



Rhode Island Department of Education

# Common Core State Standards & Core Content Connectors in Mathematics

Developed by the National Center and State Collaborative (NCSC)



Updated September 1, 2015

**Introduction:** Beginning 2014-15, all Rhode Island school districts should be fully transitioned to the Common Core State Standards in English Language Arts and Mathematics. Fully transitioned schools and districts should have all instruction, curriculum, and assessments aligned to these academic standards for all students.

In 2015-14, the NECAP assessments in Reading, Writing, and Mathematics were replaced with the PARCC assessments in ELA and mathematics. For students taking the Rhode Island Alternate Assessment, the RIAA was replaced with the NCSC alternate assessment which is also aligned to the Common Core State Standards.

Contained in this document are the Common Core State Standards (CCSS) and the Core Content Connectors (CCCs) which were used to guide item development on the NCSC alternate assessment. The CCCs are written below each Common Core Standard and are an attempt at breaking the standard down into more manageable parts. **Common Core Standards and Core Content Connectors that are in bold are those that will be measured on the NCSC alternate assessment.**

**NOTE: This document is not a complete copy of the CCSS Mathematics standards book and is not meant replace it. This CCC standards book is meant to be used in conjunction with the CCSS Mathematics standards book and other CCSS mathematics resources.**

**IEP Team Guidance:** The previous alternate assessment, the RIAA, was aligned with the Alternate Assessment Grade Span Expectations (AAGSEs) in Reading, Mathematics, and Writing. IEP Teams created IEP annual goals and short term objectives aligned with the AAGSEs. It is now expected that all IEP teams will align IEPs with the CCSS and provide students with disabilities access to the CCSS. IEP teams can use the Core Content Connectors as additional guidance particularly when creating short term objectives and when aligning IEPs to the CCSS for students on alternate assessment.

**Note for this updated edition:** The grant from the US DOE that funded the development of the NCSC alternate assessment ended in September, 2015. To prepare for this, Rhode Island has partnered with several other states to continue administration and future item development. This new consortium is the Multi State Alternate Assessment (MSAA). The NCSC test itself will remain the same but the name will now be the Multi State Alternate Assessment (MSAA).

# KINDERGARDEN

## Counting and Cardinality

K.CC

### Know number names and the count sequence.

- Count to 100 by ones and by tens.  
*K.NO.1a1 Rote count up to 10.*  
*K.NO.1a2 Rote count up to 31.*  
*K.NO.1a3 Rote count up to 100.*
- Count forward beginning from a given number within the known sequence (instead of having to begin at 1).
- Write numbers from 0 to 20. Represent a number of objects with a written numeral 0-20 (with 0 representing a count of no objects).  
*K.NO.1d1 Identify numerals 1-10.*  
*K.NO.1d2 Identify the numerals 1-10 when presented the name of the number.*  
*K.NO.1e1 Write or select the numerals 1-10.*

### Count to tell the number of objects.

- Understand the relationship between numbers and quantities; connect counting to cardinality.
  - 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.
  - 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.
  - Understand that each successive number name refers to a quantity that is one larger.  
*K.NO.1b2 Identify the set that has more.*  
*K.NO.1a4 Count up to 10 objects in a line, rectangle, or array.*  
*K.NO.1b1 Match the numeral to the number of objects in a set.*
- Count to answer “how many?” questions about as many as 20 things arranged in a line, a rectangular array, or a circle, or as many as 10 things in a scattered configuration; given a number from 1–20, count out that many objects.  
*K.DPS.1a1 Select a question that is answered by collected data.*

### Compare numbers.

- Identify whether the number of objects in one group is greater than, less than, or equal to the number objects in another group, e.g., by using matching and counting strategies.
- Compare two numbers between 1 and 10 presented as written numerals.  
*K.NO.1f1 Identify the smaller or larger number given 2 numbers between 0-10.*

## Operations and Algebraic Thinking

K.OA

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

- Represent addition and subtraction with objects, fingers, mental images, drawings, sounds (e.g., claps), acting out situations, verbal explanations, expressions, or equations.  
*K.PRF.1b1 Use objects or pictures to respond appropriately to “add \_\_\_” and “take away \_\_\_”.*  
*K.PRF.1b2 Communicate answer after adding or taking away.*
- Solve addition and subtraction word problems, and add and subtract within 10, e.g., by using objects or drawings to represent the problem.  
*K.PRF.1c1 Solve one step addition and subtraction word problems, and add and subtract within 10 using objects, drawings, pictures.*

*K.NO.2a1 Count two sets to find sums up to 10.*

*K.NO.2a3 Solve word problems within 10.*

- Decompose numbers less than or equal to 10 into pairs in more than one way, e.g., by using objects or drawings, and record each decomposition by a drawing or equation (e.g.,  $5 = 2 + 3$  and  $5 = 4 + 1$ ).

*K.NO.2a2 Decompose a set of up to ten objects into a group; count the quantity in each group.*

- 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.

- Fluently add and subtract within 5.

*No CCC developed for this standard.*

## Number and Operations in Base Ten

K.NBT

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

- Compose and decompose numbers from 11 to 19 into ten ones and some further ones, e.g., by using objects or drawings, and record each composition or decomposition by a drawing or equation (e.g.,  $18 = 10 + 8$ ); understand that these numbers are composed of ten ones and one, two, three, four, five, six, seven, eight, or nine ones.

*1.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).*

## Measurement and Data

K.MD

### Describe and compare measurable attributes.

- Describe measurable attributes of objects, such as length or weight. Describe several measurable attributes of a single object.

*K.ME.1a1 Describe objects in terms of measurable attributes (longer, shorter, heavier, lighter...).*

- Directly compare two objects with a measurable attribute in common, to see which object has “more of”/“less of” the attribute, and describe the difference. For example, directly compare the heights of two children and describe one child as taller/shorter.

*K.ME.1b2 Compare 2 objects with a measurable attribute in common to see which object has more/less of the attribute (length, height, weight).*

- Classify objects into given categories; count the numbers of objects in each category and sort the categories by count.

*K.ME.1b1 Sort objects by characteristics (e.g., big/little, colors, shapes, etc.).*

## Geometry

K.G

### Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres).

- Describe objects in the environment using names of shapes, and describe the relative positions of these objects using terms such as above, below, beside, in front of, behind, and next to.

*K.GM.1a2 Recognize two dimensional shapes in environment regardless of orientation or size.*

*K.GM.1a3 Use spatial language (e.g., above, below, etc.) to describe two-dimensional shapes.*

- Correctly name shapes regardless of their orientations or overall size.

*K.GM.1a1 Recognize two-dimensional shapes (e.g., circle, square, triangle, rectangle) regardless of orientation or size.*

- Identify shapes as two-dimensional (lying in a plane, “flat”) or three-dimensional (“solid”).

*K.GM.1b1 Identify shapes as two-dimensional (lying flat) or three dimensional (solid).*

### Analyze, compare, create, and compose shapes.

4. Analyze and compare two- and three-dimensional shapes, in different sizes and orientations, using informal language to describe their similarities, differences, parts (e.g., number of sides and vertices/“corners”) and other attributes (e.g., having sides of equal length).

*No CCC developed for this standard.*

5. Model shapes in the world by building shapes from components (e.g., sticks and clay balls) and drawing shapes.

*No CCC developed for this standard.*

6. Compose simple shapes to form larger shapes. For example, “Can you join these two triangles with full sides touching to make a rectangle?”

*K.GM.1c 1 Compose a larger shape from smaller shapes.*

# GRADE 1

## Operations and Algebraic Thinking

1.OA

### Represent and solve problems involving addition and subtraction.

1. Use addition and subtraction within 20 to solve word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using objects, drawings, and equations with a symbol for the unknown number to represent the problem.  
*1.NO.2a9 Use manipulatives or representations to write simple addition or subtraction equations within 20 based upon a word problem.*  
*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.*  
*1.NO.2a11 Solve word problems within 20.*  
*1.PRF.1b3 Using objects or pictures respond appropriately to "add \_\_\_" and "take away \_\_\_".*  
*1.PRF.1c2 Solve one step addition and subtraction word problems where the change or result is unknown ( $4+_=7$ ) or ( $4+3=_$ ), within 20 using objects, drawings, pictures.*
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.

*No CCC developed for this standard.*

### Understand and apply properties of operations and the relationship between addition and subtraction.

3. Apply properties of operations as strategies to add and subtract. Examples: If  $8 + 3 = 11$  is known, then  $3 + 8 = 11$  is also known. (Commutative property of addition.) To add  $2 + 6 + 4$ , the second two numbers can be added to make a ten, so  $2 + 6 + 4 = 2 + 10 = 12$ . (Associative property of addition.)

*1.NO.1i2 Recognize zero as an additive identity.*

4. Understand subtraction as an unknown-addend problem. For example, subtract  $10-8$  by finding the number that makes 10 when added to 8.

*No CCC developed for this standard.*

### Add and subtract within 20.

5. Relate counting to addition and subtraction (e.g., by counting on 2 to add 2).

*No CCC developed for this standard.*

6. Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g.,  $8 + 6 = 8 + 2 + 4 = 10 + 4 = 14$ ); decomposing a number leading to a ten (e.g.,  $13 - 4 = 13 - 3 - 1 = 10 - 1 = 9$ ); using the relationship between addition and subtraction (e.g., knowing that  $8 + 4 = 12$ , one knows  $12 - 8 = 4$ ); and creating equivalent but easier or known sums (e.g., adding  $6 + 7$  by creating the known equivalent  $6 + 6 + 1 = 12 + 1 = 13$ ).

*1.NO.2a6 Count two sets to find sums up to 20.*

*1.NO.2a8 Decompose a set of up to 20 objects into a group; count the quantity in each group.*

### Work with addition and subtraction equations.

7. Understand the meaning of the equal sign, and determine if equations involving addition and subtraction are true or false. For example, which of the following equations are true and which are false?  $6 = 6$ ,  $7 = 8 - 1$ ,  $5 + 2 = 2 + 5$ ,  $4 + 1 = 5 + 2$ .

*1.NO.2c1 Identify and apply addition and equal signs.*

8. Determine the unknown whole number in an addition or subtraction equation relating to three whole numbers. For example, determine the unknown number that makes the equation true in each of the equations  $8 + ? = 11$ ,  $5 = \_ - 3$ ,  $6 + 6 = \_$ .

*2.SE.1d2 Represent a "taking away" situation with the  $-$  symbol.*

**Extend the counting sequence.**

- Count to 120, starting at any number less than 120. In this range, read and write numerals and represent a number of objects with a written numeral.

*1.NO.1a6 Rote count up to 100.*

**Understand place value.**

- Understand that the two digits of a two-digit number represent amounts of tens and ones. Understand the following as special cases:
  - 100 can be thought of as a bundle of ten ones – called a “ten”.
  - The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six seven, eight, or nine ones.
  - 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).

*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).*

*1.NO.1h2 Identify the value of the numbers in the tens and ones place within a given number up to 31.*

*2.NO.1h4 Build representations of 3 digit numbers using tens and ones.*

- Compare two two-digit numbers based on meanings of the tens and ones digits, recording the results of comparisons with the symbols  $>$ ,  $=$ , and  $<$ .

*1.NO.1h3 Compare two digit numbers up to 31 using representations and numbers (e.g., identify more tens, less tens, more ones, less ones, larger number, smaller number).*

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

- 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.

*No CCC developed for this standard.*

- Given a two-digit number, mentally find 10 more or 10 less than the number, without having to count; explain the reasoning used.

*No CCC developed for this standard.*

- 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.

*2.NO.2c4 Decompose tens into ones and/or hundreds into tens in subtraction situations.*

**Measure lengths indirectly and by iterating length units.**

- Order three objects by length; compare the lengths of two objects indirectly by using a third object.

*1.ME.1b3 Order up to 3 objects based on a measurable attribute (height, weight, length).*

*1.ME.1b4 Order three objects by length; compare the lengths of two objects indirectly by using a third object.*

- 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. Limit to contexts where the object being measured is spanned by a whole number of length units with no gaps or overlaps.

- 1.ME.1a2 Measure using copies of 1 object to measure another.*
- 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.*
- 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?).*

**Tell and write time.**

- 3. Tell and write time in hours and half-hours using analog and digital clocks.
  - 1.ME.2a2 Use time to sequence up to 3 events using a digital or analog clock.*
  - 1.ME.1a5 Tell time to the nearest ½ hour using digital clocks.*

**Represent and interpret data.**

- 4. Organize, represent, and interpret data with up to three categories; ask and answer questions about the total number of data points, how many in each category, and how many more or less are in one category than in another.
  - 1.DPS.1a2 Select questions that ask about “How many” and represent up to three categories that can be concretely represented.*
  - 1.DPS.1a3 Identify 2 categories resulting from a selected question.*
  - 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.*
  - 1.DPS.1c1 Using a picture graph, represent each object/person counted on the graph (1:1 correspondence) for 2 or more categories.*
  - 1.DPS.1d1 Interpret a picture graph to answer questions about how many in each category.*
  - 1.DPS.1e1 Compare the values of the 2 categories of data in terms of more or less.*

**Geometry**

**1.G**

**Reason with shapes and their attributes.**

- 1. Distinguish between defining attributes (e.g., triangles are closed and three-sided) versus non-defining attributes (e.g., color, orientation, overall size); build and draw shapes to possess defining attributes.
  - 1.GM.1b2 Distinguish two-dimensional shapes based upon their defining attributes (i.e., size, corners, and points).*
- 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.
  - 2.GM.1d1 Compose three- dimensional shapes.*
  - 1.GM.1c 2 Compose two- and three-- dimensional shapes.*
- 3. Partition circles and rectangles into two and four equal shares, describe the shares using the words halves, fourths and quarters, and use the phrase 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 equal shares creates smaller shares.
  - 1.GM.1f1 Partition circles and rectangles into 2 and 4 equal parts.*

# GRADE 2

## Operations and Algebraic Thinking

2.OA

### Represent and solve problems involving addition and subtraction.

1. Use addition and subtraction within 100 to solve one- and two-step word problems involving situations of adding to, taking from, putting together, taking apart, and comparing, with unknowns in all positions, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.  
*2.SE.1d1 Represent addition of 2 sets when shown the + symbol*  
*2.NO.2a16 Solve word problems within 20.*  
*2.NO.2a17 Solve word problems within 100.*  
*2.PRF.1c3 Solve one or two step addition and subtraction problems, and add and subtract within 100, using objects, drawings, pictures.*  
*2.2.PRF.1c4 Use pictures, drawings or objects represent the steps of a problem.*  
*2.PRF.1c5 Write or select an equation representing the problem and it's solution.*

### Add and subtract within 20.

2. Fluently add and subtract within 20 using mental strategies. By end of Grade 2, know from memory all sums of two one-digit numbers.  
*No CCC developed for this standard.*

### Work with equal groups of objects to gain foundations for multiplication.

3. Determine whether a group of objects (up to 20) has an odd or even number of members, e.g., by pairing objects or counting them by 2s; write an equation to express an even number as a sum of two equal addends.  
*2.NO.1e7 Identify numbers as odd or even.*
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.  
*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.*  
*3.NO.2d2 Find total number inside an array with neither number in the columns or rows larger than 5.*

## Number and Operations in Base Ten

2.NBT

### Understand place value.

1. Understand that the three digits of a three-digit number represent amounts of hundreds, tens, and ones; e.g., 706 equals 7 hundreds, 0 tens, and 6 ones. Understand the following as special cases:
  - a. 100 can be thought of a bundle of ten tens – called a “hundred”.
  - b. The numbers 100, 200, 300, 400, 500, 600, 700, 800, 900 refer to one, two, three, four, five, six, seven, eight, or nine hundreds (and 0 tens and 0 ones).*2.NO.1h4 Build representations of 3 digit numbers using tens and ones.*  
*2.NO.1h5 Build representations of 3 digit numbers using hundreds, tens, and ones.*
2. Count within 1000; skip-count by 5s, 10s, and 100s.  
*2.NO.1e4 Skip count by 5s*  
*2.NO.1e5 Skip count by 10s.*  
*2.NO.1e6 Skip count by 100s.*  
*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).*
3. Read and write numbers to 1000 using base-ten numerals, number names, and expanded form.

- 2.NO.1d5 Identify numerals 0-100.
  - 2.NO.1d6 Identify the numeral between 0 and 100 when presented the name.
  - 2.NO.1e3 Write or select the numerals 0-100.
  - 2.NO.1h8 Write or select expanded form for any 2 digit number.
  - 2.NO.1h9 Write or select expanded form for any 3 digit number.
  - 2.NO.1i3 Explain what the zero represents in place value (hundreds, tens, ones) in a number.
  - 3.NO.1j2 Write or select the expanded form for up to 3 digit number.
4. Compare two three-digit numbers based on meanings of the hundreds, tens, and ones digits, using  $>$ ,  $=$ , and  $<$  symbols to record the results of comparisons.
- 2.NO.1f6 Compare (greater than, less than, equal to) 2 numbers up to 100.
  - 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).
  - 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).
  - 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).

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

5. Fluently add and subtract within 100 using strategies based on place value, properties of operations, and/or the relationship between addition and subtraction.
- 2.NO.2a12 Model addition and subtraction with base 10 blocks within 20.
  - 2.NO.2a13 Model addition and subtraction with base 10 blocks within 50.
  - 2.NO.2a14 Model addition and subtraction with base 10 blocks within 100.
6. Add up to four two-digit numbers using strategies based on place value and properties of operations.
- 2.NO.2a19 Combine up to 3 sets of 20 or less.
7. Add and subtract within 1000, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method. Understand that in adding or subtracting three-digit numbers, one adds or subtracts hundreds and hundreds, tens and tens, ones and ones; and sometimes it is necessary to compose or decompose tens or hundreds.
- 2.NO.2c3 Decompose tens into ones and/or hundreds into tens in subtraction situations.
  - 2.NO.2c4 Decompose tens into ones and/or hundreds into tens in subtraction situations.
  - 2.NO.2a18 Use diagrams and number lines to solve addition or subtraction problems.
8. Mentally add 10 or 100 to a given number 100–900, and mentally subtract 10 or 100 from a given number 100–900.
- 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?).
  - 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?).
  - 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?).
9. Explain why addition and subtraction strategies work, using place value and the properties of operations.
- No CCC developed for this standard.*

**Measure and estimate lengths in standard units.**

1. Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.  
*2.ME.1a3 Select appropriate tool and unit of measurement to measure an object (ruler or yard stick; inches or feet).*  
*2.ME.2b2 Select appropriate tools and demonstrate or identify appropriate measuring techniques.*
2. Measure the length of an object twice, using length units of different lengths for the two measurements; describe how the two measurements relate to the size of the unit chosen.  
*2.ME.1c2 Measure the attributes (length, width, height) of an object using 2 different size units.*
3. Estimate lengths using units of inches, feet, centimeters, and meters.  
*2.ME.1c3 Recognize that standard measurement units can be decomposed into smaller units.*  
*2.ME.2a3 Estimate the length of an object using units of feet and inches*
4. Measure to determine how much longer one object is than another, expressing the length difference in terms of a standard length unit.  
*2.ME.1b5 Solve word problems involving the difference in standard length units.*  
*2.ME.2a4 Solve one step subtraction problems involving the difference of the lengths of 2 objects in standard length units.*

**Relate addition and subtraction to length.**

5. Use addition and subtraction within 100 to solve word problems involving lengths that are given in the same units, e.g., by using drawings (such as drawings of rulers) and equations with a symbol for the unknown number to represent the problem.  
*No CCC developed for this standard.*
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.  
*No CCC developed for this standard.*

**Work with time and money.**

7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.  
*3.ME.1a1 Tell time to the nearest 5 minutes using a digital clock.*
8. Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using \$ and ¢ symbols appropriately. Example: If you have 2 dimes and 3 pennies, how many cents do you have?  
*2.ME.1a4 Solve word problems using dollar bills, quarters, dimes, nickles, or pennies.*

**Represent and interpret data.**

9. Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units.  
*2.DPS.1c3 Organize data by representing continuous data on a line plot.*
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.  
*2.DPS.1d2 Identify the value of each category represented on picture graph and bar graph or each point on a line plot.*  
*2.DPS.1a7 Analyze data by sorting into categories established by each question*  
*2.DPS.1c2 Organize data by representing categorical data on a pictorial graph or bar graph.*  
*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.*

**Reason with shapes and their attributes.**

1. Recognize and draw shapes having specified attributes, such as a given number of angles or a given number of equal faces. Identify triangles, quadrilaterals, pentagons, hexagons, and cubes.
  - 2.GM.1a4 Identify two- dimensional shapes such as rhombus, pentagons, hexagons, octagon, ovals, equilateral, isosceles, and scalene triangles.*
  - 2.GM.1b3 Distinguish two- or three- dimensional shapes based upon their attributes (i.e., #of sides, equal or different lengths of sides, # of faces, # of corners).*
  - 2.GM.1e1 Draw two- dimensional shapes with specific attributes.*
2. Partition a rectangle into rows and columns of same-size squares and count to find the total number of them.

*No CCC developed for this standard.*
3. Partition circles and rectangles into two, three, or four equal shares, describe the shares using the words halves, thirds, half of, a third of, etc., and describe the whole as two halves, three thirds, four fourths. Recognize that equal shares of identical wholes need not have the same shape.
  - 2.GM.1f2 Partition circles and rectangles into 2 and 4 equal parts.*
  - 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).*

# GRADE 3

## Operations and Algebraic Thinking

3.OA

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

1. Interpret products of whole numbers, e.g., interpret  $5 \times 7$  as the total number of objects in 5 groups of 7 objects each. For example, describe a context in which a total number of objects can be expressed as  $5 \times 7$ .
  - 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.
  - 3.NO.2d2 Find total number inside an array with neither number in the columns or rows larger than 5.
  - 3.NO.2d3 Solve multiplication problems with neither number greater than 5.**
  - 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.
  - 4.NO.2d6 Find total number inside an array with neither number in the columns or rows larger than 10.
  - 4.NO.2d8 Match an accurate addition and multiplication equation to a representation.
  - 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.
2. Interpret whole-number quotients of whole numbers, e.g., interpret  $56 \div 8$  as the number of objects in each share when 56 objects are partitioned equally into 8 shares, or as a number of shares when 56 objects are partitioned into equal shares of 8 objects each. For example, describe a context in which a number of shares or a number of groups can be expressed as  $56 \div 8$ .
  - 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.
  - 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.
  - 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.
3. Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.

No CCC developed for this standard.
4. Determine the unknown whole number in a multiplication or division equation relating three whole numbers. For example, determine the unknown number that makes the equation true in each of the equations  $8 \times ? = 48$ ,  $5 = \_ \div 3$ ,  $6 \times 6 = ?$ 

No CCC developed for this standard.

### Understand properties of multiplication and the relationship between multiplication and division.

5. Apply properties of operations as strategies to multiply and divide. Examples: If  $6 \times 4 = 24$  is known, then  $4 \times 6 = 24$  is also known. (Commutative property of multiplication.)  $3 \times 5 \times 2$  can be found by  $3 \times 5 = 15$ , then  $15 \times 2 = 30$ , or by  $5 \times 2 = 10$ , then  $3 \times 10 = 30$ . (Associative property of multiplication.) Knowing that  $8 \times 5 = 40$  and  $8 \times 2 = 16$ , one can find  $8 \times 7$  as  $8 \times (5 + 2) = (8 \times 5) + (8 \times 2) = 40 + 16 = 56$ . (Distributive property.)

3.PRF.2d2 Apply properties of operations as strategies to multiply and divide.
6. Understand division as an unknown-factor problem. For example, find  $32 \div 8$  by finding the number that makes 32 when multiplied by 8.

No CCC developed for this standard.

### Multiply and divide within 100.

7. Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that  $8 \times 5 = 40$ , one knows  $40 \div 5 = 8$ ) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.

No CCC developed for this standard.

### Solve problems involving the four operations, and identify and explain patterns in arithmetic.

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.

**3.NO.2e1 Solve or solve and check one or two step word problems requiring addition, subtraction or multiplication with answers up to 100.**

9. Identify arithmetic patterns (including patterns in the addition table or multiplication table), and explain them using properties of operations. For example, observe that 4 times a number is always even, and explain why 4 times a number can be decomposed into two equal addends.

*3.PRF.1e1 Describe the rule for a numerical pattern (e.g., increase by 2, 5, or 10).*

*3.PRF.1e2 Select or name the three next terms in a numerical pattern where numbers increase by 2, 5 or 10.*

**3.PRF.2d1 Identify multiplication patterns in a real word setting.**

### Number and Operations in Base Ten

3.NBT

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

1. Use place value understanding to round whole numbers to the nearest 10 or 100.

**3.NO.1j3 Use place value to round to the nearest 10 or 100.**

*3.NO.1j4 Use rounding to solve word problems.*

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 Solve multi-step addition and subtraction problems up to 100.**

*3.NO.2b1 Use the relationships between addition and subtraction to solve problems.*

3. Multiply one-digit whole numbers by multiples of 10 in the range 10–90 (e.g.,  $9 \times 80$ ,  $5 \times 60$ ) using strategies based on place value and properties of operations.

No CCC developed for this standard.

### Number and Operations – Fractions

3.NF

### Develop understanding of fractions as numbers.

1. Understand a fraction  $1/b$  as the quantity formed by 1 part when a whole is partitioned into  $b$  equal parts; understand a fraction  $a/b$  as the quantity formed by  $a$  parts of size  $1/b$ .

- a. Represent a fraction  $1/b$  on a number line diagram by defining the interval from 0 to 1 as the whole and partitioning it into  $b$  equal parts. Recognize that each part has size  $1/b$  and that the endpoint of the part based at 0 locates the number  $1/b$  on the number line.

- b. Represent a fraction  $a/b$  on a number line diagram by marking off  $a$  lengths  $1/b$  from 0. Recognize that the resulting interval has size  $a/b$  and that its endpoint located the number  $a/b$  on the number line.

*3.NO.1i1 Identify the number of highlighted parts (numerator) of a given representation (rectangles and circles).*

*3.NO.1i2 Identify the total number of parts (denominator) of a given representation (rectangles and circles).*

**3.NO.1i3 Identify the fraction that matches the representation (rectangles and circles; halves, fourths, and thirds, eighths).**

2. Understand a fraction as a number on the number line; represent fractions on a number line diagram.

*3.NO.1i4 Identify that a part of a rectangle can be represented as a fraction that has a value between 0 and 1.*

*3.NO.1i5 Locate given common unit fractions (i.e.,  $\frac{1}{2}$ ,  $\frac{1}{4}$ ,  $\frac{1}{8}$ ,) on a number line or ruler.*

*4.NO.1i6 Locate fractions on a number line.*

*4.NO.1i7 Order fractions on a number line.*

3. Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

- a. Understand two fractions as equivalent (equal) if they are the same size, or the same point on a number line.

- b. Recognize and generate simple equivalent fractions, e.g.,  $1/2 = 2/4$ ,  $4/6 = 2/3$ . Explain why the fractions are equivalent, e.g., by using a visual fraction model.
- c. Express whole numbers as fractions, and recognize fractions that are equivalent to whole numbers.  
*Examples: Express 3 in the form  $3 = 3/1$ ; recognize that  $6/1 = 6$ ; locate  $4/4$  and 1 at the same point of a number line diagram.*
- 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  $>$ ,  $=$ , or  $<$ , and justify the conclusions, e.g., by using a visual fraction model.**

**3.SE.1g1 Use  $=$ ,  $<$ , or  $>$  to compare 2 fractions with the same numerator or denominator.**

*4.SE.1h1 Express whole numbers as fractions.*

**4.NO.1m1 Determine equivalent fractions.**

*4.NO.2h3 Solve word problems involving addition and subtraction of fractions with like denominators (2, 3, 4, or 8).*

## Measurement and Data

## 3.MD

### Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.

1. Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.  
*3.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).*  
*3.PRF.1f1 Determine the equivalence between number of minutes and the fraction of the hour (e.g., 30 minutes =  $\frac{1}{2}$  hour).*  
*3.PRF.1f2 Determine the equivalence between the number of minutes and the number of hours (e.g., 60 minutes = 1 hour).*
2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.  
*3.ME.1f1 Select appropriate units for measurement (liquid volume, area, time, money).*  
*3.ME.1f2 Add to solve one step word problems.*  
*3.ME.2e1 Select appropriate tool for measurement: liquid volume, area, time, money.*  
*3.ME.2i1 Estimate liquid volume.*

### Represent and interpret data.

3. **Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs. For example, draw a bar graph in which each square in the bar graph might represent 5 pets.**  
**3.DPS.1g1 Collect data, organize into picture or bar graph.**  
*3.DPS.1i1 Select the appropriate statement that describes the data representations based on a given graph (picture, bar, line plots).*
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.  
*3.ME.2e2 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.*  
*3.ME.2e3 Measure to solve problems using number lines and ruler to 1 inch,  $\frac{1}{2}$  inch, or  $\frac{1}{4}$  of an inch.*  
*3.DPS.1g2 Organize measurement data into a line plot.*

### Geometric measurement: understand concepts of area and relate area to multiplication and to addition.

5. Recognize area as an attribute of plane figures and understand concepts of area measurement.
  - a. A square with side length 1 unit, called a “a unit square,” is said to have “one square unit” of area, and can be used to measure area.

- b. A plane figure which can be covered without gaps or overlaps by  $n$  unit squares is said to have an area of  $n$  square units.

*No CCC developed for this standard.*

- 6. **Measure areas by counting unit squares (square cm, square m, square in, square ft, and improvised units).**

**3.ME.1d2 Measure area of rectangles by counting squares.**

- 7. Relate area to the operations of multiplication and addition.
  - a. Find the area of a rectangle with whole-number side lengths by tiling it, and show that the area is the same as would be found by multiplying the side lengths.
  - 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.
  - c. Use tiling to show in a concrete case that the area of a rectangle with whole-number side lengths  $a$  and  $b + c$  is the sum of  $a \times b$  and  $a \times c$ . Use area models to represent the distributive property in mathematical reasoning.
  - d. Recognizing area as additive. Find areas of rectilinear figures by decomposing them into non-overlapping rectangles and adding the areas of the non-overlapping parts, applying this technique to solve real world problems.

*3.ME.1d1 Use tiling and addition to determine area.*

*4.ME.1d3 Use tiling and multiplication to determine area.*

*4.ME.2h1 Apply the formulas for area and perimeter to solve real world problems.*

*4.PRF.1f3 Apply the distributive property to solve problems with models.*

**Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures.**

- 8. Solve real world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

*3.ME.1g1 Identify a figure as getting larger or smaller when the dimensions of the figure changes*

*3.ME.2h1 Use addition to find the perimeter of a rectangle*

*4.ME.2h1 Apply the formulas for area and perimeter to solve real world problems.*

**Reason with shapes and their attributes.**

1. Understand that shapes in different categories (e.g., rhombuses, rectangles, and others) may share attributes (e.g., having four sides), and that the shared attributes can define a larger category (e.g., quadrilaterals). Recognize rhombuses, rectangles, and squares as examples of quadrilaterals, and draw examples of quadrilaterals that do not belong to any of these subcategories.

*3.GM.1h1 Identify shared attributes of shapes.*

2. **Partition shapes into parts with equal areas. Express the area of each part as a unit fraction of the whole. For example, partition a shape into 4 parts with equal area, and describe the area of each part as  $\frac{1}{4}$  of the area of the shape.**

*3.GM.1i1 Partition rectangles into equal parts with equal area.*

# GRADE 4

## Operations and Algebraic Thinking

4.OA

### Use the four operations with whole numbers to solve problems.

1. Interpret a multiplication equation as a comparison, e.g., interpret  $35 = 5 \times 7$  as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations.

*No CCC developed for this standard.*

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.

**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.**

**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? [ $3 \times 2 = p$ ]).**

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.

**4.NO.2e2 Solve or solve and check one or two step word problems requiring addition, subtraction, or multiplication with answers up to 100.**

### Gain familiarity with factors and multiples.

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.

*4.NO.2f1 Identify multiples for a whole number (e.g.,  $2 = 2, 4, 6, 8, 10$ ).*

### Generate and analyze patterns.

5. Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. For example, given the rule “Add 3” and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way.

*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.*

## Number and Operations in Base Ten

4.NBT

### Generalize place value understanding for multi-digit whole numbers.

1. Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. For example, recognize that  $700 \div 70 = 10$  by applying concepts of place value and division.

*4.NO.1k1 Compare the value of a number when it is represented in different place values of two 3 digit numbers.*

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.

*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.

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).

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

4. Fluently add and subtract multi-digit whole numbers using the standard algorithm.

4.NO.2f2 Solve multiplication problems up to two digits by one digit.

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.PRF.1f4 Solve a 2-digit by 1-digit multiplication problem using two different strategies.

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.

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.

## Number and Operations – Fractions

4.NF

### Extend understanding of fraction equivalence and ordering.

1. Explain why a fraction  $a/b$  is equivalent to a fraction  $(n \times a)/(n \times b)$  by using visual fraction models, with attention to how the number and size of the parts differ even though the two fractions themselves are the same size. Use this principle to recognize and generate equivalent fractions.

4.NO.1m1 Determine equivalent fractions.

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  $1/2$ . Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols  $>$ ,  $=$ , or  $<$ , and justify the conclusions, e.g., by using a visual fraction model.

4.SE.1g2 Use  $=$ ,  $<$ , or  $>$  to compare 2 fractions (fractions with a denominator or 10 or less).

4.NO.1n2 Compare up to 2 given fractions that have different denominators.

### Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers.

3. Understand a fraction  $a/b$  with  $a > 1$  as a sum of fractions  $1/b$ .
  - a. Understand addition and subtraction of fractions as joining and separating parts referring to the same whole.
  - 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. Examples:  $3/8 = 1/8 + 1/8 + 1/8$ ;  $3/8 = 1/8 + 2/8$ ;  $2 \frac{1}{8} = 1 + 1 + 1/8 = 8/8 + 8/8 + 1/8$ .
  - 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.
  - d. Solve word problems involving addition and subtraction of fractions referring to the same whole and having like denominators, e.g., by using visual fraction models and equations to represent the problem.

4.NO.2g1 Using a representation, decompose a fraction into multiple copies of a unit fraction (e.g.,  $3/4 = 1/4 + 1/4 + 1/4$ ).

4.NO.2h1 Add and subtract fractions with like denominators of (2,3,4, or 8).

4.NO.2h2 Add and subtract fractions with like denominators (2,3,4, or 8) using representations.

4.NO.2h3 Solve word problems involving addition and subtraction of fractions with like denominators (2, 3, 4, or 8).

4. Apply and extend previous understandings of multiplication to multiply a fraction by a whole number.

- a. Understand a fraction  $a/b$  as a multiple of  $1/b$ . For example, use a visual fraction model to represent  $5/4$  as the product  $5 \times (1/4)$ , recording the conclusion by the equation  $5/4 = 5 \times (1/4)$ .
- b. Understand a multiple of  $a/b$  as a multiple of  $1/b$ , and use this understanding to multiply a fraction by a whole number. For example, use a visual fraction model to express  $3 \times (2/5)$  as  $6 \times (1/5)$ , recognizing this product as  $6/5$ . (In general,  $n \times (a/b) = (n \times a)/b$ .)
- c. Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. For example, if each person at a party will eat  $3/8$  of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?

No CCCs developed for these standards.

### Understand decimal notation for fractions, and compare decimal fractions.

5. Express a fraction with denominator 10 as an equivalent fraction with denominator 100, and use this technique to add two fractions with respective denominators 10 and 100. For example, express  $3/10$  as  $30/100$ , and add  $3/10 + 4/100 = 34/100$ .
  - 4.NO.1o2 Find the equivalent decimal for a given fraction.
6. Use decimal notation for fractions with denominators 10 or 100. For example, rewrite 0.62 as  $62/100$ ; describe a length as 0.62 meters; locate 0.62 on a number line diagram.
  - 4.SE.1h2 Identify the equivalent decimal for a fraction
  - 4.NO.1o1 Match a fraction with a denominator of 10 or 100 as a decimal ( $5/10 = .5$ ).
  - 4.NO.1p1 Read, write or select decimals to the tenths place.
  - 4.NO.1p2 Read, write or select decimals to the hundredths place.
  - 5.NO.1c1 Rewrite a fraction as a decimal.
  - 5.NO.1c2 Rewrite a decimal as a fraction.
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.
  - 4.SE.1g3 Use  $=$ ,  $<$ , or  $>$  to compare 2 decimals (decimals in multiples of  $.10$ ).
  - 4.NO.1q1 Compare two decimals to the tenths place with a value of less than 1.
  - 4.NO.1q2 Compare two decimals to the hundredths place with a value of less than 1.

## Measurement and Data

## 4.MD

### Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

1. Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz.; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table. For example, know that 1 ft is 12 times as long as 1 in. Express the length of a 4 ft snake as 48 in. Generate a conversion table for feet and inches listing the number pairs (1, 12), (2, 24), (3, 36), ...
  - 4.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).
  - 4.ME.2f1 Complete a conversion table for length and mass within a single system.
  - 4.ME.1f3 Select appropriate units for measurement: mass, length, angles.
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.
  - 4.ME.1g2 Solve word problems using perimeter and area where changes occur to the dimensions of a figure.
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.

4.ME.1g2 Solve word problems using perimeter and area where changes occur to the dimensions of a figure.

4.ME.2h1 Apply the formulas for area and perimeter to solve real world problems.

### Represent and interpret data.

4. Make a line plot to display a data set of measurements in fractions of a unit ( $1/2$ ,  $1/4$ ,  $1/8$ ). Solve problems involving addition and subtraction of fractions by using information presented in line plots. *For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.*

*No CCC developed for this standard.*

### Geometric measurement: understand concepts of angle and measure angles.

5. Recognize angles as geometric shapes that are formed wherever two rays share a common endpoint, and understand concepts of angle measurement:
  - a. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through  $1/360$  of a circle is called a “one-degree angle”, and can be used to measure angles.
  - b. An angle that turns through  $n$  one-degree angles is said to have an angle measure of  $n$  degrees.
6. An angle is measured with reference to a circle with its center at the common endpoint of the rays, by considering the fraction of the circular arc between the points where the two rays intersect the circle. An angle that turns through  $1/360$  of a circle is called a “one-degree angle”, and can be used to measure angles.
7. An angle that turns through  $n$  one-degree angles is said to have an angle measure of  $n$  degrees.

*No CCC developed for this standard.*

8. Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure.

4.ME.2e4 Select appropriate tool for measurement: mass, length, angles.  
4.ME.2e5 Construct a given angle.  
4.ME.2e6 Measure right angles using a tool (e.g., angle ruler, protractor).
9. 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.

*No CCC developed for this standard.*

## Geometry

4.G

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

1. Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

4.GM.1j1 Recognize a point, line and line segment, rays in two-dimensional figures.  
4.GM.1j2 Recognize perpendicular and parallel lines in two-dimensional figure.  
4.GM.1j3 Recognize an angle in two-dimensional figures.  
5.GM.1j1 Recognize parallel and perpendicular lines within the context of two-dimensional figures.
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.**

4.GM.1h2 Classify two-dimensional shapes based on attributes (number of angles).  
4.GM.1j4 Categorize angles as right, acute, or obtuse.
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.

*4.GM.1k1 Recognize a line of symmetry in a figure.*

# GRADE 5

## Operations and Algebraic Thinking

5.OA

### Write and interpret numerical expressions.

1. Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.  
*5.SE.1a1 Given a real world problem, write an equation using 1 set of parentheses.*
2. Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. For example, express the calculation “add 8 and 7, then multiply by 2” as  $2 \times (8 + 7)$ . Recognize that  $3 \times (18932 + 921)$  is three times as large as  $18932 + 921$ , without having to calculate the indicated sum or product.  
*No CCC developed for this standard.*

### Analyze patterns and relationships.

3. **Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. For example, given the rule “Add 3” and the starting number 0, and given the rule “Add 6” and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.**  
*5.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).*

## Number and Operations in Base Ten

5.NBT

### Understand the place value system.

1. Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.  
*No CCC developed for this standard.*
2. Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.  
*6.NO.1i1 Identify what an exponent represents (e.g.,  $8^3 = 8 \times 8 \times 8$ ).*
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.,  $347.392 = 3 \times 100 + 4 \times 10 + 7 \times 1 + 3 \times (1/10) + 9 \times (1/100) + 2 \times (1/1000)$ .**
  - b. **Compare two decimals to thousandths based on meanings of the digits in each place, using  $>$ ,  $=$ , and  $<$  symbols to record the results of comparisons.**  
*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.*
4. **Use place value understanding to round decimals to any place.**  
*5.NO.1b4 Round decimals to the next whole number.*  
*5.NO.1b5 Round decimals to the tenths place.*  
*5.NO.1b6 Round decimals to the hundredths place.*

### Perform operations with multi-digit whole numbers and with decimals to hundredths.

5. Fluently multiply multi-digit whole numbers using the standard algorithm.  
*No CCC developed for this standard.*
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.**  
*5.NO.2a3 Find whole number quotients up to two dividends and two divisors.*  
*5.NO.2a4 Find whole number quotients up to four dividends and two divisors.*  
**5.NO.2a5 Solve word problems that require multiplication or division.**
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.**  
**5.NO.2c1 Solve 1 step problems using decimals.**

## Number and Operations – Fractions

5.NF

### Use equivalent fractions as a strategy to add and subtract fractions.

1. Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. For example,  $\frac{2}{3} + \frac{5}{4} = \frac{8}{12} + \frac{15}{12} = \frac{23}{12}$ . (In general,  $\frac{a}{b} + \frac{c}{d} = \frac{ad + bc}{bd}$ .)  
*5.NO.2b1 Add and subtract fractions with unlike denominators by replacing fractions with equivalent fractions (identical denominators).*  
*5.NO.2b2 Add or subtract fractions with unlike denominators.*
2. **Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. For example, recognize an incorrect result  $\frac{2}{5} + \frac{1}{2} = \frac{3}{7}$ , by observing that  $\frac{3}{7} < \frac{1}{2}$ .**  
**5.NO.2c2 Solve word problems involving the addition, subtraction, multiplication or division of fractions.**

### Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

3. Interpret a fraction as division of the numerator by the denominator ( $\frac{a}{b} = a \div b$ ). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. For example, interpret  $\frac{3}{4}$  as the result of dividing 3 by 4, noting that  $\frac{3}{4}$  multiplied by 4 equals 3, and that when 3 wholes are shared equally among 4 people each person has a share of size  $\frac{3}{4}$ . If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?  
*No CCC developed for this standard.*
4. Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.
  - a. Interpret the product  $(\frac{a}{b}) \times q$  as a parts of a partition of  $q$  into  $b$  equal parts; equivalently, as the result of a sequence of operations  $a \times q \div b$ . For example, use a visual fraction model to show  $(\frac{2}{3}) \times 4 = \frac{8}{3}$ , and create a story context for this equation. Do the same with  $(\frac{2}{3}) \times (\frac{4}{5}) = \frac{8}{15}$ . (In general,  $(\frac{a}{b}) \times (\frac{c}{d}) = \frac{ac}{bd}$ .)
  - b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.  
*5.NO.2b3 Multiply or divide fractions.*
5. **Interpret multiplication as scaling (resizing), by...**
  - a. **Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.**
  - 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 greater less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence  $a/b=(nxa)/(nxb)$  to the effect of multiplying  $a/b$  by 1.

**5.PRF.1a1 Determine whether the product will increase or decrease based on the multiplier.**

*5.PRF.1a2 Determine whether or not the quotient will increase or decrease based on the divisor.*

6. Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.  
*No CCC developed for this standard.*
7. Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions.
  - a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. For example, create a story context for  $(1/3) \div 4$ , and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that  $(1/3) \div 4 = 1/12$  because  $(1/12) \times 4 = 1/3$ .
  - b. Interpret division of a whole number by a unit fraction, and compute such quotients. For example, create a story context for  $4 \div (1/5)$ , and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that  $4 \div (1/5) = 20$  because  $20 \times (1/5) = 4$ .
  - c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. *For example, how much chocolate will each person get if 3 people share  $1/2$  lb of chocolate equally? How many  $1/3$ -cup servings are in 2 cups of raisins?*

*6.NO.2c4 Solve word problems involving the addition, subtraction, multiplication or division of fractions.*

## Measurement and Data

5.MD

### Convert like measurement units within a given measurement system.

1. **Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.**  
*5.ME.1b1 Convert measurements of time.*  
**5.ME.1b2 Convert standard measurements of length.**  
*5.ME.1b3 Convert standard measurements of mass.*  
**5.ME.2a1 Solve problems involving conversions of standard measurement units when finding area, volume, time lapse, or mass.**

### Represent and interpret data.

2. Make a line plot to display a data set of measurements in fractions of a unit ( $1/2, 1/4, 1/8$ ). Use operations on fractions for this grade to solve problems involving information presented in line plots. For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.  
*5.DPS.1c1 Collect and graph data: bar graph, line plots, picture graph (e.g., average height among 3 classrooms, # of boys and girls).*

### Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

3. Recognize volume as an attribute of solid figures and understand concepts of volume measurement.  
*No CCC developed for this standard.*
  - 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.
  - b. A solid figure which can be packed without gaps or overlaps using  $n$  unit cubes is said to have a volume of  $n$  cubic units.  
*No CCC developed for this standard.*

4. Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.  
*5.ME.2b1 Use filling and multiplication to determine volume.*
5. Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.  
*No CCC developed for this standard.*
  - 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.  
*No CCC developed for this standard.*
  - b. Apply the formula  $V=l \times w \times h$  and  $V = b \times h$  for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.  
*No CCC developed for this standard.*
  - c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.  
*5.ME.2b2 Apply formula to solve one step problems involving volume.*

## Geometry

5.G

### Graph points on the coordinate plane to solve real-world and mathematical problems.

1. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).  
*5.GM.1c1 Locate the x and y axis on a graph.*  
*5.GM.1c2 Locate points on a graph.*  
*5.GM.1c3 Use order pairs to graph given points.*
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.  
*6.GM.1c6 Find coordinate values of points in the context of a situation.*

### Classify two-dimensional figures into categories based on their properties.

3. Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.  
*5.GM.1a1 Recognize properties of simple plane figures.*
4. Classify two-dimensional figures in a hierarchy based on properties.  
*5.GM.1b1 Distinguish plane figures by their properties.*

# GRADE 6

## Ratios and Proportional Relationships

6.RP

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

1. Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities. For example, “The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak.” “For every vote candidate A received, candidate C received nearly three votes.”  
*6.NO.1f2 Write or select a ratio to match a given statement and representation.*  
*6.NO.1f31 Select or make a statement to interpret a given ratio.*  
**6.PRF.1c1 Describe the ratio relationship between two quantities for a given situation.**  
*6.PRF.2b3 Complete a statement that describes the ratio relationship between two quantities.*
2. Understand the concept of a unit rate  $a/b$  associated with a ration  $a:b$  with  $b \neq 0$ , and use rate language in the context of a ratio relationship. For example, “This recipe has a ration of 3 cups of flour to 4 cups of sugar, so there is  $\frac{3}{4}$  cup of flour for each cup of sugar.” “We paid \$75 for 15 hamburgers, which is a rate of \$5 per hamburger.”  
*6.PRF.1c2 Represent proportional relationships on a line graph.*  
*6.PRF.2b4 Determine the unit rate in a variety of contextual situations.*  
*6.NO.1f4 Find a missing value (representations, whole numbers, common fractions, decimals to hundredths place, percent) for a given ratio.*
3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
  - a. Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.
  - b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At rate were lawns being mowed?
  - 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.
  - d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.  
*6.PRF.2b5 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).*  
*6.NO.1f5 Solve unit rate problems involving unit pricing.*  
**6.ME.2a2 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).**  
**6.NO.1f1 Calculate a percent of a quantity as rate per 100.**  
*6.ME.1b4 Complete a conversion table for length, mass, time, volume.*  
*6.ME.1b5 Analyze table to answer questions.*

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

1. Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. For example, create a story context for  $(2/3) \div (3/4)$  and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that  $(2/3) \div (3/4) = 8/9$  because  $3/4$  of  $8/9$  is  $2/3$ . (In general,  $(a/b) \div (c/d) = ad/bc$ ). How much chocolate will each person get if 3 people share  $1/2$  lb of chocolate equally? How many  $3/4$ -cup servings are in  $2/3$  of a cup of yogurt? How wide is a rectangular strip of land with length  $3/4$  mi and area  $1/2$  square mi?

*6.NO.2c3 Solve one step, addition, subtraction, multiplication, or division problems with fractions or decimals.*

**Compute fluently with multi-digit numbers and find common factors and multiples.**

2. Fluently divide multi-digit numbers using the standard algorithm.  
*No CCC developed for this standard.*
3. Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.  
*No CCC developed for this standard.*
4. Find the greatest common factor of two whole numbers less than or equal to 100 and the least common multiple of two whole numbers less than or equal to 12. Use the distributive property to express a sum of two whole numbers 1–100 with a common factor as a multiple of a sum of two whole numbers with no common factor. *For example, express  $36 + 8$  as  $4(9 + 2)$ .*

*No CCC developed for this standard.*

**Apply and extend previous understandings of numbers to the system of rational numbers.**

5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.  
*6.NO.1d4 Select the appropriate meaning of a negative number in a real world situation.*
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.
  - a. Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g.,  $-(-3) = 3$ , and that 0 is its own opposite.
  - 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.
  - c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.

*6.NO.1d1 Identify numbers as positive or negative.*

*6.NO.1d2 Locate and plot positive and negative numbers on a number line.*

*6.NO.2e1 Determine the difference between two integers using a number line.*

*6.NO.1d5 Find given points between -10 and 10 on both axis of a coordinate plane.*

*6.NO.1d6 Label points between -10 and 10 on both axis of a coordinate plane.*

7. Understand ordering and absolute value of rational numbers.
  - a. Interpret statements of inequality as statements about the relative position of two numbers on a number line diagram. *For example, interpret  $-3 > -7$  as a statement that  $-3$  is located to the right of  $-7$  on a number line oriented from left to right.*

- b. Write, interpret, and explain statements of order for rational numbers in real-world contexts. *For example, write  $-3^{\circ}\text{C} > -7^{\circ}\text{C}$  to express the fact that  $-3^{\circ}\text{C}$  is warmer than  $-7^{\circ}\text{C}$ .*
- 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. *For example, for an account balance of  $-30$  dollars, write  $|-30| = 30$  to describe the size of the debt in dollars.*
- d. Distinguish comparisons of absolute value from statements about order. *For example, recognize that an account balance less than  $-30$  dollars represents a debt greater than 30 dollars.*

*6.NO.2e2 Compare two numbers on a number line (e.g.,  $-2 > -9$ ).*

*6.NO.1e1 Determine the absolute value of a rational number.*

- 8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

*No CCC developed for this standard.*

## Expressions and Equations

6.EE

### Apply and extend previous understandings of arithmetic to algebraic expressions.

- 1. Write and evaluate numerical expressions involving whole-number exponents.
  - 6.NO.1i1 Identify what an exponent represents (e.g.,  $8^3 = 8 \times 8 \times 8$ ).*
  - 6.NO.1i2 Solve numerical expressions involving whole number exponents.*
- 2. Write, read, and evaluate expressions in which letters stand for numbers.
  - a. Write expressions that record operations with numbers and with letters standing for numbers. *For example, express the calculation "Subtract  $y$  from 5" as  $5 - y$ .*
  - b. Identify parts of an expression using mathematical terms (sum, term, product, factor, quotient, coefficient); view one or more parts of an expression as a single entity. *For example, describe the expression  $2(8 + 7)$  as a product of two factors; view  $(8 + 7)$  as both a single entity and a sum of two terms.*
  - c. Evaluate expressions at specific values of their variables. Include expressions that arise from formulas used in real-world problems. Perform arithmetic operations, including those involving whole number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations). *For example, use the formulas  $V = s^3$  and  $A = 6s^2$  to find the volume and surface area of a cube with sides of length  $s = 1/2$ .*

*6.SE.1a2 Given a real world problem, write an equation using 1 set of parentheses.*

- 3. Apply the properties of operations to generate equivalent expressions. For example, apply the distributive property to the expression  $3(2 + x)$  to produce the equivalent expression  $6 + 3x$ ; *apply the distributive property to the expression  $24x + 18y$  to produce the equivalent expression  $6(4x + 3y)$ ; apply properties of operations to  $y + y + y$  to produce the equivalent expression  $3y$ .*

*No CCC developed for this standard.*

- 4. Identify when two expressions are equivalent (i.e., when the two expressions name the same number regardless of which value is substituted into them). *For example, the expressions  $y + y + y$  and  $3y$  are equivalent because they name the same number regardless of which number  $y$  stands for.*

*No CCC developed for this standard.*

### Reason about and solve one-variable equations and inequalities.

- 5. Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true.

*No CCC developed for this standard.*

6. Use variables to represent numbers and write expressions when solving a real-world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.
- 6.PRF.2a2 Use a variable to represent numbers and write expressions when solving real world problems.*  
*6.SE.1a3 Write expressions for real-world problems involving one unknown number.*
7. **Solve real-world and mathematical problems by writing and solving equations of the form  $x + p = q$  and  $px = q$  for cases in which  $p$ ,  $q$  and  $x$  are all nonnegative rational numbers.**
- 6.NO.2a6 Solve problems or word problems using up to three digit numbers and any of the four operations.***  
***6.PRF.1d1 Solve real world, single step linear equations.***
8. Write an inequality of the form  $x > c$  or  $x < c$  to represent a constraint or condition in a real-world or mathematical problem. Recognize that inequalities of the form  $x > c$  or  $x < c$  have infinitely many solutions; represent solutions of such inequalities on number line diagrams.
- No CCC developed for this standard.*

### **Represent and analyze quantitative relationships between dependent and independent variables.**

9. Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation  $d = 65t$  to represent the relationship between distance and time.
- 6.PRF.2a3 Use variables to represent two quantities in a real-world problem that change in relationship to one another.*  
*6.PRF.2a4 Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation*

## **Geometry**

**6.G**

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

1. **Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.**
- 6.ME.1a2 Identify the appropriate formula (i.e., perimeter, area, volume) to use when measuring for different purposes in a real life context.*  
*6.ME.2a3 Apply the formula to find the area of triangles.*  
*6.ME.2b3 Decompose complex shapes (polygon, trapezoid, pentagon) into simple shapes (rectangles, squares, triangles) to measure area.*
- 6.GM.1d1 Find area of quadrilaterals.***  
*6.GM.1d2 Find area of triangles*
2. Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas  $V = lwh$  and  $V = bh$  to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.
- 6.ME.1a2 Identify the appropriate formula (i.e., perimeter, area, volume) to use when measuring for different purposes in a real life context.*  
*6.ME.1c1 Find the area of a 2-dimensional figure and the volume of a 3-dimensional figure.*
3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.
- 6.GM.1c7 Use coordinate points to draw polygons.*  
*6.GM.1c8 Use coordinate points to find the side lengths of polygons that are horizontal or vertical.*

**Develop understanding of statistical variability.**

1. Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. *For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.*  
*6.DPS.1a2 Identify statistical questions and make a plan for data collection.*
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.  
*6.DPS.1d4 Find the range of a given data set.*  
*6.DPS.1d6 Explain or identify what the mode represents in a set of data.*
3. Recognize that a measure of center for a numerical data set summarizes all of its values with a single number, while a measure of variation describes how its values vary with a single number.  
*5.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.*  
*5.DPS.1e1 Use measures of central tendency to interpret data including overall patterns in the data.*  
*6.DPS.1d2 Solve for mean of a given data set.*  
*6.DPS.1d5 Explain or identify what the mean represents in a set of data.*

**Summarize and describe distributions.**

4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.  
*6.DPS.1c2 Collect and graph data: bar graph, line plots, dot plots, histograms.*
5. **Summarize numerical data sets in relation to their context, such as by:**
  - a. **Reporting the number of observations.**
  - b. **Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.**
  - c. **Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.**
  - d. **Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.**  
*6.DPS.1d3 Select statement that matches mean, mode, and spread of data for 1 measure of central tendency for a given data set.*  
*6.DPS.1d7 Explain or identify what the median represents in a set of data.*  
*6.DPS.1e2 Use measures of central tendency to interpret data including overall patterns in the data.*

# GRADE 7

## Ratios and Proportional Relationships

7.RP

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

1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. *For example, if a person walks  $1/2$  mile in each  $1/4$  hour, compute the unit rate as the complex fraction  $^{1/2}/_{1/4}$  miles per hour, equivalently 2 miles per hour.*  
*7.NO.2f3 Find unit rates given a ratio.*  
*7.PRF.1e1 Determine unit rates associated with ratios of lengths, areas, and other quantities measured in like units.*  
*7.ME.2e2 Solve one step problems involving unit rates associated with ratios of fractions.*
2. **Recognize and represent proportional relationships between quantities.**
  - a. **Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.**
  - b. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.
  - c. Represent proportional relationships by equations. For example, if total cost  $t$  is proportional to the number  $n$  of items purchased at a constant price  $p$ , the relationship between the total cost and the number of items can be expressed as  $t = pn$ .
  - d. Explain what a point  $(x, y)$  on the graph of a proportional relationship means in terms of the situation, with special attention to the points  $(0, 0)$  and  $(1, r)$  where  $r$  is the unit rate.  
*7.NO.2f1 Identify the proportional relationship between two quantities.*  
*7.NO.2f2 Determine if two quantities are in a proportional relationship using a table of equivalent ratios or points graphed on a coordinate plane.*  
*7.PRF.1e2 Represent proportional relationships on a line graph.*  
*7.NO.2f4 Use a rate of change or proportional relationship to determine the points on a coordinate plane.*
3. **Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.**  
*7.NO.2f5 Use proportions to solve ratio problems.*  
*7.NO.2f6 Solve word problems involving ratios.*  
*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.*

## The Number System

7.NS

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

1. Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.
  - a. Describe situations in which opposite quantities combine to make 0. For example, a hydrogen atom as 0 charge because its two constituents are oppositely charged.
  - b. Understand  $p + q$  as the number located a distance  $|q|$  from  $p$ , in the positive or negative direction depending on whether  $q$  is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts.
  - c. Understand subtraction of rational numbers as adding the additive inverse,  $p - q = p + (-q)$ . Show that the distance between two rational numbers on the number line is the absolute value of their difference, and apply this principle in real-world contexts.
  - d. Apply properties of operations as strategies to add and subtract rational numbers.

7.NO.1g1 Identify the additive inverse of a number (e.g., -3 and +3).

7.NO.1g2 Identify the difference between two given numbers on a number line using absolute value.

2. **Apply and extend previous understandings of multiplication and division and of fractions to multiply and divide rational numbers.**

- Understand that multiplication is extended from fractions to rational numbers by requiring that operations continue to satisfy the properties of operations, particularly the distributive property, leading to products such as  $(-1)(-1) = 1$  and the rules for multiplying signed numbers. Interpret products of rational numbers by describing real-world contexts.
- Understand that integers can be divided, provided that the divisor is not zero, and every quotient of integers (with non-zero divisor) is a rational number. If  $p$  and  $q$  are integers, then  $-(p/q) = (-p)/q = p/(-q)$ . Interpret quotients of rational numbers by describing real-world contexts.
- Apply properties of operations as strategies to multiply and divide rational numbers.
- 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.

**7.NO.2i1 Solve multiplication problems with positive/negative numbers.**

**7.NO.2i2 Solve division problems with positive/negative numbers.**

3. Solve real-world and mathematical problems involving the four operations with rational numbers.

*No CCC developed for this standard.*

## Expressions and Equations

7.EE

### Use properties of operations to generate equivalent expressions.

- Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.

*No CCC developed for this standard.*

- Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example,  $a + 0.05a = 1.05a$  means that “increase by 5%” is the same as “multiply by 1.05.”

*No CCC developed for this standard.*

### Solve real-life and mathematical problems using numerical and algebraic expressions and equations.

- 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. 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  $9 \frac{3}{4}$  inches long in the center of a door that is  $27 \frac{1}{2}$  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.

*7.PRF.1g1 Solve real world multi step problems using whole numbers.*

- 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.
  - Solve word problems leading to equations of the form  $px + q = r$  and  $p(x + q) = r$ , where  $p$ ,  $q$ , and  $r$  are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. *For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?*

*7.NO.3c5 Explain how to solve a multi-step equation.*

- Solve word problems leading to inequalities of the form  $px + q > r$  or  $px + q < r$ , where  $p$ ,  $q$ , and  $r$  are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. *For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want*

**your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.**

*7.SE.1f1 Set up equations with 1 variable based on real world problems.*

*7.SE.1f2 Solve equations with 1 variable based on real world problems.*

**7.PRF.1g2 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.**

*7.PRF.2d Use a calculator to solve word problems leading to inequalities of the form  $px + q > r$  or  $px + q < r$ , where  $p$ ,  $q$ , and  $r$  are specific rational numbers.*

## Geometry

## 7.G

### Draw, construct, and describe geometrical figures and describe the relationships between them.

1. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

*7.ME.1d1 Solve problems that use proportional reasoning with ratios of length and area.*

*7.ME.2e1 Solve one step real world problems related to scaling.*

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.

*7.GM.1e1 Construct or draw plane figures using properties.*

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.

*No CCC developed for this standard.*

### Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.

4. **Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.**

*7.ME.2d1 Apply formula to measure area and circumference of circles.*

5. Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure.

*8.GM.1i1 Identify supplementary angles*

*8.GM.1i2 Identify complimentary angles.*

*8.GM.1i3 Identify adjacent angles.*

*8.GM.1i4 Use angle relationships to find the value of a missing angle.*

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.**

*7.GM.1h1 Add the area of each face of a prism to find surface area of three dimensional objects.*

**7.GM.1h2 Find the surface area of three-dimensional figures using nets of rectangles or triangles.**

*7.GM.1h3 Find area of plane figures and surface area of solid figures (quadrilaterals).*

*7.GM.1h4 Find area of an equilateral, isosceles, and scalene triangle.*

*7.ME.2c 1 Solve one step real world measurement problems involving area, volume, or surface area of two- and three-dimensional objects.*

**Use random sampling to draw inferences about a population.**

1. Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.

*7.DPS.1b1 Determine sample size to answer a given question.*

2. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.

*No CCC developed for this standard.*

**Draw informal comparative inferences about two populations.**

3. Informally assess the degree of visual overlap of two numerical data distributions with similar variabilities, measuring the difference between the centers by expressing it as a multiple of a measure of variability. For example, the mean height of players on the basketball team is 10 cm greater than the mean height of players on the soccer team, about twice the variability (mean absolute deviation) on either team; on a dot plot, the separation between the two distributions of heights is noticeable.

*7.DPS.1j1 Make or select a statement to compare the distribution of 2 data sets.*

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.**

*7.DPS.1i2 Identify the range (high/low), median(middle), mean, or mode of a given data set.*

***7.DPS.1k1 Analyze graphs to determine or select appropriate comparative inferences about two samples or populations.***

*8.DPS.1j2 Make or select an appropriate statements based upon two unequal data sets using measure of central tendency and shape.*

**Investigate chance processes and develop, use, and evaluate probability models.**

5. Understand that the probability of a chance event is a number between 0 and 1 that expresses the likelihood of the event occurring. Larger numbers indicate greater likelihood. A probability near 0 indicates an unlikely event, a probability around 1/2 indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.

*7.DPS.2d1 Describe the probability of events as being certain or impossible, likely, less likely or equally likely.*

*7.DPS.2d2 State the theoretical probability of events occurring in terms of ratios(words, percentages, decimals).*

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.

*7.DPS.2a1 Conduct simple probability experiments*

*7.DPS.2d4 Make a prediction regarding the probability of an event occurring; conduct simple probability experiments.*

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

- 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.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.*

- 8. Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.
  - a. Understand that, just as with simple events, the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs.
  - 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.
  - c. Design and use a simulation to generate frequencies for compound events. For example, use random digits as a simulation tool to approximate the answer to the question: If 40% of donors have type A blood, what is the probability that it will take at least 4 donors to find one with type A blood?

*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.*

# GRADE 8

## The Number System

8.NS

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

1. Know that numbers that are not rational are 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 expansion which repeats eventually into a rational number.
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.,  $\pi^2$ ).**

*8.NO.1k1 Identify  $\pi$  as an irrational number.*

*8.NO.1k2 Round irrational numbers to the hundredths place.*

*8.NO.1k3 Use approximations of irrational numbers to locate them on a number line.*

## Expressions and Equations

8.EE

### Work with radicals and integer exponents.

1. Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example,  $32 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$ .

*No CCC developed for this standard.*

2. Use square root and cube root symbols to represent solutions to equations of the form  $x^2 = p$  and  $x^3 = p$ , where  $p$  is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that  $\sqrt{2}$  is irrational.

*No CCC developed for this standard.*

3. Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. For example, estimate the population of the United States as  $3 \times 10^8$  and the population of the world as  $7 \times 10^9$ , and determine that the world population is more than 20 times larger.

*8.NO.1i1 Convert a number expressed in scientific notation up to 10,000.*

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.

*No CCC developed for this standard.*

### Understand the connections between proportional relationships, lines, and linear equations.

5. **Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.**
6. Use similar triangles to explain why the slope  $m$  is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation  $y = mx$  for a line through the origin and the equation  $y = mx + b$  for a line intercepting the vertical axis at  $b$ .

*No CCC developed for this standard.*

### Analyze and solve linear equations and pairs of simultaneous linear equations.

7. **Solve linear equations in one variable.**
  - a. **Analyze and solve pairs of simultaneous linear equations.**

*8.PRF.1g3 Solve linear equations with 1 variable.*

- b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.
8. Analyze and solve pairs of simultaneous linear equations.
- a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.
  - b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. *For example,  $3x + 2y = 5$  and  $3x + 2y = 6$  have no solution because  $3x + 2y$  cannot simultaneously be 5 and 6.*
  - c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

*No CCCs developed for these standards.*

## Functions

8.F

### Define, evaluate, and compare functions.

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.  
*No CCC developed for this standard.*
2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change.  
*No CCC developed for this standard.*
3. Interpret the equation  $y = mx + b$  as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. *For example, the function  $A = s^2$  giving the area of a square as a function of its side length is not linear because its graph contains the points (1, 1), (2, 4) and (3, 9), which are not on a straight line.*  
*8.PRF.2c1 Given two graphs, describe the function as linear and not linear.*

### Use functions to model relationships between quantities.

4. **Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.**  
*8.PRF.2e2 Identify the rate of change (slope) and initial value (y-intercept) from graphs.*
5. **Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.**  
*8.PRF.2c1 Given two graphs, describe the function as linear and not linear.*  
*8.PRF.2e3 Given a verbal description of a situation, create or identify a graph to model the situation.*  
*8.PRF.2e4 Given a graph of a situation, generate a description of the situation.*  
**8.PRF.1f2 describe or select the relationship between the two quantities given a line graph of a situation.**  
*8.NO.3c3 Analyze provided information (e.g., a graph) to describe the relationship between two quantities.*

## Geometry

8.G

### Understand congruence and similarity using physical models, transparencies, or geometry software.

1. Verify experimentally the properties of rotations, reflections, and translations:
  - a. Lines are taken to lines, and line segments to line segments of the same length.
  - b. Angles are taken to angles of the same measure.

c. Parallel lines are taken to parallel lines.

*8.GM.1f1 Recognize a rotation, reflection, or translation of a figure.*

*H.GM.1d1 Use the reflections, rotations, or translations in the coordinate plane to solve problems with right angles.*

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. none

3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates.

*8.GM.1f2 Identify a rotation, reflection, or translation of a plane figure when given coordinates.*

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.**

*8.GM.1g1 Recognize congruent and similar figures.*

*8.ME.1e1 Describe the changes in surface area, area, and volume when the figure is changed in some way (e.g., scale drawings).*

*8.ME.1e2 Compare area and volume of similar figures.*

5. Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. For example, arrange three copies of the same triangle so that the sum of the three angles appears to form a line, and give an argument in terms of transversals why this is so.

*8.GM.1i4 Use angle relationships to find the value of a missing angle.*

### **Understand and apply the Pythagorean Theorem.**

6. Explain a proof of the Pythagorean Theorem and its converse.

*No CCC developed for this standard.*

7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

*8.ME.2f1 Apply the Pythagorean theorem to determine lengths/distances in real-world situations.*

*8.GM.1j1 Find the hypotenuse of a two-dimensional right triangle (Pythagorean Theorem).*

*8.GM.1j2 Find the missing side lengths of a two-dimensional right triangle (Pythagorean Theorem).*

*H.GM.1a1 Find the hypotenuse of a two-dimensional right triangle (Pythagorean Theorem).*

*H.GM.1a2 Find the missing side lengths of a two-dimensional right triangle (Pythagorean Theorem).*

8. Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.

*No CCC developed for this standard.*

### **Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres.**

9. Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

*8.ME2d2 Apply the formula to find the volume of 3 dimensional shapes (i.e., cubes, spheres, and cylinders).*

## **Statistics and Probability**

**8.SP**

### **Investigate patterns of association in bivariate data.**

1. **Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.**

*8.SP.1a Recognize a pattern of association using existing data.*

*8.DPS.1g2 Graph data using line graphs, histograms, or box plots.*

*8.DPS.1h1 Graph bivariate data using scatter plots and identify possible associations between the variables.*

*8.DPS.1i3 using box plots and scatter plots, identify data points that appear to be outliers.*

2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

*8.DPS.2g1 Distinguish between a linear and non-linear association when analyzing bivariate data on a scatter plot*

3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

*8.DPS.2g2 Interpret the slope and the y-intercept of a line in the context of a problem.*

4. **Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?**

***8.DPS.1k2 Analyze displays of bivariate data to develop or select appropriate claims about those data.***

*8.DPS.1f3 Construct a two-way table summarizing data on two categorical variables collected from the same subjects; identify possible association between the two variables.*

# HIGH SCHOOL

## The Real Number System

N-RN

### Extend the properties of exponents to rational exponents.

1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define  $5^{1/2}$  to be the cube root of 5 because we want  $(5^{1/3})^3 = 5^{(1/3)3}$  to hold, so  $(5^{1/3})^3$  must be equal to 5.*

*No CCC developed for this standard.*

2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.

**HS.NO.1a1 Simplify expressions that include exponents.**

*HS.NO.1a2 Explain the influence of an exponent on the location of a decimal point in a given number.*

*HS.NO.1a3 Convert a number expressed in scientific notation.*

*HS.NO.2c2 Rewrite expressions that include rational exponents.*

### Use properties of rational irrational numbers.

3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.

*HS.NO.2b1 Explain the pattern for the sum or product for combinations of rational and irrational numbers.*

## Quantities

N-Q

### Reason quantitatively and use units to solve problems.

1. Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.

*H.ME.1a1 Determine the necessary unit(s) to use to solve real world problems.*

**H.ME.1a2 Solve real world problems involving units of measurement.**

2. Define appropriate quantities for the purpose of descriptive modeling.

*No CCC developed for this standard.*

3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

*H.ME.2a1 Describe the accuracy of measurement when reporting quantity (you can lessen your limitations by measuring precisely)*

## The Complex Number System

N-CN

### Perform arithmetic operations with complex numbers.

1. Know there is a complex number  $i$  such that  $i^2 = -1$ , and every complex number has the form  $a + bi$  with  $a$  and  $b$  real.

*No CCC developed for this standard.*

2. Use the relation  $i^2 = -1$  and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

*No CCC developed for this standard.*

3. (+) Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.

*No CCC developed for this standard.*

## Represent complex numbers and their operations on the complex plane.

- (+) 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.

*No CCC developed for this standard.*

- (+) 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  $120^\circ$ .*

*No CCC developed for this standard.*

- (+) 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.

*No CCC developed for this standard.*

## Use complex numbers in polynomial identities and equations.

- Solve quadratic equations with real coefficients that have complex solutions.

*No CCC developed for this standard.*

- (+) Extend polynomial identities to the complex numbers. *For example, rewrite  $x^2 + 4$  as  $(x + 2i)(x - 2i)$ .*

*No CCC developed for this standard.*

- (+) Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.

*No CCC developed for this standard.*

## Vector and Matrix Quantities

N-VM

### Represent and model with vector quantities.

- (+) 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.,  $\mathbf{v}$ ,  $|\mathbf{v}|$ ,  $\|\mathbf{v}\|$ ,  $v$ ).

*No CCC developed for this standard.*

- (+) Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

*No CCC developed for this standard.*

- (+) Solve problems involving velocity and other quantities that can be represented by vectors.

*No CCC developed for this standard.*

### Perform operations on vectors.

- (+) Add and subtract vectors.

- Add vectors end-to-end, component-wise, and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.

- Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.

- Understand vector subtraction  $\mathbf{v} - \mathbf{w}$  as  $\mathbf{v} + (-\mathbf{w})$ , where  $-\mathbf{w}$  is the additive inverse of  $\mathbf{w}$ , with the same magnitude as  $\mathbf{w}$  and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order, and perform vector subtraction component-wise.

*No CCC developed for this standard.*

- (+) Multiply a vector by a scalar.

- Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise, e.g., as  $c(v_x, v_y) = (cv_x, cv_y)$ .

- b. Compute the magnitude of a scalar multiple  $c\mathbf{v}$  using  $\|c\mathbf{v}\| = |c|\mathbf{v}$ . Compute the direction of  $c\mathbf{v}$  knowing that when  $|c|\mathbf{v} \neq 0$ , the direction of  $c\mathbf{v}$  is either along  $\mathbf{v}$  (for  $c > 0$ ) or against  $\mathbf{v}$  (for  $c < 0$ ).

*No CCC developed for this standard.*

### **Perform operations on matrices and use matrices in applications.**

6. (+) Use matrices to represent and manipulate data, e.g., to represent payoffs or incidence relationships in a network.

*No CCC developed for this standard.*

7. (+) Multiply matrices by scalars to produce new matrices, e.g., as when all of the payoffs in a game are doubled.

*No CCC developed for this standard.*

8. (+) Add, subtract, and multiply matrices of appropriate dimensions.

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

12. (+) Work with  $2 \times 2$  matrices as transformations of the plane, and interpret the absolute value of the determinant in terms of area.

*No CCC developed for this standard.*

# ALGEBRA

## Seeing Structure in Expressions

A-SSE

### Interpret the structure of expressions

1. Interpret expressions that represent a quantity in terms of its context.
  - a. Interpret parts of an expression, such as terms, factors, and coefficients.
  - b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret  $P(1+r)^n$  as the product of  $P$  and a factor not depending on  $P$ .*  
*H.PRF.2a1 Translate an algebraic expression into a word problem.*
2. Use the structure of an expression to identify ways to rewrite it. For example, see  $x^4 - y^4$  as  $(x^2)^2 - (y^2)^2$ , thus recognizing it as a difference of squares that can be factored as  $(x^2 - y^2)(x^2 + y^2)$ .  
*H.NO.2c1 Simplify expressions that include exponents.*  
*H.NO.2c2 Rewrite expressions that include rational exponents.*

### Write expressions in equivalent forms to solve problems

3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
  - a. Factor a quadratic expression to reveal the zeros of the function it defines.
  - b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.  
*H.NO.3a2 Rewrite mathematical statements (e.g., an expression) in multiple forms.*
  - c. Use the properties of exponents to transform expressions for exponential functions. For example the expression  $1.15t$  can be rewritten as  $(1.151/12)12t \approx 1.01212t$  to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.  
*H.NO.1a1 Simplify expressions that include exponents.*
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.*  
*No CCC developed for this standard.*

## Arithmetic with Polynomials and Rational Expressions

A-APR

### Perform arithmetic operations on polynomials

1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.  
*No CCC developed for this standard.*

### Understand the relationship between zeros and factors of polynomials

2. Know and apply the Remainder Theorem: For a polynomial  $p(x)$  and a number  $a$ , the remainder on division by  $x - a$  is  $p(a)$ , so  $p(a) = 0$  if and only if  $(x - a)$  is a factor of  $p(x)$ .  
*No CCC developed for this standard.*
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.  
*No CCC developed for this standard.*

### Use polynomial identities to solve problems

4. Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity  $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$  can be used to generate Pythagorean triples.

No CCC developed for this standard.

- (+) Know and apply the Binomial Theorem for the expansion of  $(x + y)^n$  in powers of  $x$  and  $y$  for a positive integer  $n$ , where  $x$  and  $y$  are any numbers, with coefficients determined for example by Pascal's Triangle.

No CCC developed for this standard.

### Rewrite rational expressions

- Rewrite simple rational expressions in different forms; write  $a(x)/b(x)$  in the form  $q(x) + r(x)/b(x)$ , where  $a(x)$ ,  $b(x)$ ,  $q(x)$ , and  $r(x)$  are polynomials with the degree of  $r(x)$  less than the degree of  $b(x)$ , using inspection, long division, or, for the more complicated examples, a computer algebra system.

No CCC developed for this standard.

- (+) 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.

No CCC developed for this standard.

## Creating Equations

A-CED

### Create equations that describe numbers or relationships

- Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.

*H.PRF.2b1 Translate a real-world problem into a one variable linear equation.*

- Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

*H.PRF.2b2 Solve equations with one or two variables using equations or graphs.*

- Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.

No CCC developed for this standard.

- Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. For example, rearrange Ohm's law  $V = IR$  to highlight resistance  $R$ .

No CCC developed for this standard.

## Reasoning with Equations and Inequalities

A-REI

### Understand solving equations as a process of reasoning and explain the reasoning.

- 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.

*H.PRF.2b2 Solve equations with one or two variables using equations or graphs*

- Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.

*H.NO.2a1Solve simple equations using rational numbers with one or more variables.*

### Solve equations and inequalities in one variable.

- Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

*H.PRF.2b2 Solve equations with one or two variables using equations or graphs.*

*H.ME.1b2 Solve a linear equation to find a missing attribute given the area, surface area, or volume and the other attribute.*

4. Solve quadratic equations in one variable.
  - a. Use the method of completing the square to transform any quadratic equation in  $x$  into an equation of the form  $(x - p)^2 = q$  that has the same solutions. Derive the quadratic formula from this form.
  - b. Solve quadratic equations by inspection (e.g., for  $x^2 = 49$ ), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as  $a \pm bi$  for real numbers  $a$  and  $b$ .

*No CCC developed for this standard.*

### **Solve systems of equations**

5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.

*No CCC developed for this standard.*

6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

*No CCC developed for this standard.*

7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line  $y = -3x$  and the circle  $x^2 + y^2 = 3$ .

*No CCC developed for this standard.*

8. (+) Represent a system of linear equations as a single matrix equation in a vector variable.

*No CCC developed for this standard.*

9. (+) Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension  $3 \times 3$  or greater).

*No CCC developed for this standard.*

### **Represent and solve equations and inequalities graphically**

10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

12. Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.

*No CCC developed for this standard.*

# FUNCTIONS OVERVIEW

## Interpreting Functions

F-IF

### Understand the concept of a function and use function notation.

1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If  $f$  is a function and  $x$  is an element of its domain, then  $f(x)$  denotes the output of  $f$  corresponding to the input  $x$ . The graph of  $f$  is the graph of the equation  $y = f(x)$ .  
*No CCC developed for this standard.*
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.  
*No CCC developed for this standard.*
3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by  $f(0) = f(1) = 1$ ,  $f(n+1) = f(n) + f(n-1)$  for  $n \geq 1$ .  
*No CCC developed for this standard.*

### Interpret functions that arise in applications in terms of the context

4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*  
*No CCC developed for this standard.*
5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function  $h(n)$  gives the number of person-hours it takes to assemble  $n$  engines in a factory, then the positive integers would be an appropriate domain for the function.  
*No CCC developed for this standard.*
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.  
*No CCC developed for this standard.*

### Analyze functions using different representations

7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
  - a. Graph linear and quadratic functions and show intercepts, maxima, and minima.
  - b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
  - c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.
  - d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.
  - e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*No CCC developed for this standard.*
8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
  - a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

- b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as  $y = (1.02)^t$ ,  $y = (0.97)^t$ ,  $y = (1.01)^{12t}$ ,  $y = (1.2)^t/10$ , and classify them as representing exponential growth or decay.

*No CCC developed for this standard.*

9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.

*No CCC developed for this standard.*

## Building Functions

F-BF

### Build a function that models a relationship between two quantities

- Write a function that describes a relationship between two quantities.
  - Determine an explicit expression, a recursive process, or steps for calculation from a context.
  - Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.
  - (+) Compose functions. For example, if  $T(y)$  is the temperature in the atmosphere as a function of height, and  $h(t)$  is the height of a weather balloon as a function of time, then  $T(h(t))$  is the temperature at the location of the weather balloon as a function of time.
- Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

*No CCC developed for this standard.*

### Build new functions from existing functions

- Identify the effect on the graph of replacing  $f(x)$  by  $f(x) + k$ ,  $k f(x)$ ,  $f(kx)$ , and  $f(x + k)$  for specific values of  $k$  (both positive and negative); find the value of  $k$  given the graphs. Experiment with 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.
- Find inverse functions.
  - Solve an equation of the form  $f(x) = c$  for a simple function  $f$  that has an inverse and write an expression for the inverse. For example,  $f(x) = 2x^3$  or  $f(x) = (x+1)/(x-1)$  for  $x \neq 1$ .
  - (+) Verify by composition that one function is the inverse of another.
  - (+) Read values of an inverse function from a graph or a table, given that the function has an inverse.
  - (+) Produce an invertible function from a non-invertible function by restricting the domain.
- (+) Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.

*No CCC developed for this standard.*

## Linear, Quadratic, and Exponential Models

F-LE

### Construct and compare linear, quadratic, and exponential models and solve problems.

- Distinguish between situations that can be modeled with linear functions and with exponential functions.**
  - Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.**
  - Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.**

- c. **Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.**

**H.PRF.1c1 Select the appropriate graphical representation of a linear model based on real world events.**

*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?).*

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).

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

4. For exponential models, express as a logarithm the solution to  $ab^{ct} = d$  where  $a$ ,  $c$ , and  $d$  are numbers and the base  $b$  is 2, 10, or  $e$ ; evaluate the logarithm using technology.

*No CCC developed for this standard.*

### **Interpret expressions for functions in terms of the situation they model.**

5. Interpret the parameters in a linear or exponential function in terms of a context.

*No CCC developed for this standard.*

## **Trigonometric Functions**

**F-TF**

### **Extend the domain of trigonometric functions using the unit circle**

1. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

3. (+) Use special triangles to determine geometrically the values of sine, cosine, tangent for  $\pi/3$ ,  $\pi/4$  and  $\pi/6$ , and use the unit circle to express the values of sine, cosines, and tangent for  $x$ ,  $\pi+x$ , and  $2\pi-x$  in terms of their values for  $x$ , where  $x$  is any real number.

*No CCC developed for this standard.*

4. (+) Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.

*No CCC developed for this standard.*

### **Model periodic phenomena with trigonometric functions**

5. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

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.

*No CCC developed for this standard.*

### Prove and apply trigonometric identities

8. Prove the Pythagorean identity  $\sin^2(\theta) + \cos^2(\theta) = 1$  and use it to find  $\sin(\theta)$ ,  $\cos(\theta)$ , or  $\tan(\theta)$  given  $\sin(\theta)$ ,  $\cos(\theta)$ , or  $\tan(\theta)$  and the quadrant of the angle.

*No CCC developed for this standard.*

9. (+) Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems.

*No CCC developed for this standard.*

# Geometry

## Congruence

## G-CO

### Experiment with transformations in the plane

1. Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.  
*No CCC developed for this standard.*
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 preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).  
*No CCC developed for this standard.*
3. Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself.  
*H.GM.1c1 Construct, draw or recognize a figure after its rotation, reflection, or translation.*
4. Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.  
*No CCC developed for this standard.*
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.  
*H.GM.1c1 Construct, draw or recognize a figure after its rotation, reflection, or translation.*

### Understand congruence in terms of rigid motions

6. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.  
*No CCC developed for this standard.*
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.**  
*H.GM.1b1 Use definitions to demonstrate congruency and similarity in figures.*
8. Explain how the criteria for triangle congruence (ASA, SAS, and SSS) follow from the definition of congruence in terms of rigid motions.  
*No CCC developed for this standard.*

## Prove geometric theorems

9. Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints.

*No CCC developed for this standard.*

10. Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to  $180^\circ$ ; 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.

*No CCC developed for this standard.*

11. Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and conversely, rectangles are parallelograms with congruent diagonals.

*No CCC developed for this standard.*

## Make geometric constructions

12. Make formal geometric constructions with a variety of tools and methods (compass and straightedge, string, reflective devices, paper folding, dynamic geometric software, etc.). Copying a segment; copying an angle; bisecting a segment; bisecting an angle; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line.

*H.GM.1e1 Make formal geometric constructions with a variety of tools and methods.*

13. Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle.

*No CCC developed for this standard.*

## Similarity, Right Triangles, and Trigonometry

G-SRT

### Understand similarity in terms of similarity transformations

1. Verify experimentally the properties of dilations given by a center and a scale factor:
  - d. 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.
  - e. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

*H.ME.2b1 Determine the dimensions of a figure after dilation*

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.

*H.ME.2b2 Determine if two figures are similar.*

*H.ME.2b3 Describe or select why two figures are or are not similar.*

*H.GM.1b1 Use definitions to demonstrate congruency and similarity in figures.*

*H.GM.1d1 Use the reflections, rotations, or translations in the coordinate plane to solve problems with right angles.*

3. Use the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

*No CCC developed for this standard.*

### Prove theorems involving similarity

4. Prove theorems about triangles. Theorems include: a line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity.

*No CCC developed for this standard.*

5. Use congruence and similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

*No CCC developed for this standard.*

## Define trigonometric ratios and solve problems involving right triangles

6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles.  
*No CCC developed for this standard.*
7. Explain and use the relationship between the sine and cosine of complementary angles.  
*No CCC developed for this standard.*
8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.  
*No CCC developed for this standard.*

## Apply trigonometry to general triangles

9. (+) Derive the formula  $A = 1/2 ab \sin(C)$  for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.  
*No CCC developed for this standard.*
10. (+) Prove the Laws of Sines and Cosines and use them to solve problems.  
*No CCC developed for this standard.*
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).  
*No CCC developed for this standard.*

## Circles

G-C

### Understand and apply theorems about circles

1. Prove that all circles are similar.  
*No CCC developed for this standard.*
2. Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle.  
*No CCC developed for this standard.*
3. Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle.  
*No CCC developed for this standard.*
4. (+) Construct a tangent line from a point outside a given circle to the circle.  
*No CCC developed for this standard.*

### Find arc lengths and sectors of circles.

5. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.  
*H.ME.2b4 Apply the formula to the area of a sector (e.g., area of a slice of pie).*

## Expressing Geometric Properties with Equations

G-GPE

### Translate between the geometric description and the equation for a conic section

1. Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation.  
*No CCC developed for this standard.*
2. Derive the equation of a parabola given a focus and directrix.  
*No CCC developed for this standard.*

3. (+) Derive the equations of ellipses and hyperbolas given foci and directrices.

*No CCC developed for this standard.*

### **Use coordinates to prove simple geometric theorems algebraically**

4. Use coordinates to prove simple geometric theorems algebraically. For example, prove or disprove that a figure defined by four given points in the coordinate plane is a rectangle; prove or disprove that the point  $(1, \sqrt{3})$  lies on the circle centered at the origin and containing the point  $(0, 2)$ .

*No CCC developed for this standard.*

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).

*No CCC developed for this standard.*

6. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

*No CCC developed for this standard.*

7. Use coordinates to compute perimeters of polygons and areas of triangles and rectangles, e.g., using the distance formula.

*No CCC developed for this standard.*

## **Geometric Measurement and Dimension**

**G-GMD**

### **Explain volume formulas and use them to solve problems**

1. Give an informal argument for the formulas for the circumference of a circle, area of a circle, volume of a cylinder, pyramid, and cone. Use dissection arguments, Cavalieri's principle, and informal limit arguments.

*No CCC developed for this standard.*

2. (+) Give an informal argument using Cavalieri's principle for the formulas for the volume of a sphere and other solid figures.

*No CCC developed for this standard.*

3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.

*No CCC developed for this standard.*

### **Visualize relationships between two-dimensional and three-dimensional objects**

4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects.

*No CCC developed for this standard.*

## **Modeling with Geometry**

**G-MG**

### **Apply geometric concepts in modeling situations**

1. Use geometric shapes, their measures, and their properties to describe objects (e.g., modeling a tree trunk or a human torso as a cylinder).

*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.*

2. Apply concepts of density based on area and volume in modeling situations (e.g., persons per square mile, BTUs per cubic foot).

*No CCC developed for this standard.*

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).

*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).*

# Statistics and Probability

## Interpreting Categorical and Quantitative Data

S-ID

### Summarize, represent, and interpret data on a single count or measurement variable

1. **Represent data with plots on the real number line (dot plots, histograms, and box plots).**  
*H.DPS.1b1 Complete a graph given the data, using dot plots, histograms, or box plots.*
2. Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets.  
*H.DPS.1c2 Compare means, median, and range of 2 sets of data.*
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).  
*No CCC developed for this standard.*
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.**  
*H.DPS.1c1 Use descriptive stats; range, median, mode, mean, outliers/gaps to describe the data set.*

### Summarize, represent, and interpret data on two categorical and quantitative variables

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.  
*H.DPS.1a1 Design study using categorical and continuous data, including creating a question, identifying a sample, and making a plan for data collection.*  
*H.DPS.1c1 Use descriptive statistics; range, median, mode, mean, outliers/gaps to describe the data set.*
6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
  - a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.
  - b. Informally assess the fit of a function by plotting and analyzing residuals.
  - c. Fit a linear function for a scatter plot that suggests a linear association.*H.DPS.1d1 Represent data on a scatter plot to describe and predict.*  
*H.DPS.1d2 Select an appropriate statement that describes the relationship between variables*

### Interpret Linear Models

7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of data.  
*H.PRF.1a1 Interpret the rate of change using graphical representations.*
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.  
*No CCC developed for this standard.*
9. Distinguish between correlation and causation.  
*No CCC developed for this standard.*

**Understand and evaluate random processes underlying statistical experiments**

1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population

*H.DPS.1c3 Determine what inferences can be made from statistics*

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 of 0.5. Would a result of 5 tails in a row cause you to question the model?

**Make inferences and justify conclusions from sample surveys, experiments, and observational studies**

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

*No CCC developed for this standard.*

4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling.

*No CCC developed for this standard.*

5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

*No CCC developed for this standard.*

6. Evaluate reports based on data.

*H.DPS.1d3 Make or select an appropriate statement(s) about findings.*

*H.DPS.1d4 Apply the results of the data to a real world situation*

**Understand independence and conditional probability and use them to interpret data**

1. Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events (“or,” “and,” “not”).

*No CCC developed for this standard.*

2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.

*No CCC developed for this standard.*

3. Understand the conditional probability of A given B as  $P(A \text{ and } B)/P(B)$ , and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.

*No CCC developed for this standard.*

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. 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.

*H.DSP.2d Select or make an appropriate statement based on a two-way frequency table.*

5. Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.

*H.DSP.2e Select or make an appropriate statement based on real world examples of conditional probability.*

## Use the rules of probability to compute probabilities of compound events in a uniform probability model.

6. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.  
*No CCC developed for this standard.*
7. Apply the Addition Rule,  $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$ , and interpret the answer in terms of the model.  
*No CCC developed for this standard.*
8. (+) Apply the general Multiplication Rule in a uniform probability model,  $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$ , and interpret the answer in terms of the model.  
*No CCC developed for this standard.*
9. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.  
*No CCC developed for this standard.*

## Using Probability to Make Decisions

S-MD

### Calculate expected values and use them to solve problems

1. (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same graphical displays as for data distributions.  
*No CCC developed for this standard.*
2. (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution.  
*No CCC developed for this standard.*
3. (+) Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. For example, find 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.  
*H.DPS.2c1 Determine the theoretical probability of multistage probability experiments.*  
*H.DPS.2c2 Collect data from multistage probability experiments.*  
*H.DPS.2c3 Compare actual results of multistage experiment with theoretical probabilities.*
4. (+) Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. For example, find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households?  
*No CCC developed for this standard.*

### Use probability to evaluate outcomes of decisions

5. (+) Weigh the possible outcomes of a decision by assigning probabilities to pay off values and finding expected values.
  - a. Find the expected payoff for a game of chance. For example, find the expected winnings from a state lottery ticket or game at a fast-food restaurant.
  - b. Evaluate and compare strategies on the basis of expected values. For example, compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or major accident.  
*No CCC developed for this standard.*
6. (+) Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).  
*No CCC developed for this standard.*
7. (+) Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).

*H.DSP.2b Identify and describe the degree to which something is rated “good” or “bad”/desirable or undesirable based on numerical information.*