Cambridge Public Schools
Grade 8 Algebra Curriculum Map
MATH IN FOCUS 2015 – 2016

In Grade 8, instructional time should focus on three critical areas:

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

(1) Students use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. Students recognize equations for proportions ($y/x = m$ or $y = mx$) as special linear equations ($y = mx + b$), understanding that the constant of proportionality (m) is the slope, and the graphs are lines through the origin. They understand that the slope (m) of a line is a constant rate of change, so that if the input or x-coordinate changes by an amount A, the output or y-coordinate changes by the amount $m \cdot A$. Students also use a linear equation to describe the association between two quantities in bivariate data (such as arm span vs. height for students in a classroom). At this grade, fitting the model, and assessing its fit to the data are done informally. Interpreting the model in the context of the data requires students to express a relationship between the two quantities in question and to interpret components of the relationship (such as slope and y-intercept) in terms of the situation.

Students strategically choose and efficiently implement procedures to solve linear equations in one variable, understanding that when they use the properties of equality and the concept of logical equivalence, they maintain the solutions of the original equation. Students solve systems of two linear equations in two variables and relate the systems to pairs of lines in the plane; these intersect, are parallel, or are the same line. Students use linear equations, systems of linear equations, linear functions, and their understanding of slope of a line to analyze situations and solve problems.

(2) Students grasp the concept of a function as a rule that assigns to each input exactly one output. They understand that functions describe situations where one quantity determines another. They can translate among representations and partial representations of functions (noting that tabular and graphical representations may be partial representations), and they describe how aspects of the function are reflected in the different representations.

(3) Students use ideas about distance and angles, how they behave under translations, rotations, reflections, and dilations, and ideas about congruence and similarity to describe and analyze two-dimensional figures and to solve problems. Students show that the sum of the angles in a triangle is the angle formed by a straight line, and that various configurations of lines give rise to similar triangles because of the angles created when a transversal cuts parallel lines. Students understand the statement of the Pythagorean Theorem and its converse, and can explain why the Pythagorean Theorem holds, for example, by decomposing a square in two different ways. They apply the Pythagorean Theorem to find distances between points on the coordinate plane, to find lengths, and to analyze polygons. Students complete their work on volume by solving problems involving cones, cylinders, and spheres.

Cambridge Public Schools
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MATH IN FOCUS 2015 – 2016

Changes from the previous Grade 8 course to the new Grade 8 Algebra course

The following information can be used to identify the new content being added to Grade 8 to form the Grade 8 Algebra course. Content marked with an asterisk (*) is content previously taught in high school (Algebra I, Geometry, or Algebra II). Content marked with a degree symbol (°) is new content being added to Grade 8 Algebra.

The Number System

Grade 8	Grade 8 Algebra
Compare, order, estimate, and translate among rational numbers	**Same content, as well as** ● identify numbers as rational or irrational by their decimal representations° ● approximate any irrational number using rational numbers and locate it on a number line°
Define, compare, order, and apply frequently used irrational numbers	
Represent numbers in scientific notation and use them in calculations and problem situations	**Same content, as well as** ● represent very small numbers* ● perform operations with numbers expressed in scientific notation° ● interpret scientific notation that has been generated by technology°

Expressions and Equations

Grade 8	Grade 8 Algebra
Know and apply properties of integer exponents	**Same content, as well as** ● work with negative exponents* (*Algebra II*)
Finding squares and square roots and identify square roots that irrational	**Same content, as well as** ● work with cube roots of small perfect cubes*
Use ratios and proportions in the solution of problems	**Same content, as well as** ● comparison of two different proportional relationships represented in different ways° ● graph proportional relationships, interpreting the unit rate of the slope of the graph°
Identify the slope of a line as a measure of its steepness and as a constant rate of change	
Identify the roles of variables in the equations $y = mx + b$, expressing y as a function of x with parameters m and b	**Same content, as well as** ● relate slope to similar triangles°
Classify figures in terms of congruence and similarity	
Setup and solve linear equations and inequalities	**Solve linear equations, as well** ● use examples with one solution, no solution, and infinitely many solutions° ● use rational number coefficients° ● solve systems of linear equations* *Algebra I now covers systems of linear inequalities; setting up and solving linear inequalities has moved to Grade 7*

Cambridge Public Schools
Grade 8 Algebra Curriculum Map
MATH IN FOCUS 2015 – 2016

Functions

Grade 8	Grade 8 Algebra
Explain and analyze how a change in one variable results in a change in another variable in functional relationships	**Same content, as well as** ● introduce the concept of function* ● compare properties of two functions° ● interpret a linear equation as a function* ● read information about a linear or non-linear relationship from a variety of displays*
Use models, graphs, and formulas to solve simple problems involving rates	
Use tables and graphs to represent and compare linear rates of change and x- and y-intercepts of different linear patterns.	**Same content, as well as** ● create a graph that exhibits the qualitative features of a function° *Algebra I will now focus on quadratic, and exponential functions*

Geometry

Grade 8	Grade 8 Algebra
Predict the results of transformations and draw the transformed figure	**Same content, as well as** ● verify the properties of transformations° ● use transformations to prove congruence°
Classify figures as congruent or similar	
Demonstrate an understanding of the Pythagorean theorem and apply it to the solution of problems	**Same content, as well as** ● prove the Pythagorean theorem and its converse° ● relate the Pythagorean theorem to distance between two points in a coordinate system* ● Apply the Pythagorean theorem in two and three dimensions°
Understand and apply the formulas for the area, perimeter and circumference of parallelograms, trapezoids, and circles	**Determine the volume of cylinders and spheres, as well as** ● the volume of a cone* ● students are expected to know the formulas* *Other geometric concepts have moved to Grades 6 and 7*
Given the formulas, determine the surface area and volume of rectangular prisms, cylinders, and spheres	

Statistics and Probability

Grade 8	Grade 8 Algebra
Select, create, interpret, and utilize circle graphs, Venn diagrams, scatterplots, stem-and-leaf plots, box-and-whisker plots, histograms, tables, and charts	**Construct and interpret scatterplots, as well as** ● use bivariate data; apply a linear model, interpreting the slope and intercept° ● investigate patterns of clustering, outliers, and positive and negative associations° ● apply a line of best fit and assess fit* ● display frequencies and relative frequencies in a two-way table° *Other graphical models have moved to Grade 6*

Cambridge Public Schools
Grade 8 Algebra Curriculum Map
MATH IN FOCUS 2015 – 2016

Information from the *PARCC Model Content Framework for Mathematics*
Grade 8

The following are examples of *Key Advances* from Grade 7 to Grade 8

- Students build on previous work with proportional relationships, unit rates and graphing to connect these ideas and understand that the points (x, y) on a non-vertical line are the solutions of the equation $y = mx + b$, where m is the slope of the line as well as the unit rate of a proportional relationship (in the case $b = 0$). Students also formalize their previous work with linear relationships by working with functions — rules that assign to each input exactly one output.
- By working with equations such as $x^2 = 2$ and in geometric contexts such as the Pythagorean theorem, students enlarge their concept of number beyond the system of rationals to include irrational numbers. They represent these numbers with radical expressions and approximate these numbers with rationals.

Fluency Expectations or Examples of Culminating Standards

8.EE.7 Students have been working informally with one-variable linear equations since as early as kindergarten. This important line of development culminates in grade 8 with the solution of general one-variable linear equations, including cases with infinitely many solutions or no solutions as well as cases requiring algebraic manipulation using properties of operations. Coefficients and constants in these equations may be any rational numbers.

8.G.9 When students learn to solve problems involving volumes of cones, cylinders and spheres — together with their previous grade 7 work in angle measure, area, surface area and volume (7.G.4–6) — they will have acquired a well-developed set of geometric measurement skills. These skills, along with proportional reasoning (7.RP) and multistep numerical problem solving (7.EE.3), can be combined and used in flexible ways as part of modeling during high school — not to mention after high school for college and careers.

Examples of Major Within-Grade Dependencies

- An important development takes place in grade 8 when students make connections between proportional relationships, lines and linear equations (8.EE, **second cluster**). Making these connections depends on prior grades' work, including 7.RP.2 and 6.EE.9. There is also a major dependency within grade 8 itself: The angle-angle criterion for triangle similarity underlies the fact that a non-vertical line in the coordinate plane has equation $y = mx + b$.[1] Therefore, students must do work with congruence and similarity (8.G.1–5) before they are able to justify the connections among proportional relationships, lines and linear equations. Hence the indicated geometry work should likely begin at or near the very start of the year.[2]
- Much of the work of grade 8 involves lines, linear equations and linear functions (8.EE.5–8; 8.F.3–4; 8.SP.2–3). Irrational numbers, radicals, the Pythagorean theorem and volume (8.NS.1–2; 8.EE.2; 8.G.6–9) are nonlinear in nature. Curriculum developers might choose to address linear and nonlinear bodies of content somewhat separately. An exception, however, might be that when addressing functions, pervasively treating linear functions as separate from nonlinear functions might obscure the concept of function *per se*. There should also be sufficient treatment of nonlinear functions to avoid giving students the misleading impression that all functional relationships are linear (see also 7.RP.2a).

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[1] See page 12 of the *Progression for Expressions and Equations:*
http://commoncoretools.files.wordpress.com/2011/04/ccss_progression_ee_2011_04_25.pdf

[2] Note that the Geometry cluster "Understand congruence and similarity using physical models, transparencies or geometry software" supports high school work with congruent triangles and congruent figures.

Cambridge Public Schools
Grade 8 Algebra Curriculum Map
MATH IN FOCUS 2015 – 2016

Standards for Mathematical Practice

The 2011 framework introduces Standards for Mathematical Practice. These standards complement the content standards so that students increasingly engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle, and high school years. These standards are the same at all grades from Prekindergarten to 12th grade. These eight practices can be clustered into the following categories as shown in the chart below:

<table>
<tr><td rowspan="3">Habits of Mind of a Productive Mathematical Thinker:
MP.1: Make sense of problems and persevere in solving them.
MP.6: Attend to precision.</td><td>Reasoning and Explaining
MP.2: Reason abstractly and quantitatively.
MP.3: Construct viable arguments and critique the reasoning of others</td></tr>
<tr><td>Modeling and Using Tools
MP.4: Model with mathematics.
MP.5: Use appropriate tools strategically.</td></tr>
<tr><td>Seeing Structure and Generalizing
MP.7: Look for and make use of structure.
MP.8: Look for and express regularity in repeated reasoning.</td></tr>
</table>

The Standards for Mathematical Practice in Grade 8

The Pre-K – 12 Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. The following lists examples of what the practice standards look like in Grade 8.

Standards	***Explanations and Examples***
Students are expected to: **1. Make sense of problems and persevere in solving them**.	In grade 8, students solve real world problems through the application of algebraic and geometric concepts. Students seek the meaning of a problem and look for efficient ways to represent and solve it. They may check their thinking by asking themselves, "What is the most efficient way to solve the problem?", "Does this make sense?", and "Can I solve the problem in a different way?"
Students are expected to: **2. Reason abstractly and quantitatively.**	In grade 8, students represent a wide variety of real world contexts through the use of real numbers and variables in mathematical expressions, equations, and inequalities. They examine patterns in data and assess the degree of linearity of functions. Students contextualize to understand the meaning of the number or variable as related to the problem and decontextualize to manipulate symbolic representations by applying properties of

	operations.
Students are expected to: **3. Construct viable arguments and critique the reasoning of others.**	In grade 8, students construct arguments using verbal or written explanations accompanied by expressions, equations, inequalities, models, and graphs, tables, and other data displays (i.e. box plots, dot plots, histograms, etc.). They further refine their mathematical communication skills through mathematical discussions in which they critically evaluate their own thinking and the thinking of other students. They pose questions like "How did you get that?", "Why is that true?" "Does that always work?" They explain their thinking to others and respond to others' thinking.
Students are expected to: **4. Model with mathematics.**	In grade 8, students model problem situations symbolically, graphically, tabularly, and contextually. Students form expressions, equations, or inequalities from real world contexts and connect symbolic and graphical representations. Students solve systems of linear equations and compare properties of functions provided in different forms. Students use scatterplots to represent data and describe associations between variables. Students need many opportunities to connect and explain the connections between the different representations. They should be able to use all of these representations as appropriate to a problem context.
Students are expected to: **5. Use appropriate tools strategically.**	Students consider available tools (including estimation and technology) when solving a mathematical problem and decide when certain tools might be helpful. For instance, students in grade 8 may translate a set of data given in tabular form to a graphical representation to compare it to another data set. Students might draw pictures, use applets, or write equations to show the relationships between the angles created by a transversal.
Students are expected to: **6. Attend to precision.**	In grade 8, students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students use appropriate terminology when referring to the number system, functions, geometric figures, and data displays.
Students are expected to: **7. Look for and make use of structure.**	Students routinely seek patterns or structures to model and solve problems. In grade 8, students apply properties to generate equivalent expressions and solve equations. Students examine patterns in tables and graphs to generate equations and describe relationships. Additionally, students experimentally verify the effects of transformations and describe them in terms of congruence and similarity.
Students are expected to: **8. Look for and express regularity in**	In grade 8, students use repeated reasoning to understand algorithms and make generalizations about patterns. Students use

repeated reasoning.	iterative processes to determine more precise rational approximations for irrational numbers. During multiple opportunities to solve and model problems, they notice that the slope of a line and rate of change are the same value. Students flexibly make connections between covariance, rates, and representations showing the relationships between quantities.

Cambridge Public Schools
Grade 8 Algebra Curriculum Map
MATH IN FOCUS 2015 – 2016

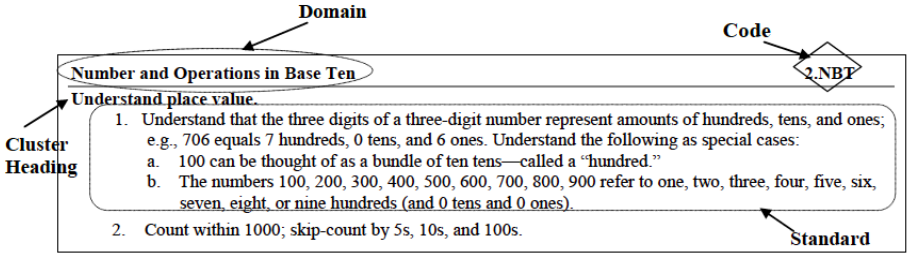
Organization of the Pre-Kindergarten to Grade 8 Content Standards in the 2011 framework
The Pre-Kindergarten through Grade 8 content standards are organized by **grade level**. Within each grade level, standards are grouped first by **domain**, and then are further subdivided into **clusters** of related standards.

- **Standards** define what students should understand and be able to do.
- **Clusters** are groups of related standards. Note that standards from different clusters may sometimes be closely related, because mathematics is a connected subject.
- **Domains** are larger groups of related standards. Standards from different domains may sometimes be closely related.

The table below shows which domains are addressed at each grade level from Prekindergarten through Grade 5. When the domain ends, it is expected that students will show mastery of that content by the end of that grade (i.e., Students should mastery in Counting and Cardinality by the end of Kindergarten).

Grade	Pre-K	K	1	2	3	4	5	6	7	8
Domains	Counting and Cardinality									
	Operations and Algebraic Thinking									
		Number and Operations in Base Ten								
					Number and Operations – Fractions					
							The Number System			
								Ratios and Proportional Relationships		
								Expressions and Equations		
										Functions
	Measurement and Data									
	Geometry									
								Statistics and Probability		

Standards Identifiers/Coding
Each standard has a unique identifier that consists of the grade level, (PK, K, 1, 2, 3, 4, 5, 6, 7, or 8), the domain code, and the standard number, as shown in the example below. The standard below is identified as **2.NBT.1**, identifying it as a Grade 2 standard in the Numbers in Base Ten domain, and as the first standard in that domain.



Unique Massachusetts Standards
Standards unique to Massachusetts are included in the appropriate domain and cluster and are initially coded by "MA." For example, the Massachusetts standard **MA.2.OA.2a** is identified with "MA" indicating a

Massachusetts addition, "2" indicating a grade 2 standard, "OA" indicating the Operations and Algebraic Thinking domain, and "2a" indicating that it is a further specification to the second standard in that domain.

UNIT 1: *September 8 – October 23*
Chapter 4: Lines and Linear Equations *and* lessons from Chapter 10: Statistics

Unit Notes:
- In this chapter, students will need to make connections to the work they did in grade 6 and grade 7 with ratio, unit rate, and direct and indirect proportion.
- Students should understand slope and describe the slope of a line. They should also use slope to describe the relationship between the two quantities that the line represents.
- Be sure students can make connections between linear equations and graphical representations. Focus on more than just calculating the slope.
- Include creating scatter plots, finding and writing the equation of the line of best fit. ***(Use Chapter 10.1-10.2)***
- In these two lessons, students will construct and interpret scatter plots to investigate patterns of association between two quantities. This includes interpreting whether the association is strong or weak, and positive or negative.
- By the end of this unit, students should be able to interpret slope and *y*-intercept.
- Plan to use technology, but also have students construct their own graphs on graph paper.
- As the students work with linear equations $y=mx$ and $y=mx+b$, they should recognize that slope m is the constant rate of change in the relationship between two variables.
- Lesson 4.5 is a critical lesson and should be done thoroughly.

Standards:

8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*

8.EE.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.

Scope of standard:
- Triangles are similar when there is a constant rate of proportionality between them. Using a graph, students construct triangles between two points on a line and compare the sides to understand that the slope (ratio of rise to run) is the same between any two points on a line.
- Given an equation in slope-intercept form, students graph the line represented. Students write equations in the form $y = mx$ for lines going through the origin, recognizing that m represents the slope of the line.
- Students write equations in the form $y = mx + b$ for lines not passing through the origin, recognizing that m represents the slope and b represents the y-intercept.

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

Scope of standard:
- Bivariate data refers to two-variable data, one to be graphed on the x-axis and the other on the y-axis.

Students represent numerical data on a scatter plot, to examine relationships between variables. They analyze scatter plots to determine if the relationship is linear (positive, negative association or no association) or nonlinear.

- Students recognize that points may be away from the other points (outliers) and have an effect on the linear model.
- NOTE: Use of the formula to identify outliers is not expected at this level.
- Students recognize that not all data will have a linear association. Some associations will be non-linear.

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

Scope of standard:

- Students understand that a straight line can represent a scatter plot with linear association. The most appropriate linear model is the line that comes closest to most data points. The use of linear regression is not expected. If there is a linear relationship, students draw a linear model. Given a linear model, students write an equation.

8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. *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.P.5*)

Scope of standard:

- Linear models can be represented with a linear equation. Students interpret the slope and *y*-intercept of the line in the context of the problem.

UNIT 2: *October 26 – November 25*
Chapter 1: Exponents

Sequencing:
- Before beginning Chapter 1 in the textbook, start instruction with the ***Online Common Core Additional Resources:***
  - Lesson 1.2: Writing Rational Numbers as Decimals (8.NS.1, 8.NS.2)
  - Lesson 1.3: Introducing Irrational Numbers (8.NS.1, 8.NS.2, 8.EE.2)
  - Lesson 1.4: Introducing the Real Number System (8.NS.1, 8.NS.2, 8.EE.2)
- Then begin instruction of Chapter 1.

Unit Notes:
- Students need to be able to apply the properties of exponents to create equivalent expressions. This chapter extends student understanding that expressions can be manipulated to solve problems.
- Expanded form is used to show students why the rules for operations with exponents work. Be sure to repeat these several times so students can figure out, for instance, the quotient rule or the power of a power rule.
- Students will use square roots and cube roots to solve equations and to represent solutions to equations.
- This is a fairly abstract chapter, and students will have to understand that sometimes practice in these abstract concepts is required so they can use them later on.
- Students will work with all types of rational numbers throughout this chapter; this is a good time to review some operations with rational numbers.
- Skip prime factorization (part of 1.1).
- Use 1.4 as extension work.

Standards:
8.NS.1 Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion which repeats eventually into a rational number.

Scope of standard:
- Students understand that Real numbers are either rational or irrational. They distinguish between rational and irrational numbers, recognizing that any number that can be expressed as a fraction is a rational number.
- Students recognize that the decimal equivalent of a fraction will either terminate or repeat. Fractions that terminate will have denominators containing only prime factors of 2 and/or 5. This understanding builds on work in 7th grade when students used long division to distinguish between repeating and terminating decimals.
- Students convert repeating decimals into their fraction equivalent using patterns or algebraic reasoning.
- Additionally, students can investigate repeating patterns that occur when fractions have denominators of 9, 99, or 11.

8.NS.2 Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2). *For example, by truncating the decimal expansion of* $\sqrt{2}$*, show that* $\sqrt{2}$ *is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations.*

Scope of standard:
- Students locate rational and irrational numbers on the number line. Students compare and order rational and irrational numbers. Students also recognize that square roots may be negative and written as $-\sqrt{28}$.

- Additionally, students understand that the value of a square root can be approximated between integers and that non-perfect square roots are irrational.

8.EE.1 Know and apply the properties of integer exponents to generate equivalent numercal expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.

Scope of standard:

- In 6th grade, students wrote and evaluated simple numerical expressions with whole number exponents (ie. $5^3 = 5 \cdot 5 \cdot 5 = 125$). Integer (positive and negative) exponents are further developed to generate equivalent numerical expressions when multiplying, dividing or raising a power to a power. Using numerical bases and the laws of exponents, students generate equivalent expressions.
- Students understand:
  - Bases must be the same before exponents can be added, subtracted or multiplied.
  - Exponents are subtracted when like bases are being divided.
  - A number raised to the zero (0) power is equal to one.
  - Negative exponents occur when there are more factors in the denominator. These exponents can be expressed as a positive if left in the denominator.
  - Exponents are added when like bases are being multiplied.
  - Exponents are multiplied when an exponents is raised to an exponent.
  - Several properties may be used to simplify an expression.

8.EE.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.

Scope of standard:

- Students recognize perfect squares and cubes, understanding that non-perfect squares and non-perfect cubes are irrational.
- Students recognize that squaring a number and taking the square root of a number are inverse operations; likewise, cubing a number and taking the cube root are inverse operations.
- This understanding is used to solve equations containing square or cube numbers. Rational numbers would have perfect squares or perfect cubes for the numerator and denominator. In the standard, the value of p for square root and cube root equations must be positive.
- Students understand that in geometry, the square root of the area is the length of the side of a square and a cube root of the volume is the length of the side of a cube. Students use this information to solve problems, such as finding the perimeter.

UNIT 3: *November 30 – January 15*
Chapter 3: Algebraic Linear Equations

Unit Notes:

- The goal of this chapter is for students to master solving equations with rational coefficients, distributive property, and combining like terms. Students will solve, write and model equations. Spend more time on fewer problems and give students opportunities to make connections and discuss/explain.
- Students need to have the ability to manipulate equations accurately and efficiently using the procedures they have learned to simplify and solve equations.
- *Math in Focus* assumes some prior understanding of combining like terms (8.EE.7b "collecting like terms"). Teachers may need to informally assess where students are with this understanding and familiarity with distributive property and solving 1-step equations.
- In Chapter 3, students solve single variable equations with rational coefficients, identify consistent and inconsistent equations, and even solve two variable linear equations in terms of each other. If students are fluent with these equations, the next two chapters – linear functions and systems of linear equations – will be much easier to do.
- Lesson 3.2 will be revisited in Chapter 5.
- Lesson 3.3 revisits concepts of linear equations from Chapter 4.

Standards:

8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*

Scope of standard:

- Students build on their work with unit rates from 6th grade and proportional relationships in 7th grade to compare graphs, tables and equations of proportional relationships. Students identify the unit rate (or slope) in graphs, tables and equations to compare two proportional relationships represented in different ways.
- Given an equation of a proportional relationship, students draw a graph of the relationship. Students recognize that the unit rate is the coefficient of x and that this value is also the slope of the line.

8.EE.7 Solve linear equations in one variable.

8.EE.7a Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).

8.EE.7b Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms. (*8.M.5*)

Scope of standard:

- Students solve one-variable equations including those with the variables being on both sides of the equal sign. Students recognize that the solution to the equation is the value(s) of the variable, which make a true equality when substituted back into the equation. Equations shall include rational numbers, distributive property and combining like terms.
- This solution means that no matter what value is substituted for x the final result will never be equal to each other. If each side of the equation were treated as a linear equation and graphed, the lines would be parallel.
- Students write equations from verbal descriptions and solve.

UNIT 4: *January 19 – February 12*
Chapter 5: Systems of Linear Equations

Unit Notes:

- In this chapter, students will analyze and solve pairs of simultaneous equations. Students should make the connection that solutions to systems of equations correspond to points of intersection of their graphs and represent a common solution to both equations.
- Students should solve systems algebraically, but also use tables, graphs, and bar models to make sense of the solutions.
- The standard requires that students solve systems of equations graphically and algebraically. Both the elimination method and substitution method are included in 5.2, but elimination is not required. Note that practice problems may need to be adjusted so that at least one equation is written in slope-intercept form.
- Although they may not solve every problem, it is very important for students to experience some level of problem solving with systems of equations.

Standards:

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

- **8.EE.8a** Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.
- **8.EE.8b** 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.*
- **8.EE.8c** 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.* (*8.P.7*)

Scope of standard:

- Systems of linear equations can also have one solution, infinitely many solutions or no solutions. Students will discover these cases as they graph systems of linear equations and solve them algebraically.
- Students graph a system of two linear equations, recognizing that the ordered pair for the point of intersection is the x-value that will generate the given y-value for both equations.
- Students recognize that graphed lines with one point of intersection (different slopes) will have one solution, parallel lines (same slope, different y-intercepts) have no solutions, and lines that are the same (same slope, same y-intercept) will have infinitely many solutions.
- By making connections between algebraic and graphical solutions and the context of the system of linear equations, students are able to make sense of their solutions. Students need opportunities to work with equations and context that include whole number and/or decimals/fractions. Students define variables and create a system of linear equations in two variables
- For many real world contexts, equations may be written in standard form. Students are not expected to change the standard form to slope-intercept form. However, students may generate ordered pairs recognizing that the values of the ordered pairs would be solutions for the equation.

UNIT 5: *February 22 – March 4*
Chapter 6: Functions

Unit Notes:

- During Chapter 6, students will begin to explore the concept of a function. Graphing functions and creating tables of ordered pairs will help students to understand that a function is a specific relation in which only one output is assigned for each input (a set of ordered pairs consisting of an input and only one corresponding output).
- This is an introduction to the concept of functions, and students should build a solid foundation in this chapter. That is why the material begins with many kinds of relations before defining functions and why functions are examined in algebraic, numeric and graphical form.
- Solidify the understanding of comparing functions represented in different ways, which was introduced in Chapter 4.
- While students will not be asked to manipulate non-linear functions, they do need to identify the difference between linear and non-linear functions.

Standards:

8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. *(Function notation is not required in Grade 8.)*

Scope of standard:

- Students understand rules that take x as input and gives y as output is a function. Functions occur when there is exactly one y-value is associated with any x-value. Using y to represent the output, we can represent this function with the equations $y = x^2 + 5x + 4$.
- Students are not expected to use the function notation $f(x)$ at this level.
- Students identify functions from equations, graphs, and tables/ordered pairs:
  - Graphs: Students recognize graphs as functions by using the vertical line test, showing that each x-value has only one y-value.
  - Table of Values: Students read tables or look at a set of ordered pairs to determine functions and identify equations where there is only one output (y-value) for each input (x-value).
  - Equations: Students recognize equations such as $y = x$ or $\underline{y} = x^2 + 3x + 4$ as functions; whereas, equations such as $x^2 + y^2 = 25$ are not functions.

8.F.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.*

Scope of standard:

- Students compare two functions from different representations (graphs, table of values, words, or equation).
- Functions could be expressed in standard form. However, the intent is not to change from standard form to slope-intercept form, but to use the standard form to generate ordered pairs. Substituting a zero (0) for x and y will generate two ordered pairs. From these ordered pairs, the slope could be determined.

Unit Considerations:

- The unit focuses on being able to compare two functions from different representations. Standard form is formally introduced to students in Chapter 7.

8.F.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.*

Scope of standard:

- Students understand that linear functions have a constant rate of change between any two points. Students use equations, graphs and tables to categorize functions as linear or non-linear.

8.F.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.

Scope of standard:

- Students identify the rate of change (slope) and initial value (y-intercept) from tables, graphs, equations or verbal descriptions to write a function (linear equation). Students understand that the equation represents the relationship between the x-value and the y-value; what math operations are performed with the x-value to give the y-value. Slopes could be undefined slopes or zero slopes.
- Tables: Students recognize that in a table the y-intercept is the y-value when x is equal to 0. The slope can be determined by finding the ratio $\frac{y}{x}$ between the change in two y-values and the change between the two corresponding x-values.
- Graphs: Using graphs, students identify the y-intercept as the point where the line crosses the y-axis and the slope as the $\frac{rise}{run}$.
- Equations: In a linear equation, the coefficient of x is the slope and the constant is the y-intercept. Students need to be given the equations in formats other than $y = mx + b$, such as $y = ax + b$ (format from graphing calculator), $y = b + mx$ (often the format from contextual situations), etc.
- Point and Slope: Students write equations to model lines that pass through a given point with the given slope. Note that point-slope form is not an expectation at this level.
- Students also write equations given two ordered pairs. Students use the slope and y-intercepts to write a linear function in the form $y = mx + b$.
- Contextual Situations: In contextual situations, the y-intercept is generally the starting value or the value in the situation when the independent variable is 0. The slope is the rate of change that occurs in the problem. Students interpret the rate of change and the y-intercept in the context of the problem.

Unit Considerations:

- In Grade 7, students use variables to represent quantities and to construct simple equations. This unit is the first time students will see the equation $y = mx + b$. It will be important students understand all the vocabulary associated with linear relationships and their representations.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

Scope of standard:

- Given a verbal description of a situation, students sketch a graph to model that situation. Given a graph of a situation, students provide a verbal description of the situation.

UNIT 6: *March 7 – March 18*
Chapter 2: Scientific Notation

Unit Notes:
- Students should understand why we use scientific notation and choose appropriate size measurements for very small or very large quantities.
- If possible, collaborate with science teachers for meaningful applications (astronomy, chemistry, physics).
- Use this chapter to assess student understanding of decimal place value and rules for operations with exponents.
- Lesson 2.2 can be used as an extension. Students are not required to add/subtract *in* scientific notation.

Standards:

8.EE.3 Use numbers expressed in the form of a single digit times an interger power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. *For example, estimate the population of the United States as* 3×10^8 *and the population of the world as* 7×10^9*, and determine that the world population is more than 20 times larger.* (*8.N.1, 8.N.4*)

Scope of standard:
- Students use scientific notation to express very large or very small numbers. Students compare and interpret scientific notation quantities in the context of the situation, recognizing that if the exponent increases by one, the value increases 10 times. Likewise, if the exponent decreases by one, the value decreases 10 times.
- Students solve problems using addition, subtraction or multiplication, expressing the answer in scientific notation. (Addition and subtraction can be done in standard form with the answer expressed in scientific notation. Multiplication and division should be done in scientific notation, which also serves as review of Chapter 1.)

8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millieters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Scope of standard:
- Students understand scientific notation as generated on various calculators or other technology. Students enter scientific notation using E or EE (scientific notation), * (multiplication), and ^ (exponent) symbols.

UNIT 7: *March 21 – April 15*
Chapter 7: The Pythagorean Theorem *and* Mini-Unit on Volume and Surface Area

Unit Notes:
- Spend time exploring the proof of the Pythagorean Theorem and its converse. There are many visual and geometric proofs of the Pythagorean theorem online.
- In Chapter 7, students will begin to understand and apply the Pythagorean Theorem. Use the hands on activities to help students build conceptual understanding.
- The distance formula is taught as an extension of the Pythagorean on the coordinate grid. Rather than memorizing the formula, students derive it from the vertical and horizontal distances. Solving distance lengths of 3-dimensional objects is a good application of the theorem.

Standards:
8.EE.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.

8.G.6 Explain a proof of the Pythagorean Theorem and its converse.
Scope of standard:
- Using models, students explain the Pythagorean Theorem, understanding that the sum of the squares of the legs is equal to the square of the hypotenuse in a right triangle. Students also understand that given three side lengths with this relationship forms a right triangle (the converse of the Pythagorean Theorem).

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

8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.
Scope of standard:
- One application of the Pythagorean Theorem is finding the distance between two points on the coordinate plane. Students build on work from 6th grade (finding vertical and horizontal distances on the coordinate plane) to determine the lengths of the legs of the right triangle drawn connecting the points. Students understand that the line segment between the two points is the length of the hypotenuse.
- NOTE: The use of the distance formula is not an expectation.

8.G.9 Know the formulas for the volume of cones, cylinders, and spheres and use them to solve real world and mathematical problems.
- Use ***Online Common Core Additional Resources:***
  - Lesson 8.1: Recognizing Cylinders, Cones, Spheres, and Pyramids (8.G.9)
  - Lesson 8.2: Finding Volume and Surface Area of Cylinders (8.G.9)
  - Lesson 8.3: Finding Volume and Surface Area of Pyramids and Cones (8.G.9)
  - Lesson 8.4: Finding Volume and Surface Area of Spheres (8.G.9)
  - Lesson 8.5: Real-World Problems: Composite Solids (8.G.9)

UNIT 8: *April 25 – May 13*
Chapter 8: Geometric Transformations *and* Mini Unit on Angles

Unit Notes:
- While teaching translations, reflections, and rotations (8.1 – 8.3) simultaneously review congruence. Use 9.1 and 9.3 as extension.
- While teaching dilations (8.4) simultaneously review similarity. Use 9.2 and 9.3 as extension.
- Transformations are taught with similarity and congruence because these concepts are as satisfying a series of transformations. (e.g similarity as a dilation).
- Students should experiment with the effects of rotations, reflections and translations. Provide scaffolding for students with tools like symmetry mirrors or graph paper.
- Students will use the coordinate grid to help describe the effect of dilations, translations, rotations and reflections. Use technology such as Geogebra, to enable students to visualize and see the effects of geometric transformations.

Before beginning Chapter 8 in the textbook, start instruction with the ***Online Common Core Additional Resources (Math in Focus).***
- Lesson 6.1: Complementary, Supplementary, and Adjacent Angles (8.G.5)
- Lesson 6.2: Angles that Share a Vertex (8.G.5)
- Lesson 6.3: Alternate Interior, Alternate Exterior, and Corresponding Angles (8.G.5)
- Lesson 6.4: Interior and Exterior Angles (8.G.5)

Standards:

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

Scope of standard:
- Students use compasses, protractors and rulers or technology to explore figures created from translations, reflections and rotations. Characteristics of figures, such as lengths of line segments, angle measures and parallel lines, are explored before the transformation (pre-image) and after the transformation (image). Students understand that these transformations produce images of exactly the same size and shape as the pre-image and are known as rigid transformations.

8.G.2 Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them.

Scope of standard:
- This standard is the students' introduction to congruency. Congruent figures have the same shape and size. Translations, reflections and rotations are examples of rigid transformations. A rigid transformation is one in which the pre-image and the image both have exactly the same size and shape since the measures of the corresponding angles and corresponding line segments remain equal (are congruent).
- Students examine two figures to determine congruency by identifying the rigid transformation(s) that produced the figures. Students recognize the symbol for congruency ($\cong$) and write statements of congruency.

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

Scope of standard:

- Students identify resulting coordinates from translations, reflections, and rotations (90º, 180º, and 270º, both clockwise and counterclockwise), recognizing the relationship between coordinates and the transformation.
- Translations: Translations move the object so that every point of the object moves in the same direction as well as the same distance. In a translation, the translated object is congruent to its pre-image.
- Reflections: A reflection is the "flipping" of an object over a line, known as the "line of reflection". In the 8th grade, the line of reflection will be the *x*-axis and the *y*-axis. Students recognize that when an object is reflected across the *y*-axis, the reflected *x*-coordinate is the opposite of the pre-image *x*-coordinate. Likewise, in a reflection across the *x*-axis, the reflected *y*-coordinate is the opposite of the pre-image *y*-coordinate.
- Rotations: A rotation is a transformation performed by "spinning" the figure around a fixed point known as the center of rotation. The figure may be rotated clockwise or counterclockwise up to 360º (at 8th grade, rotations will be around the origin and a multiple of 90º). In a rotation, the rotated object is congruent to its pre-image.
- Dilations: A dilation is a non-rigid transformation that moves each point along a ray which starts from a fixed center, and multiplies distances from this center by a common scale factor. Dilations enlarge (scale factors greater than one) or reduce (scale factors less than one) the size of a figure by the scale factor. In 8th grade, dilations will be from the origin. The dilated figure is similar to its pre-image. The scale factor would also be evident in the length of the line segments using the ratio: $\frac{\text{image length}}{\text{pre-image length}}$.
- Students recognize the relationship between the coordinates of the pre-image, the image and the scale factor for a dilation from the origin. Using the coordinates, students are able to identify the scale factor (image/pre-image). Students identify the transformation based on given coordinates.

8.G.4 Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

Scope of standard:

- Similar figures and similarity are first introduced in the 8th grade. Students understand similar figures have congruent angles and sides that are proportional. Similar figures are produced from dilations. Students describe the sequence that would produce similar figures, including the scale factors. Students understand that a scale factor greater than one will produce an enlargement in the figure, while a scale factor less than one will produce a reduction in size.
- Students need to be able to identify that triangles are similar or congruent based on given information.

8.G.5 Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. *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.*

Scope of standard:

- Students use exploration and deductive reasoning to determine relationships that exist between the following: a) angle sums and exterior angle sums of triangles, b) angles created when parallel lines are cut by a transversal, and c) the angle-angle criterion for similarity of triangle.
- Students construct various triangles and find the measures of the interior and exterior angles. Students make conjectures about the relationship between the measure of an exterior angle and the other two angles of a

triangle: the measure of an exterior angle of a triangle is equal to the sum of the measures of the other two interior angles, and the sum of the exterior angles (360º). Using these relationships, students use deductive reasoning to find the measure of missing angles.

- Students construct parallel lines and a transversal to examine the relationships between the created angles. Students recognize vertical angles, adjacent angles, and supplementary angles from 7th grade and build on these relationships to identify other pairs of congruent angles. Using these relationships, students use deductive reasoning to find the measure of missing angles.
- Students can informally conclude that the sum of the angles in a triangle is 180º (the angle-sum theorem) by applying their understanding of lines and alternate interior angles.
    - Students construct various triangles having line segments of different lengths but with two corresponding congruent angles. Comparing ratios of sides will produce a constant scale factor, meaning the triangles are similar. Students solve problems with similar triangles.

UNIT 9: *May 16 – May 27*
Chapter 10: Statistics

Unit Notes:
- Reminder: 10.1-10.2 were included in Unit 1.

Standards:
8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical 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?*

Scope of standard:
- Students understand that a two-way table provides a way to organize data between two categorical variables. Data for both categories needs to be collected from each subject. Students calculate the relative frequencies to describe associations.

Chapter 11: Probability covers 7th grade content and is not included in 8th grade pacing.

UNIT 10: *May 31 – June 21*
End-of-Year Unit: Extensions

Unit Notes:
- In this unit, students will revisit extension work from previous chapters:
    - 1.4: The Power of a Product and the Power of a Quotient
    - 2.2: Adding and Subtracting in Scientific Notation
    - Additional practice problems from Chapter 3
    - 7.4: Identifying Volumes of Composite Solids