <p>HSG.CO.A.3: Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.</p> <p>HSG.CO.A.4: Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.</p> <p>HSG.CO.A.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.</p>
<p><b>Understand congruence in terms of rigid motions</b></p>	<p><b>Understand congruence in terms of rigid motions</b></p>	<p><b>Standard - GR.A.2 Understand congruence in terms of rigid motions.</b></p>
<p>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.</p> <p>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.</p> <p>8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>H.GM.1b1 Use definitions to demonstrate congruency and similarity in figures.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.CO.B.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.</p> <p>HSG.CO.B.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.</p> <p>HSG.CO.B.8: Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.</p>
<p><b>Prove geometric theorems</b></p>	<p><b>Prove geometric theorems</b></p>	<p><b>Standard - GR.A.3 Prove geometric theorems and when appropriate, the converse of theorems.</b></p>

<p>9. Prove theorems about lines and angles. <i>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 the segment's endpoints.</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSG.CO.C.9: Prove theorems about lines and angles. <i>Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent, and conversely prove lines are parallel; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.</i></p>
<p>10. Prove theorems about triangles. <i>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.</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSG.CO.C.10: Prove theorems about triangles. <i>Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangles are congruent, and conversely prove a triangle is isosceles; 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.</i></p>
<p>11. Prove theorems about parallelograms. <i>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.</i></p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSG.CO.C.11: Prove theorems about parallelograms. <i>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.</i></p>
<p><b>Make geometric constructions</b></p>	<p><b>Make geometric constructions</b></p>	<p><b>Standard - GR.A.4 Make geometric constructions.</b></p>
<p>12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). <i>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.</i></p>	<p><i>H.GM.1e1 Make formal geometric constructions with a variety of tools and methods.</i></p>	<p>HSG.CO.D.12: Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). <i>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.</i></p>
<p>13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSG.CO.D.13: Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.</p>
<p><b>Similarity, Right Triangles, and Trigonometry</b></p>	<p><b>Similarity, Right Triangles, and Trigonometry</b></p>	<p><b>Geometric Reasoning</b> <span style="float: right;"><b>GR</b></span></p>

HSG-SRT	HSG-SRT	HSG-SRT
<b>Understand similarity in terms of similarity transformations</b>	<b>Understand similarity in terms of similarity transformations</b>	<b>Standard - GR.A.5 Understand similarity in terms of similarity transformations.</b>
<p>1. Verify experimentally the properties of dilations given by a center and a scale factor:</p> <p>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.</p> <p>b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.</p> <p>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.</p> <p>3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.</p>	<p><i>H.ME.2b1 Determine the dimensions of a figure after dilation.</i></p> <p><i>H.ME.2b2 Determine if two figures are similar.</i></p> <p><i>H.ME.2b3 Describe or select why two figures are or are not similar.</i></p> <p><i>H.GM.1b1 Use definitions to demonstrate congruency and similarity in figures.</i></p> <p><i>H.GM.1d1 Use the reflections, rotations, or translations in the coordinate plane to solve problems with right angles.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.SRT.A.1: Verify experimentally the properties of dilations given by a center and a scale factor:</p> <p>HSG.SRT.A.1a: 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.</p> <p>HSG.SRT.A.1b: The dilation of a line segment is longer or shorter in the ratio given by the scale factor.</p> <p>HSG.SRT.A.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.</p> <p>HSG.SRT.A.3: Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.</p>
<b>Prove theorems involving similarity</b>	<b>Prove theorems involving similarity</b>	<b>Standard - GR.A.6 Prove theorems involving similarity using a variety of ways of writing proofs, showing validity of underlying reasoning.</b>
<p>4. Prove theorems about triangles. <i>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.</i></p> <p>5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.SRT.B.4: Prove theorems about triangles. <i>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.</i></p> <p>HSG.SRT.B.5: Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.</p>

<b>Define trigonometric ratios and solve problems involving right triangles</b>	<b>Define trigonometric ratios and solve problems involving right triangles</b>	<b>Standard - GR.A.7 Define trigonometric ratios and solve problems involving right triangles.</b>
<p>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.</p> <p>7. Explain and use the relationship between the sine and cosine of complementary angles.</p> <p>8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.SRT.C.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.</p> <p>HSG.SRT.C.7: Explain and use the relationship between the sine and cosine of complementary angles.</p> <p>HSG.SRT.C.8: Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. <i>For example, find the current height of the tallest pine tree in Maine using the angle of elevation and the distance from the tree.*</i></p>
<b>Apply trigonometry to general triangles</b>	<b>Apply trigonometry to general triangles</b>	<b>Standard - GR.A.8 (+) Apply trigonometry to general triangles.</b>
<p>9. (+) Derive the formula <math>A = 1/2 ab \sin(C)</math> for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.</p> <p>10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.</p> <p>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).</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>(+) HSG.SRT.D.9: Derive the formula <math>A = 1/2 ab \sin(C)</math> for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.</p> <p>(+) HSG.SRT.D.10: Prove the Laws of Sines and Cosines and use them to solve problems.</p> <p>(+) HSG.SRT.D.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).</p>
<b>Circles</b> HSG-C	<b>Circles</b> HSG-C	<b>Geometric Reasoning</b> GR
<b>Understand and apply theorems about circles</b>	<b>Understand and apply theorems about circles</b>	<b>Standard - GR.A.9 Understand and apply theorems about circles.</b>
<p>1. Prove that all circles are similar.</p> <p>2. Identify and describe relationships among inscribed angles, radii, and chords. <i>Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a</i></p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.C.A.1: Prove that all circles are similar.</p> <p>HSG.C.A.2: Identify and describe relationships among inscribed angles, radii, and chords. <i>Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a</i></p>

<p>diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</p> <p>3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.</p> <p>4. (+) Construct a tangent line from a point outside a given circle to the circle.</p>	<p>No CCC developed for this standard.</p> <p>No CCC developed for this standard.</p>	<p>diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</p> <p>HSG.C.A.3: Construct the inscribed and circumscribed circles of a triangle and prove properties of angles for a quadrilateral inscribed in a circle.</p> <p>(+) HSG.C.A.4: Construct a tangent line from a point outside a given circle to the circle.</p>
<b>Find arc lengths and areas of sectors of circles</b>	<b>Find arc lengths and areas of sectors of circles</b>	<b>Standard - GR.A.10 Find arc lengths and areas of sectors of circles.</b>
<p>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.</p>	<p><i>H.ME.2b4 Apply the formula to the area of a sector (e.g., area of a slice of pie).</i></p>	<p>HSG.C.B.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.</p>
<b>Expressing Geometric Properties with Equations</b> HSG-GPE	<b>Expressing Geometric Properties with Equations</b> HSG-GPE	<b>Geometric Reasoning</b> <span style="float: right;"><b>GR</b></span>
<b>Translate between the geometric description and the equation for a conic section</b>	<b>Translate between the geometric description and the equation for a conic section</b>	<b>Standard - GR.A.11 Translate between the geometric description and the equation for a conic section.</b>
<p>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.</p> <p>2. Derive the equation of a parabola given a focus and directrix.</p> <p>3. (+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.</p>	<p>No CCC developed for this standard.</p> <p>No CCC developed for this standard.</p> <p>No CCC developed for this standard.</p>	<p>HSG.GPE.A.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.</p> <p>HSG.GPE.A.2: Derive the equation of a parabola given a focus and directrix.</p> <p>(+) HSG.GPE.A.3: Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.</p>
<b>Use coordinates to prove simple geometric theorems algebraically</b>	<b>Use coordinates to prove simple geometric theorems algebraically</b>	<b>Standard - GR.A.12 Use coordinates to prove simple geometric theorems algebraically.</b>

<p>4. Use coordinates to prove simple geometric theorems algebraically. <i>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 <math>(1, \sqrt{3})</math> lies on the circle centered at the origin and containing the point <math>(0, 2)</math>.</i></p> <p>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).</p> <p>6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.</p> <p>7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSG.GPE.B.4: Use coordinates to prove simple geometric theorems algebraically including the distance formula and its relationship to the Pythagorean Theorem. <i>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 <math>(1, \sqrt{3})</math> lies on the circle centered at the origin and containing the point <math>(0, 2)</math>.</i></p> <p>HSG.GPE.B.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).</p> <p>HSG.GPE.B.6: Find the point on a directed line segment between two given points that partitions the segment in a given ratio.</p> <p>HSG.GPE.B.7: Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.*</p>
<p><b>Geometric Measurement and Dimension</b> HSG-GMD</p>	<p><b>Geometric Measurement and Dimension</b> HSG-GMD</p>	<p><b>Geometric Reasoning</b> <span style="float: right;"><b>GR</b></span></p>
<p><b>Explain volume formulas and use them to solve problems</b></p>	<p><b>Explain volume formulas and use them to solve problems</b></p>	<p><b>Standard - GR.A.13 Explain volume formulas and use them to solve problems.</b></p>
<p>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. <i>Use dissection arguments, Cavalieri's principle, and informal limit arguments.</i></p> <p>2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.</p> <p>3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSG.GMD.A.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. <i>Use dissection arguments, Cavalieri's principle, and/or informal limit arguments.</i></p> <p>(+) HSG.GMD.A.2: Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.</p> <p>HSG.GMD.A.3: Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.*</p>

<b>Visualize relationships between two-dimensional and three-dimensional objects</b>	<b>Visualize relationships between two-dimensional and three-dimensional objects</b>	<b>Standard - GR.A.14 Visualize relationships between two-dimensional and three-dimensional objects.</b>
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.	<i>No CCC developed for this standard.</i>	HSG.GMD.B.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.
<b>Modeling with Geometry</b> HSG-MG	<b>Modeling with Geometry</b> HSG-MG	<b>Geometric Reasoning</b> GR
<b>Apply geometric concepts in modeling situations</b>	<b>Apply geometric concepts in modeling situations</b>	<b>Standard - GR.A.15 Apply geometric concepts in modeling situations.*</b>
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).*	<i>H.ME.1b1 Describe the relationship between the attributes of a figure and the changes in the area or volume when 1 attribute is changed.</i>	HSG.MG.A.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).*
2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).*	<i>No CCC developed for this standard.</i>	HSG.MG.A.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).*	<i>H.ME.2b5 Apply the formula of geometric figures to solve design problems (e.g., designing an object or structure to satisfy physical restraints or minimize cost).</i>	HSG.MG.A.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).*
<b>Interpreting Categorical and Quantitative Data</b> HSS-ID	<b>Interpreting Categorical and Quantitative Data</b> HSS-ID	<b>Statistical Reasoning</b> SR
<b>Summarize, represent, and interpret data on a single count or measurement variable</b>	<b>Summarize, represent, and interpret data on a single count or measurement variable</b>	<b>Standard - SR.A.1 Summarize, represent, and interpret data on a single count or measurement variable.*</b>
1. Represent data with plots on the real number line (dot plots, histograms, and box plots).	<i>H.DPS.1b1 Complete a graph given the data, using dot plots, histograms, or box plots.</i>	HSS.ID.A.1: Represent data with plots on the real number line (dot plots, histograms, and box plots).*
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.	<i>H.DPS.1c2 Compare means, median, and range of 2 sets of data.</i>	HSS.ID.A.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.*

<p>3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).</p> <p>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.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>H.DPS.1c1 Use descriptive stats; range, median, mode, mean, outliers/gaps to describe the data set.</i></p>	<p>HSS.ID.A.3: Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*</p> <p>HSS.ID.A.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.*</p>
<p><b>Summarize, represent, and interpret data on two categorical and quantitative variables</b></p>	<p><b>Summarize, represent, and interpret data on two categorical and quantitative variables</b></p>	<p><b>Standard - SR.A.2 Summarize, represent, and interpret data on two categorical variables and two quantitative variables.*</b></p>
<p>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.</p> <p>6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.</p> <p>a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. <i>Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.</i></p> <p>b. Informally assess the fit of a function by plotting and analyzing residuals.</p>	<p><i>H.DPS.1a1 Design study using categorical and continuous data, including creating a question, identifying a sample, and making a plan for data collection.</i></p> <p><i>H.DPS.1c1 Use descriptive statistics; range, median, mode, mean, outliers/gaps to describe the data set.</i></p> <p><i>H.DPS.1d1 Represent data on a scatter plot to describe and predict.</i></p> <p><i>H.DPS.1d2 Select an appropriate statement that describes the relationship between variables.</i></p>	<p>HSS.ID.B.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.*</p> <p>HSS.ID.B.6: Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.*</p> <p>HSS.ID.B.6a: Fit a function to the data; use functions fitted to data to solve problems in the context of the data. <i>Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.*</i></p> <p>HSS.ID.B.6b: Informally assess the fit of a function by plotting and analyzing residuals.*</p>

c. Fit a linear function for a scatter plot that suggests a linear association.		HSS.ID.B.6c: Fit a linear function for a scatter plot that suggests a linear association. *
<b>Interpret linear models</b>	<b>Interpret linear models</b>	<b>Standard - SR.A.3 Interpret linear models.*</b>
7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.	<i>H.PRF.1a1 Interpret the rate of change using graphical representations.</i>	HSS.ID.C.7: Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. *
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.	<i>No CCC developed for this standard.</i>	HSS.ID.C.8: Compute (using technology) and interpret the correlation coefficient of a linear fit. *
9. Distinguish between correlation and causation.	<i>No CCC developed for this standard.</i>	HSS.ID.C.9: Distinguish between correlation and causation. *
<b>Making Inferences and Justifying Conclusions</b> HSS-IC	<b>Making Inferences and Justifying Conclusions</b> HSS-IC	<b>Statistical Reasoning</b> <span style="float: right;"><b>SR</b></span>
<b>Understand and evaluate random processes underlying statistical experiments</b>	<b>Understand and evaluate random processes underlying statistical experiments</b>	<b>Standard - SR.A.4 Understand and evaluate random processes underlying statistical experiments.*</b>
1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.	<i>H.DPS.1c3 Determine what inferences can be made from statistics.</i>	HSS.IC.A.1: Understand statistics as a process for making inferences about population parameters based on a random sample from that population. *
2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. <i>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?</i>	<i>No CCC developed for this standard.</i>	HSS.IC.A.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? *
<b>Make inferences and justify conclusions from sample surveys, experiments and observational studies</b>	<b>Make inferences and justify conclusions from sample surveys, experiments and observational studies</b>	<b>Standard - SR.A.5 Make inferences and justify conclusions from sample surveys, experiments, and observational studies.*</b>
3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.	<i>No CCC developed for this standard.</i>	HSS.IC.B.3: Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. *
4. Use data from a sample survey to estimate a population mean or proportion; develop a margin	<i>No CCC developed for this standard.</i>	HSS.IC.B.4: Use data from a sample survey to estimate a population mean or proportion;

<p>of error through the use of simulation models for random sampling.</p> <p>5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.</p> <p>6. Evaluate reports based on data.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>H.DPS.1d3 Make or select an appropriate statement(s) about findings.</i></p> <p><i>H.DPS.1d4 Apply the results of the data to a real world situation.</i></p>	<p>develop a margin of error through the use of simulation models for random sampling.*</p> <p>HSS.IC.B.5: Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*</p> <p>HSS.IC.B.6: Evaluate reports based on data. <i>For example, use an article in the local news and interpret the validity of the information presented. Consider animal wildlife reports, medical studies, and/or manufacturer claims.*</i></p>
<p><b>Conditional Probability and the Rules of Probability</b> HSS-CP</p>	<p><b>Conditional Probability and the Rules of Probability</b> HSS-CP</p>	<p><b>Statistical Reasoning</b> SR</p>
<p><b>Understand independence and conditional probability and use them to interpret data</b></p>	<p><b>Understand independence and conditional probability and use them to interpret data</b></p>	<p><b>Standard - SR.A.6 Understand independence and conditional probability and use them to interpret data.*</b></p>
<p>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").</p> <p>2. Understand that two events <math>A</math> and <math>B</math> are independent if the probability of <math>A</math> and <math>B</math> occurring together is the product of their probabilities, and use this characterization to determine if they are independent.</p> <p>3. Understand the conditional probability of <math>A</math> given <math>B</math> as <math>P(A \text{ and } B)/P(B)</math>, and interpret independence of <math>A</math> and <math>B</math> as saying that the conditional probability of <math>A</math> given <math>B</math> is the same as the probability of <math>A</math>, and the conditional probability of <math>B</math> given <math>A</math> is the same as the probability of <math>B</math>.</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>HSS.CP.A.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").*</p> <p>HSS.CP.A.2: Understand that two events <math>A</math> and <math>B</math> are independent if the probability of <math>A</math> and <math>B</math> occurring together is the product of their probabilities, and use this characterization to determine if they are independent.*</p> <p>HSS.CP.A.3: Understand the conditional probability of <math>A</math> given <math>B</math> as <math>P(A \text{ and } B)/P(B)</math>, and interpret independence of <math>A</math> and <math>B</math> as saying that the conditional probability of <math>A</math> given <math>B</math> is the same as the probability of <math>A</math>, and the conditional probability of <math>B</math> given <math>A</math> is the same as the probability of <math>B</math>.*</p>

<p>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 events are independent and to approximate conditional probabilities. <i>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.</i></p> <p>5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. <i>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.</i></p>	<p><i>H.DSP.2d Select or make an appropriate statement based on a two-way frequency table.</i></p> <p><i>H.DSP.2e Select or make an appropriate statement based on real world examples of conditional probability.</i></p>	<p>HSS.CP.A.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 events are independent and to approximate conditional probabilities. <i>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.*</i></p> <p>HSS.CP.A.5: Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. <i>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.*</i></p>
<p><b>Use the rules of probability to compute probabilities of compound events in a uniform probability model</b></p>	<p><b>Use the rules of probability to compute probabilities of compound events in a uniform probability model</b></p>	<p><b>Standard - SR.A.7 Use the rules of probability to compute probabilities of compound events in a uniform probability model.*</b></p>
<p>6. Find the conditional probability of <math>A</math> given <math>B</math> as the fraction of <math>B</math>'s outcomes that also belong to <math>A</math>, and interpret the answer in terms of the model.</p> <p>7. Apply the Addition Rule, <math>P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)</math>, and interpret the answer in terms of the model.</p> <p>8. (+) Apply the general Multiplication Rule in a uniform probability model, <math>P(A \text{ and } B) = P(A)P(B A) = P(B)P(A B)</math>, and interpret the answer in terms of the model.</p> <p>9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>HSS.CP.B.6: Find the conditional probability of <math>A</math> given <math>B</math> as the fraction of <math>B</math>'s outcomes that also belong to <math>A</math>, and interpret the answer in terms of the model.*</p> <p>HSS.CP.B.7: Apply the Addition Rule, <math>P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)</math>, and interpret the answer in terms of the model.*</p> <p>(+) HSS.CP.B.8: Apply the general Multiplication Rule in a uniform probability model, <math>P(A \text{ and } B) = P(A)P(B A) = P(B)P(A B)</math>, and interpret the answer in terms of the model.*</p> <p>(+) HSS.CP.B.9: Use permutations and combinations to compute probabilities of compound events and solve problems.*</p>

Using Probability to Make Decisions HSS-MD	Using Probability to Make Decisions HSS-MD	Statistical Reasoning SR
<b>Calculate expected values and use them to solve problems</b>	<b>Calculate expected values and use them to solve problems</b>	<b>Standard - SR.A.8 (+) Calculate expected values and use them to solve problems.*</b>
<p>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.</p> <p>2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.</p> <p>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. <i>For example, find 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.</i></p> <p>4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. <i>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?</i></p>	<p><i>No CCC developed for this standard.</i></p> <p><i>No CCC developed for this standard.</i></p> <p><i>H.DPS.2c1 Determine the theoretical probability of multistage probability experiments.</i>  <i>H.DPS.2c2 Collect data from multistage probability experiments.</i>  <i>H.DPS.2c3 Compare actual results of multistage experiment with theoretical probabilities.</i></p> <p><i>No CCC developed for this standard.</i></p>	<p>(+) HSS.MD.A.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.*</p> <p>(+) HSS.MD.A.2: Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.*</p> <p>(+) HSS.MD.A.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. <i>For example, find 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.*</i></p> <p>(+) HSS.MD.A.4: Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. <i>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?*</i></p>
<b>Use probability to evaluate outcomes of decisions</b>	<b>Use probability to evaluate outcomes of decisions</b>	<b>Standard - SR.A.9 (+) Use probability to evaluate outcomes of decisions.*</b>
<p>5. (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.</p>	<p><i>No CCC developed for this standard.</i></p>	<p>(+) HSS.MD.B.5: Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.*</p>

<p>a. Find the expected payoff for a game of chance. <i>For example, find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.</i></p> <p>b. Evaluate and compare strategies on the basis of expected values. <i>For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident.</i></p> <p>6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).</p> <p>7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).</p>	<p><i>No CCC developed for this standard.</i></p> <p><i>H.DSP.2b Identify and describe the degree to which something is rated “good” or “bad”/desirable or undesirable based on numerical information.</i></p>	<p>(+) HSS.MD.B.5a: 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.*</p> <p>(+) HSS.MD.B.5b: 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 reasonable, chances of having a minor or a major accident.*</p> <p>(+) HSS.MD.B.6: Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*</p> <p>(+) HSS.MD.B.7: Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game and replacing the goalie with an extra skater).*</p>
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<sup>1</sup>The Binomial Theorem can be proved by mathematical induction or by a combinatorial argument.