Grade 8

Louisiana Student Standards: Companion Document for Teachers 2.0

This document is designed to assist educators in interpreting and implementing the Louisiana Student Standards for Mathematics. Found here are descriptions of each standard which answer questions about the standard's meaning and application to student understanding. Also included are the intended level of rigor and coherence links to prerequisite and corequisite standards. Examples are samples only and should not be considered an exhaustive list.

Additional information on the Louisiana Student Standards for Mathematics, including how to read the standards' codes, a listing of standards for each grade or course, and links to additional resources, is available on the Louisiana Department of Education's K-12 Math Planning Page. Please direct any questions to STEM@la.gov.

Updated August 15, 2022

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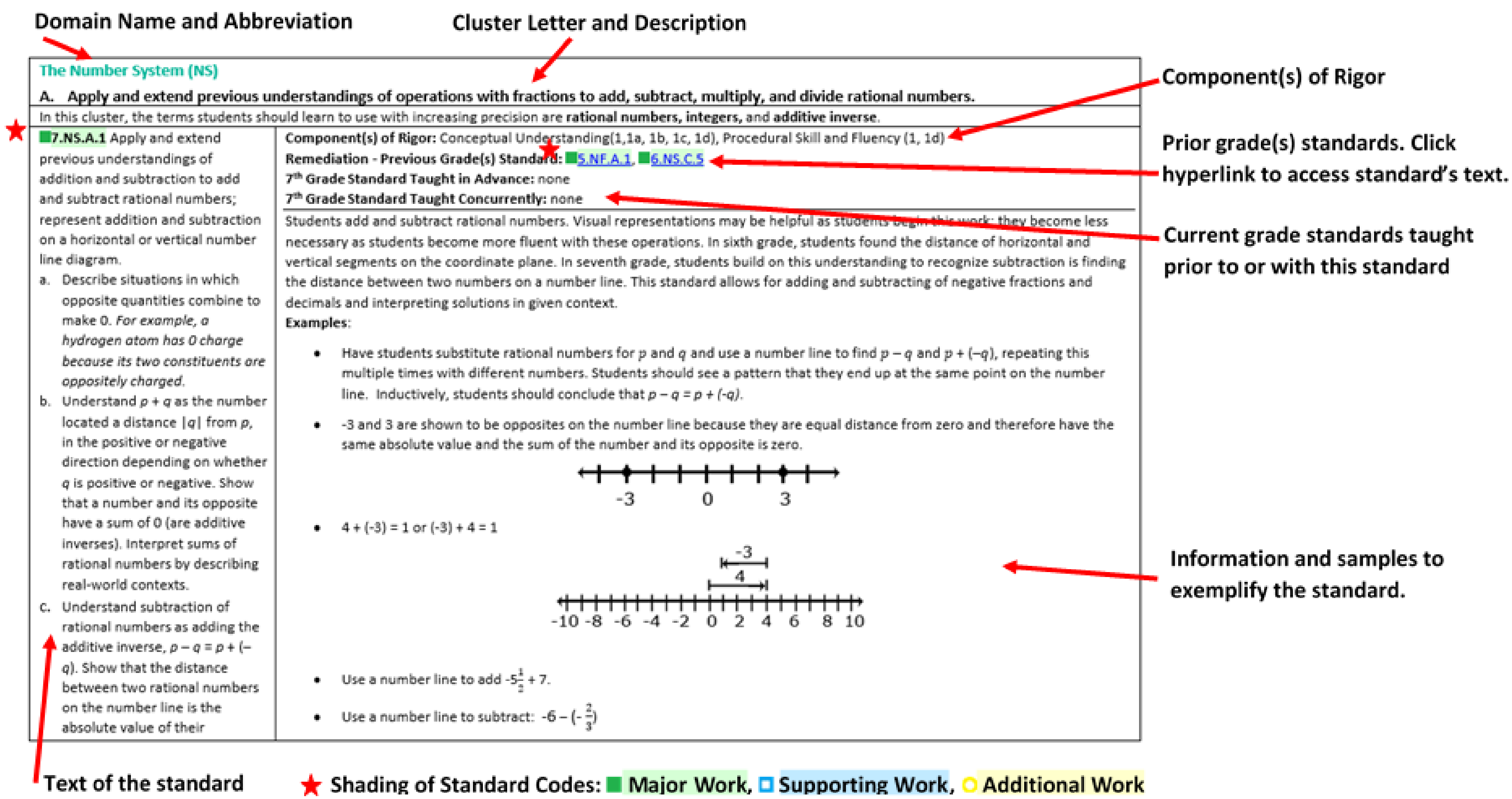
How-to-Read Guide

The diagram below provides an overview of the information found in all companion documents. Definitions and more complete descriptions are provided on the next page.



The Number System (NS)

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

In this cluster, the terms students should learn to use with increasing precision are **rational numbers, integers,** and **additive inverse**.

7.NS.A.1 Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. a. Describe situations in which opposite quantities combine to make 0. *For example, a hydrogen atom has 0 charge because its two constituents are oppositely charged.* 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	**Component(s) of Rigor:** Conceptual Understanding(1,1a, 1b, 1c, 1d), Procedural Skill and Fluency (1, 1d) **Remediation - Previous Grade(s) Standard:** 5.NF.A.1, 6.NS.C.5 **7th Grade Standard Taught in Advance:** none **7th Grade Standard Taught Concurrently:** none Students add and subtract rational numbers. Visual representations may be helpful as students begin this work; they become less necessary as students become more fluent with these operations. In sixth grade, students found the distance of horizontal and vertical segments on the coordinate plane. In seventh grade, students build on this understanding to recognize subtraction is finding the distance between two numbers on a number line. This standard allows for adding and subtracting of negative fractions and decimals and interpreting solutions in given context. **Examples:** • Have students substitute rational numbers for p and q and use a number line to find $p - q$ and $p + (-q)$, repeating this multiple times with different numbers. Students should see a pattern that they end up at the same point on the number line. Inductively, students should conclude that $p - q = p + (-q)$. • -3 and 3 are shown to be opposites on the number line because they are equal distance from zero and therefore have the same absolute value and the sum of the number and its opposite is zero. -3 0 3 • 4 + (-3) = 1 or (-3) + 4 = 1 -3 4 -10 -8 -6 -4 -2 0 2 4 6 8 10 • Use a number line to add $-5\frac{1}{2} + 7$. • Use a number line to subtract: $-6 - (-\frac{2}{3})$

1. **Domain Name and Abbreviation:** A grouping of standards consisting of related content that are further divided into clusters. Each domain has a unique abbreviation and is provided in parentheses beside the domain name.
2. **Cluster Letter and Description:** Each cluster within a domain begins with a letter. The description provides a general overview of the focus of the standards in the cluster.
3. **Previous Grade(s) Standards:** One or more standards that students should have mastered in previous grades to prepare them for the current grade standard. If students lack the pre-requisite knowledge and remediation is required, the previous grade standards provide a starting point.
4. **Standards Taught in Advance:** These current grade standards include skills or concepts on which the target standard is built. These standards are best taught before the target standard.
5. **Standards Taught Concurrently:** Standards which should be taught with the target standard to provide coherence and connectedness in instruction.
6. **Component(s) of Rigor:** See full explanation on components of rigor.
7. **Sample Problem:** The sample provides an example how a student might meet the requirements of the standard. Multiple examples are provided for some standards. However, sample problems should not be considered an exhaustive list. Explanations, when appropriate, are also included.
8. **Text of Standard:** The complete text of the targeted Louisiana Student Standards of Mathematics is provided.

Classification of Major, Supporting, and Additional Work

Students should spend the large majority of their time on the ■ major work of the grade. ◻ Supporting work and, where appropriate, ○ additional work can engage students in the major work of the grade. Each standard is color-coded to quickly and simply determine how class time should be allocated. Furthermore, standards from previous grades that provide foundational skills for current grade standards are also color-coded to show whether those standards are classified as ■ major, ◻ supporting, or ○ additional in their respective grades.

Components of Rigor

The K-12 mathematics standards lay the foundation that allows students to become mathematically proficient by focusing on conceptual understanding, procedural skill and fluency, and application.

Conceptual Understanding refers to understanding mathematical concepts, operations, and relations. It is more than knowing isolated facts and methods. Students should be able to make sense of why a mathematical idea is important and the kinds of contexts in which it is useful. It also allows students to connect prior knowledge to new ideas and concepts.

Procedural Skill and Fluency is the ability to apply procedures accurately, efficiently, and flexibly. It requires speed and accuracy in calculation while giving students opportunities to practice basic skills. Students' ability to solve more complex application tasks is dependent on procedural skill and fluency.

Application provides a valuable content for learning and the opportunity to solve problems in a relevant and a meaningful way. It is through real-world application that students learn to select an efficient method to find a solution, determine whether the solution makes sense by reasoning, and develop critical thinking skills.

Standards for Mathematical Practice

The Louisiana Standards for Mathematical Practice are expected to be integrated into every mathematics lesson for all students in grades K-12. Below are a few examples of how these practices may be integrated into tasks that students in grade 8 complete.

Louisiana Standards for Mathematical Practice (MP)	
Louisiana Standard	**Explanations and Examples**
8.MP.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?"
8.MP.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.
8.MP.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 (e.g., box plots, dot plots, histograms). 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?", and "Does that always work?" They explain their thinking to others and respond to others' thinking.
8.MP.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.

Louisiana Standard	Explanations and Examples
8.MP.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.
8.MP.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.
8.MP.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.
8.MP.8 Look for and express regularity in repeated reasoning.	In grade 8, students use repeated reasoning to understand algorithms and make generalizations about patterns. Students use 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.

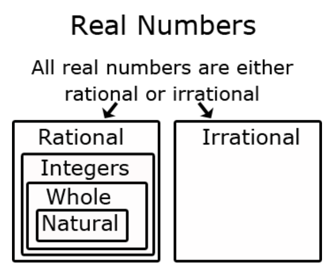
The Number System (NS)

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

In this cluster, the terms students should learn to use with increasing precision are **Real numbers, Irrational numbers, Rational numbers, Integers, Whole numbers, radical, radicand, square roots, perfect squares, terminating decimals, repeating decimals,** and **truncate**.

Louisiana Standard	Explanations and Examples
8.NS.A.1 Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually. Convert a decimal expansion which repeats eventually into a rational number by analyzing repeating patterns.	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** none **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** 8.NS.A.2, 8.EE.A.2

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. The diagram below illustrates the relationship between the subgroups of the real number system.



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 seventh grade when students used long division to distinguish between repeating and terminating decimals.

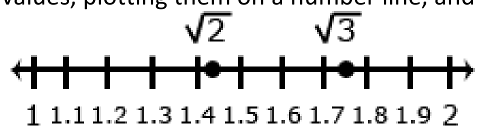
- Let $x = 0.444444.....$
- Multiply both sides so that the repeating digits will be in front of the decimal. In this example, one digit repeats so both sides are multiplied by 10, giving $10x = 4.4444444....$
- Subtract the original equation from the new equation.

$$\begin{array}{r} 10x = 4.4444444.... \\ \underline{-\,x = 0.444444.....} \\ 9x = 4 \end{array}$$

- Solve the equation to determine the equivalent fraction.

$$x = 4/9$$

8.NS.A.1 *continued*	**Example:** Change $0.\overline{4}$ to a fraction. • Let *x* = 0.444444….. • Multiply both sides so that the repeating digits will be in front of the decimal. In this example, one digit repeats so both sides are multiplied by 10, giving 10*x* = 4.4444444…. • Subtract the original equation from the new equation. 10*x* = 4.4444444…. – *x* = 0.444444….. 9*x* = 4 • Solve the equation to determine the equivalent fraction. $\frac{9x}{9} = \frac{4}{9}$ $x = \frac{4}{9}$ Additionally, students can investigate repeating patterns that occur when fractions have denominators of 9, 99, or 11 (e.g., $\frac{5}{9}$ = $0.\overline{5}$).

8.NS.A.2 Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions (e.g., π^2). *For example, by truncating the decimal expansion of √2, show that √2 is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximation to the hundredths place.*	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** none **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** 8.NS.A.1, 8.EE.A.2 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 the opposite of the positive square root (i.e., $-\sqrt{28}$). **Examples:** • Approximate the value of $\sqrt{5}$ to the nearest hundredth. Solution: Students start with a rough estimate based upon perfect squares. $\sqrt{5}$ falls between 2 and 3 because 5 falls between $2^2 = 4$ and $3^2 = 9$. The value will be closer to 2 than to 3. Students continue the iterative process with the tenths place value. $\sqrt{5}$ falls between 2.2 and 2.3 because 5 falls between $2.2^2 = 4.84$ and $2.3^2 = 5.29$. The value is closer to 2.2. Further iteration shows that the value of $\sqrt{5}$ is between 2.23 and 2.24 since 2.23^2 is 4.9729 and 2.24^2 is 5.0176. • Compare √2 and √3 by estimating their values, plotting them on a number line, and making comparative statements.  *Solution:* Statements for the comparison could include: o $\sqrt{2}$ is approximately 0.3 less than $\sqrt{3}$ o $\sqrt{2}$ is between the whole numbers 1 and 2 o $\sqrt{3}$ is between 1.7 and 1.8

Expressions and Equations (EE)

A. Work with radicals and integer exponents.

In this cluster, the terms students should learn to use with increasing precision are **laws of exponents, power, perfect squares, perfect cubes, root, square root, cube root, scientific notation,** and **standard form of a number**. Students should also be able to read and use the symbol: **±.**

Louisiana Standard	Explanations and Examples
8.EE.A.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$.	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** 6.EE.A.1 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** none In sixth grade, students wrote and evaluated simple numerical expressions with whole number exponents (i.e., $5^3 = 5 \bullet 5 \bullet 5 = 125$). 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. These properties need to be developed with understanding (e.g., $3^2 \bullet 3^4 = (3 \times 3) \bullet (3 \times 3 \times 3 \times 3) = 3^6$). 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 to the zero (0) power is equal to one. • Factors with negative exponents can be written in the denominator using positive exponents. • Exponents are added when like bases are being multiplied • Exponents are multiplied when an exponential expression is raised to an exponent • Several properties may be used to simplify an expression **Examples**: • $\frac{4^3}{5^2} = \frac{64}{25}$ • $\frac{4^3}{4^7} = 4^{3-7} = 4^{-4} = \frac{1}{4^4} = \frac{1}{256}$ • $\frac{4^{-3}}{5^2} = 4^{-3} \times \frac{1}{5^2} = \frac{1}{4^3} \times \frac{1}{5^2} = \frac{1}{64} \times \frac{1}{25} = \frac{1}{16{,}000}$

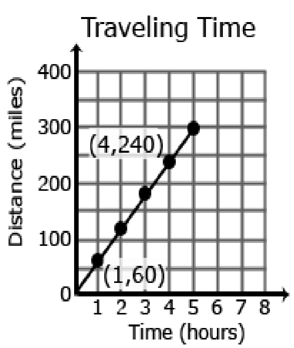
8.EE.A.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** 6.EE.B.5, 7.NS.A.3 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** 8.NS.A.1, 8.NS.A.2, 8.G.B.6 Students recognize perfect squares and cubes, understanding that non-perfect squares and non-perfect cubes are irrational. In the standard, the value of *p* for square root and cube root equations must be positive. 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. 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. **Examples**: • $3^2 = 9$ and $\sqrt{9} = \pm 3$ (There are two solutions because 3×3 and -3×-3 both equal 9.) • $\left(\frac{1}{3}\right)^3 = \frac{1^3}{3^3} = \frac{1}{27}$ and $\sqrt[3]{\frac{1}{27}} = \frac{\sqrt[3]{1}}{\sqrt[3]{27}} = \frac{1}{3}$ (There no negative cube root since $(-3)^3 = -27$.) • Solve $x^2 = 9$ *Solution:* $\sqrt{x^2} = \pm\sqrt{9}$ $x = \pm 3$ • Solve $x^3 = 8$ *Solution:* $\sqrt[3]{x^3} = \sqrt[3]{8}$ $x = 2$ • Solve $x^2 = 30.$ *Solution:* $\sqrt{x^2} = \pm\sqrt{30}$ $x = \pm\sqrt{30}$ $x \approx \pm 5{,}5$

8.EE.A.3 Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. *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.*	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** 4.OA.A.2, 5.NBT.A.2 **8th Grade Standard Taught in Advance:** 8.EE.A.1 **8th Grade Standard Taught Concurrently:** 8.EE.A.4 Students use scientific notation to express very large or very small quantities. 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. **Example:** • Hannah's collection of rocks has 6×10^5 rocks while Derek's collection of rocks has 2×10^3 rocks. Whose collection is larger? By how much? *Solution:* Hannah has the larger collection of rocks. Her collection is 3×10^2 or 300 times larger than Derek's collection.
8.EE.A.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** 7.EE.B.3 **8th Grade Standard Taught in Advance:** 8.EE.A.1 **8th Grade Standard Taught Concurrently:** 8.EE.A.3 Students understand scientific notation as generated on various calculators or other technology. They perform the four operations in which both decimals and scientific notation are used. **Examples:** • $14.305 + 9.571 \times 10^2$ *Solution:* 971.405 or 9.71405×10^2 • $\dfrac{3.45 \times 10^5}{6.7 \times 10^{-2}}$ *Solution:* 5.15×10^6 • 2.45E+23 is 2.45×10^{23} and 3.5E-4 is 3.5×10^{-4} (NOTE: There are other notations for scientific notation depending on the calculator being used.)

Expressions and Equations (EE)

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

In this cluster, the terms students should learn to use with increasing precision are **unit rate, proportional relationships, slope, vertical, horizontal, similar triangles,** and ***y*-intercept**.

Louisiana Standard	Explanations and Examples
8.EE.B.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. *For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.*	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency, Application **Remediation - Previous Grade(s) Standard:** 7.RP.A.2 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** 8.EE.B.6 Students build on their work with unit rates from sixth grade and proportional relationships in seventh 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 ($y = mx$), students draw a graph of the relationship. Students recognize that the unit rate is the coefficient of the independent variable and that this value, m, is also the slope of the line. Compare the scenarios to determine which represents a greater speed. Explain your choice including a written description of each scenario. Be sure to include the rates in your explanation. **Scenario 1:**  **Scenario 2:** $y = 55x$ x is time in hours y is distance in miles

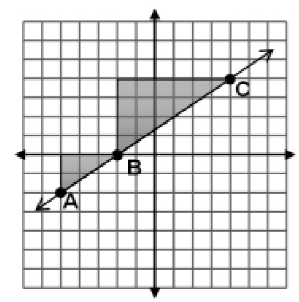
8.EE.B.6 Use similar triangles to explain why the slope *m* is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation *y* = *mx* for a line through the origin and the equation *y* = *mx* + *b* for a line intercepting the vertical axis at *b*.

Component(s) of Rigor: Conceptual Understanding
Remediation - Previous Grade(s) Standard: 7.RP.A.2, 7.G.A.2
8th Grade Standard Taught in Advance: 8.G.A.5
8th Grade Standard Taught Concurrently: 8.EE.B.5

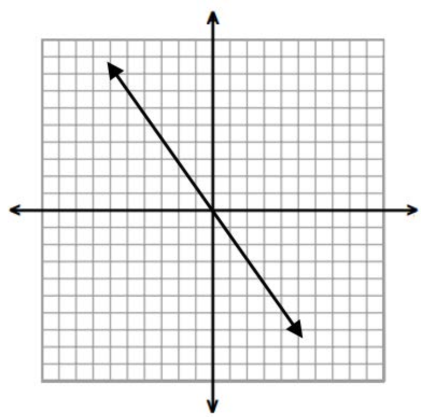
Triangles are similar when there is a constant rate of proportionality between them. Using a graph, students construct triangles between two points on a line and compare the sides to understand that the slope is the value of the ratio of change in y to change in x is the same between any two points on a line.

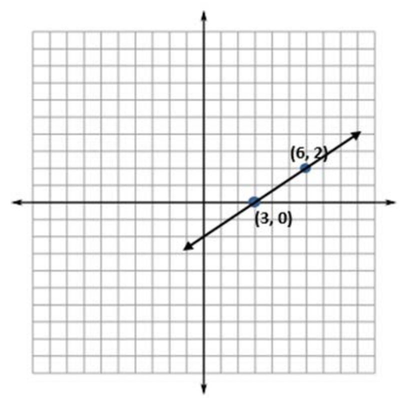
Example:

- The triangle between A and B has a vertical height of 2 and a horizontal length of 3. The triangle between B and C has a vertical height of 4 and a horizontal length of 6. The simplified ratio of the vertical height to the horizontal length of both triangles is 2 to 3, which has a value of $\frac{2}{3}$ and represents the slope of the line AC, indicating that the triangles are similar.



- Write equations to represent the two graphs below.





Solution: $y = -\frac{3}{2}x$

Solution: $y = \frac{2}{3}x - 2$

Expressions and Equations (EE) **C. Analyze and solve linear equations and pairs of simultaneous linear equations.**	
In this cluster, the terms students should learn to use with increasing precision are **intersecting, parallel lines, coefficient, distributive property, like terms, substitution,** and **system of linear equations**.	
Louisiana Standard	**Explanations and Examples**
8.EE.C.7 Solve linear equations in one variable. a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form *x* = *a*, *a* = *a*, or *a* = *b* results (where *a* and *b* are different numbers). b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.	**Component(s) of Rigor:** Conceptual Understanding (7a), Procedural Skill and Fluency (7, 7a, 7b) **Remediation - Previous Grade(s) Standard:** 7.EE.A.1 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** 8.SP.A.3 As students transform linear equations in one variable into simpler forms, they discover the equations can have one solution, infinitely many solutions, or no solution. When the equation has one solution, the variable has one value that makes the equation true as in $12 - 4y = 16$. The only value for *y* that makes this equation true is -1. When the equation has infinitely many solutions, the equation is true for all real numbers as in $7x + 14 = 7(x + 2)$. As this equation is simplified, the variable terms cancel leaving 14 = 14 or 0 = 0. Since the expressions are equivalent, the value for the two sides of the equation will be the same regardless which real number is used for the substitution. When an equation has no solutions it is also called an inconsistent equation. This is the case when the two expressions are not equivalent as in $5x - 2 = 5(x + 1)$. When simplifying this equation, students will find that the solution appears to be two numbers that are not equal or $-2 \neq 1$. In this case, regardless which real number is used for the substitution, the equation is not true and therefore has no solution. **Examples**: • Solve for *x:* ▪ $3x - 8 = 4x - 8$ *Solution: x* = 0 ▪ $3(x + 1) - 5 = 3x - 2$ *Solution:* infinitely many solutions • Solve for the missing value: ▪ $\frac{1}{4} - \frac{2}{3}y = \frac{3}{4} - \frac{1}{3}y$ *Solution: y* = $\frac{-3}{2}$

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8.EE.C.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.*

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Component(s) of Rigor: Conceptual Understanding (8, 8a, 8b), Procedural Skill and Fluency (8,8b, 8c), Application (8c)
Remediation - Previous Grade(s) Standard: 6.EE.B.5
8th Grade Standard Taught in Advance: 8.EE.B.6
8th Grade Standard Taught Concurrently: none

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.

Examples:

- Solve this system of equations.

$$\begin{cases} 3x + 4y = 8 \\ y = x - 5 \end{cases}$$

Solution: (4, -1)

- Plant A and Plant B are on different watering schedules. This affects their rate of growth. Compare the growth of the two plants to determine when their heights will be the same.

Let *W* = number of weeks

Let *H* = height of the plant after *W* weeks

Plant A

W	*H*	(*W*, *H*)
0	4	(0, 4)
1	6	(1, 6)
2	8	(2, 8)
3	10	(3, 10)

Plant B

W	*H*	(*W*, *H*)
0	2	(0, 2)
1	6	(1, 6)
2	10	(2, 10)
3	14	(3, 14)

Graph the lines that represent the growth of each plant on the same coordinate plane.

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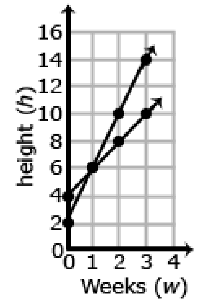
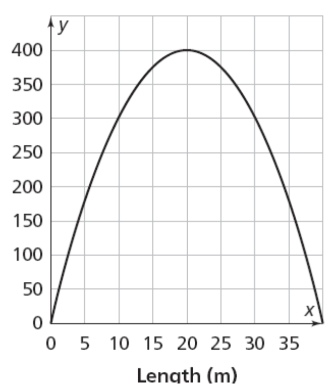
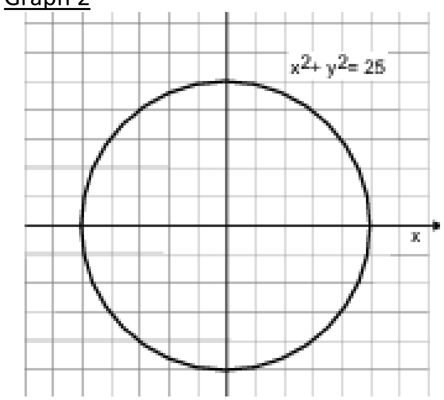
8.EE.C.8 *continued* c. Solve real-world and mathematical problems leading to two linear equations in two variables. *For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.*	*Solution:*  • Write equations that represent the growth rates of Plant A and Plant B. *Solution:* Plant A $H = 2W + 4$ Plant B $H = 4W + 2$ • At which week will the plants have the same height? Explain using the graphs you drew. *Solution:* After one week, the height of Plant A and Plant B are both 6 inches. I know because the point where the lines intersect is at (1, 6) which means that after 1 week both plants had a height of 6 inches.

Functions (F)

A. Define, evaluate, and compare functions.

In this cluster, the terms students should learn to use with increasing precision are **functions, y-value, x-value, vertical line test, input, output, rate of change, linear function,** and **non-linear function**.

Louisiana Standard	Explanations and Examples
8.F.A.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. (Function notation is not required in this grade level.)	**Component(s) of Rigor:** Conceptual Understanding **Remediation - Previous Grade(s) Standard:** 7.RP.A.2 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** none Students understand that a function is a rule that takes an input and produces only one output; therefore, functions occur when there is exactly one *y*-value associated with any *x*-value. Students identify functions from equations, graphs, and tables/ordered pairs and are **not** expected to use the function notation *f(x)* at this level. **Graphs** Students recognize graphs such as graph 1 below is a function because each x-value has only one *y*-value; whereas, graphs such as graph 2 are not functions because there is at least one instance where an input has more than one output (e.g., for $x = 0$, $y = 5$ and $y = -5$.) Graph 1  Graph 2 

8.F.A.1 *continued*

Tables or Ordered Pairs

Students read tables or look at a set of ordered pairs to determine which are functions, recognizing that functions have only one output (y-value) for each input (x-value).

Functions

x	0	1	2
y	3	9	27

$\{(0, 2), (1, 3), (2, 5), (3, 6)\}$

Not Functions

x	16	16	25	25
y	4	-4	5	-5

$\{(0, 0), (0, 1), (1, 2)\}$

8.F.A.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.*

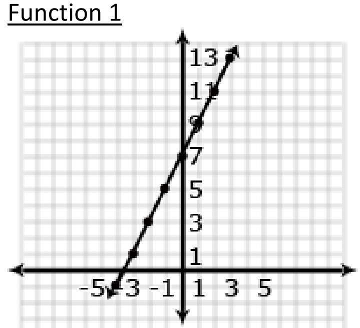
Component(s) of Rigor: Conceptual Understanding, Application
Remediation - Previous Grade(s) Standard: 7.RP.A.2
8th Grade Standard Taught in Advance: 8.EE.B.5, 8.EE.B.6, 8.F.A.1
8th Grade Standard Taught Concurrently: none

Students compare two functions from different representations.

Examples:

- Compare the two linear functions listed below and determine which function has a greater rate of change.

Function 1



Function 2

The function whose input x and output y are related by $y = 3x + 7$.

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<td>8.F.A.2 continued</td>
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- Compare the two linear functions listed below and determine which has a negative slope.

Function 1: Gift Card

Samantha starts with $20 on a gift card for the book store. She spends $3.50 per week to buy a magazine. Let y be the amount remaining as a function of the number of weeks, x.

x	y
0	20
1	16.50
2	13.00
3	9.50
4	6.00

Function 2: Calculator Rental

The school bookstore rents graphing calculators for $5 per month. It also collects a non-refundable fee of $10.00 for the school year. Write the rule for the total cost (c) of renting a calculator as a function of the number of months (m).

Solution:

Function 1 is an example of a function whose graph has negative slope. Samantha starts with $20 and spends money each week. The amount of money left on the gift card decreases each week. The graph has a negative slope of -3.5, which is the amount the gift card balance decreases with Samantha's weekly magazine purchase. Function 2 is an example of a function whose graph has a positive slope. Students pay a yearly nonrefundable fee for renting the calculator and pay $5 for each month they rent the calculator. This function has a positive slope of 5 which is the amount of the monthly rental fee. An equation for Example 2 could be $c = 5m + 10$.

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8.F.A.3 Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; categorize functions as linear or nonlinear when given equations, graphs, or tables. *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.*

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Component(s) of Rigor: Conceptual Understanding , Procedural Skill and Fluency
Remediation - Previous Grade(s) Standard: none
8th Grade Standard Taught in Advance: 8.EE.B.6, 8.F.A.1, 8.F.A.2
8th Grade Standard Taught Concurrently: none

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 nonlinear.

Example:

- Determine which of the functions listed below are linear and which are not linear and explain your reasoning.
  - $y = -2x^2 + 3$ nonlinear, because the variable x is squared
  - $y = 2x$ linear, because it has a constant rate of change
  - $A = \pi r^2$ nonlinear, because the radius is squared
  - $y = 0.25 + 0.5(x - 2)$ linear, because it has a constant rate of change

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<table>
<tr><td colspan="2">Functions (F)
B. Use functions to model relationships between quantities.</td></tr>
<tr><td colspan="2">In this cluster, the terms students should learn to use with increasing precision are linear relationship, rate of change, slope, initial value, y-intercept.</td></tr>
<tr><td>Louisiana Standard</td><td>Explanations and Examples</td></tr>
<tr><td>8.F.B.4 Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values.</td><td>Component(s) of Rigor: Conceptual Understanding, Procedural Skill and Fluency
Remediation - Previous Grade(s) Standard: 7.RP.A.2
8th Grade Standard Taught in Advance: 8.F.A.3
8th Grade Standard Taught Concurrently: 8.F.B.5, 8.SP.A.2, 8.SP.A.3

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. 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 value of the ratio of the change in two y-values and the change in the two corresponding x-values, $\frac{y_1-y_2}{x_1-x_2}$. Using graphs, students identify the y-intercept as the point where the line crosses the y-axis and the slope as the $\frac{\text{change in } y}{\text{change in } x}$. When an equation is written as $y = mx + b$, 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 $y = b + mx$ (often the format from contextual situations). While slope-intercept form is the predominant form for a linear equation in grade 8, 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. Point-slope form is not an expectation at this level.

Examples:
The table below shows the cost of renting a car. The company charges $45 a day for the car as well as charging a one-time $25 fee for the car's navigation system (GPS). Write an equation for the cost in dollars, c, as a function of the number of days, d.

Students might write the equation, c = 45d + 25, using the verbal description or by first making a table.</td></tr>
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<td>8.F.B.4 continued</td>
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Days (d)	Cost (c) in dollars
1	70
2	115
3	160
4	205

Students should recognize that the rate of change is $45 per day which means the line will have a slope of 45 (the cost of renting the car) and that initial cost (the first day charge) also includes paying for the navigation system. Classroom discussion about one time fees vs. recurrent fees will help students model contextual situations.
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<tr>
<td>8.F.B.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.</td>
<td>

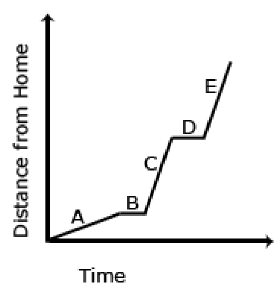
Component(s) of Rigor: Conceptual Understanding
Remediation - Previous Grade(s) Standard: none
8th Grade Standard Taught in Advance: 8.F.A.1, 8.F.A.2, 8.F.A.3
8th Grade Standard Taught Concurrently: 8.F.B.4

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.

Example:

- The graph below shows a student's trip to school. This student walks to his friend's house and, together, they ride a bus to school. The bus stops once before arriving at school.

  Describe how each part A-E of the graph relates to the story.



- Tides: https://www.illustrativemathematics.org/content-standards/8/F/B/5/tasks/628
- Distance: https://www.illustrativemathematics.org/content-standards/8/F/B/5/tasks/632
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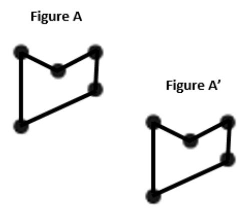
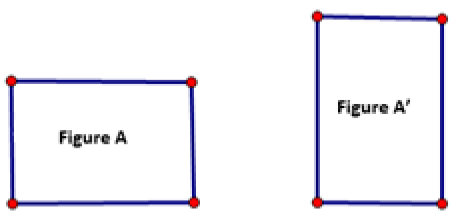
Geometry (G)

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

In this cluster, the terms students should learn to use with increasing precision are **translations, rotations, reflections, line of reflection, center of rotation, clockwise, counterclockwise, parallel lines, congruence, ≅, reading A' as "A prime", similarity, dilations, pre-image, image, rigid transformations, exterior angles, interior angles, alternate interior angles, angle-angle criterion, deductive reasoning, vertical angles, adjacent, supplementary, complementary, corresponding, scale factor, transversal,** and **parallel**.

Louisiana Standard	Explanations and Examples
8.G.A.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.	**Component(s) of Rigor:** Conceptual Understanding (1, 1a, 1b, 1c) **Remediation - Previous Grade(s) Standard:** 7.G.A.2, 7.G.B.5 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** none Students use compasses, protractors and rulers, tracing paper and/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. Reflections can be made completing the following steps, using graph paper or tracing paper. 1) Draw a set of axes and two parallel segments. 2) Fold the paper on the *y*-axis, flip the folded paper over, and trace the two segments. The y-axis is now the line of reflection. 3) Open the tracing paper and retrace the segments on the same side of the paper as segments AC and BD. images fold Students should see that a reflection of parallel segments results in parallel segments. If needed, students should use a ruler to verify that the lengths are the same. (Some deviation may occur due to tracing.) Have the students mark the corresponding endpoints of the reflected segments as A', C', B', and D'. Students should learn to interpret these labels as "A prime," etc. Since segments are parts of a line, most students will not need to repeat the process for parallel lines. The same process can be used to show that reflection of an angle results in an image with the same measure. This can be verified by using a protractor to measure the angle and its image. The following can be used to verify informally the results of rotations and reflections. • Rotate the paper with the images around the origin. A straightened paper clip or the end of a student's pencil can placed

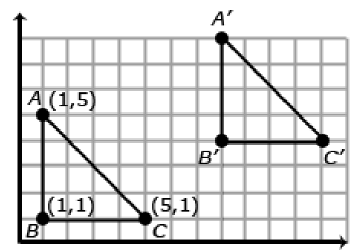
8.G.A.1 *continued*	on the origin as the paper is rotated. • Slide the paper with the images by a specified distance and direction (e.g., 4 inches vertically, 5 inches to the right).
8.G.A.2 Explain that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them. (Rotations are only about the origin and reflections are only over the *y*-axis and *x*-axis in grade 8.)	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** none **8th Grade Standard Taught in Advance:** 8.G.A.1 **8th Grade Standard Taught Concurrently:** none This standard is the students' introduction to congruence. 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). **Examples**: Students examine two figures to determine congruence by identifying the rigid transformation(s) that produced the figures. Students recognize the symbol for congruence (≅) and write statements of congruence. • Is Figure A congruent to Figure A'? Explain how you know.  • Describe the sequence of transformations that results in the transformation of Figure A to Figure A'. 

8.G.A.3 Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (Rotations are only about the origin, dilations only use the origin as the center of dilation, and reflections are only over the *y*-axis and *x*-axis in grade 8.)

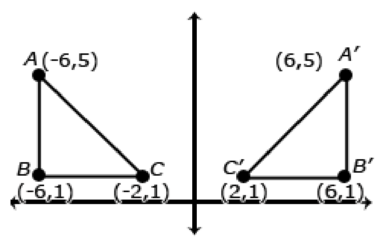
Component(s) of Rigor: Conceptual Understanding
Remediation - Previous Grade(s) Standard: 6.G.A.3
8th Grade Standard Taught in Advance: 8.G.A.1
8th Grade Standard Taught Concurrently: none

Students identify resulting coordinates from translations, reflections, and rotations (90°, 180° and 270° both clockwise and counterclockwise), recognizing the relationship between the coordinates and the transformation.

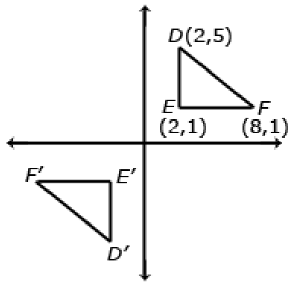
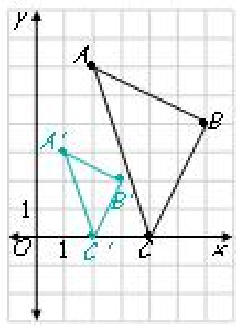
Translations
Translations move the object so that every point of the object moves in the same direction as well as the same distance. In a translation, the translated object is *congruent* to its pre-image. Triangle ABC has been translated 7 units to the right and 3 units up. To get from A (1, 5) to A' (8, 8), move point A 7 units to the right (from *x* = 1 to *x* = 8) and 3 units up (from *y* = 5 to *y* = 8). Points B and C also move in the same direction (7 units to the right and 3 units up), resulting in the same changes to each coordinate.

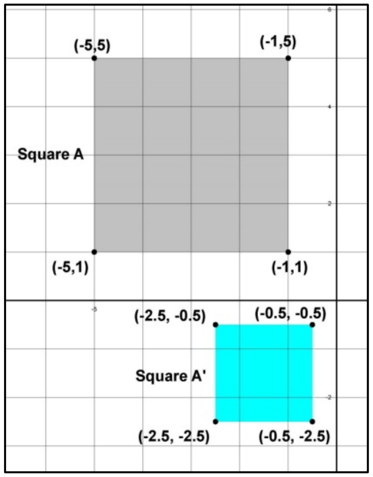


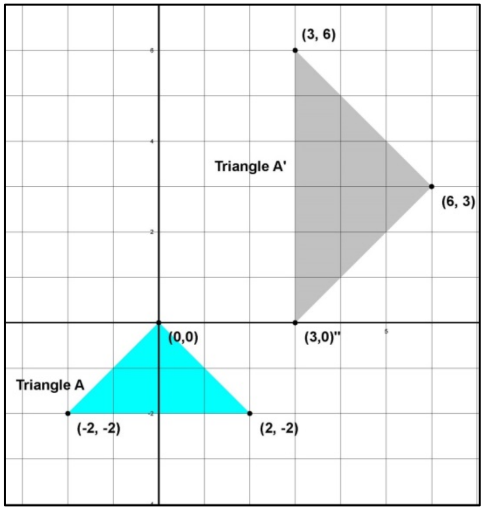
Reflections
A reflection is the "flipping" of an object over a line, known as the "line of reflection". In the 8th grade, the line of reflection will be the *x*-axis or the *y*-axis. Students recognize that when an object is reflected across the *y*-axis, the reflected *x*-coordinate is the opposite of the pre-image x-coordinate (see figure below).

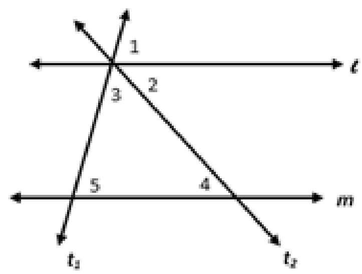


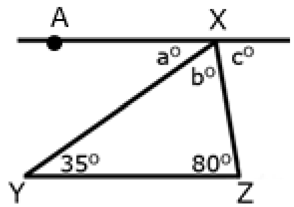
Likewise, a reflection across the *x*-axis would change a pre-image coordinate (3, -8) to the image coordinate of (3, 8). NOTE: The reflected *y*-coordinate is opposite of the pre-image *y*-coordinate.

8.G.A.3 *continued*	**Rotations** A rotation is a transformation performed by "turning" the figure around a fixed point known as the center of rotation. The figure may be rotated clockwise or counterclockwise up to 360° (at 8th grade, rotations will be centered around the origin). In a rotation, the rotated object is *congruent* to its pre-image. Consider when triangle DEF is rotated 180° clockwise about the origin. The coordinate of triangle DEF are D (2, 5), E (2, 1), and F (8, 1). When rotated 180° about the origin, the new coordinates are D'(-2, -5), E'(-2, -1) and F'(-8, -1). In this case, each coordinate is the opposite of its pre-image (see figure below).  **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 coordinates of A are (2, 6); A' (1, 3). The coordinates of B are (6, 4) and B' are (3, 2). The coordinates of C are (4, 0) and C' are (2, 0). Each of the image coordinates is ½ the value of the pre-image coordinates indicating a scale factor of ½. The scale factor would also be evident in the length of the line segments using the value of the ratio: $\frac{\text{image length}}{\text{pre−image length}}$. Students recognize the relationship between the coordinates of the its image length and pre-image length, and the scale factor for a dilation from the origin. Using the coordinates, students are able to identify the scale factor (image/pre-image). 

8.G.A.4 Explain 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. (Rotations are only about the origin, dilations only use the origin as the center of dilation, and reflections are only over the *y*-axis and *x*-axis in grade 8.)	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** none **8th Grade Standard Taught in Advance:** 8.G.A.2, 8.G.A.3 **8th Grade Standard Taught Concurrently:** none Similar figures and similarity are first introduced in the eighth grade. Students understand similar figures have congruent angles and sides that are proportional. Similar figures are produced from dilations. Dilations are limited to those with the origin as the center of dilation. 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. **Examples**: • Describe the sequence of transformations that create Square A' from Square A.  *Solution*: Square A is dilated with a scale factor of ½ then reflected across the x-axis.

8.G.A.4 *continued*	• Describe the sequence of transformations that results in the transformation of Triangle A to Triangle A'. *Solution*: Triangle A is rotated 90° clockwise, translated 4 right and 2 up, and then dilated by $\frac{3}{2}$. In this case, the scale factor of the dilation can be found by using the bases of each isosceles triangle (Base of Triangle A' = 6 units; Base of Triangle A = 4 units)  • Teacher Video Resource: Dilations in the Plane

8.G.A.5 Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. *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.*	**Component(s) of Rigor:** Conceptual Understanding **Remediation - Previous Grade(s) Standard:** none **8th Grade Standard Taught in Advance:** 8.G.A.2, 8.G.A.4 **8th Grade Standard Taught Concurrently:** none
	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 (360°). 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 seventh 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. **Example**: • Show that $m\angle 3 + m\angle 4 + m\angle 5 = 180°$ if line *l* and line *m* are parallel lines and lines t_1 and t_2 are transversals.  *Solution:* $m\angle 1 + m\angle 2 + m\angle 3 = 180°$. Angle 1 and Angle 5 are congruent ($\angle 5 \cong \angle 1$) because they are corresponding angles. $\angle 1$ can be substituted for $\angle 5$. $\angle 4 \cong \angle 2$ because alternate interior angles are congruent. $\angle 4$ can be substituted for $\angle 2$. Therefore, $m\angle 3 + m\angle 4 + m\angle 5 = 180°$.

8.G.A.5 *continued*	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. **Examples**: • In the figure below, Segment AX is parallel to Segment YZ:  Angle *a* is 35° because it alternates with the angle inside the triangle that measures 35°. Angle *c* is 80° because it alternates with the angle inside the triangle that measures 80°. Because lines have a measure of 180°, and angles *a* + *b* + *c* form a straight line, then angle *b* must be 65° (180 – (35 + 80) = 65). Therefore, the sum of the angles of the triangle is 35° + 65° + 80°.

Geometry (G)

B. Understand and apply the Pythagorean Theorem.

In this cluster, the terms students should learn to use with increasing precision are **right triangle, hypotenuse, legs, Pythagorean Theorem, Pythagorean triple, converse of the Pythagorean Theorem.**

Louisiana Standard	Explanations and Examples
8.G.B.6 Explain a proof of the Pythagorean Theorem and its converse using the areas of squares.	**Component(s) of Rigor:** Conceptual Understanding **Remediation - Previous Grade(s) Standard:** 7.G.B.6 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** 8.EE.A.2, 8.G.B.7 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 should also understand that if the sum of the squares of the 2 smaller legs of a triangle is equal to the square of the third leg, then the triangle is a right triangle. Students should be provided opportunities to explore the Pythagorean Theorem using models such as the one to the right so that the formula has meaning. Much of the confusion that students have in applying the Pythagorean Theorem is a result of not recognizing that *a* and *b* in the formula $a^2 + b^2 = c^2$ represent the perpendicular sides (legs) of the right triangle and that *c* is the longest side (hypotenuse) which lies opposite the right angle. Additionally, when asked to solve for a missing side of a right triangle, the squares don't exist; thus, the model helps to give meaning to a^2, b^2 and c^2 as areas of squares that can be created on each side of the right triangle. While students can count squares to prove that the relationship works in models such as the one to the right, some students may be more convinced if they can "fit" the two smaller squares into the larger squares. NOVA online allows the students to experience this interactively at http://www.pbs.org/wgbh/nova/proof/puzzle/theorem.html. A paper puzzle (and the solution) to allow students to experience this can be found at http://teachers.henrico.k12.va.us/math/HCPSCourse3/8-10/8-10_PythagoreanConstr.pdf on pages 12 and 13. Students also need experiences in testing the Pythagorean Theorem on non-right triangles to see that it only applies to right triangles. An application of the converse of the Pythagorean Theorem is provided below. • A triangular section on a map has sides with lengths of 5 in, 6 in, and 9 in. a. Is the section in the shape of a right triangle? Explain how you determined your answer?

<table>
<tr>
<td>8.G.B.6 continued</td>
<td>Students also need experiences in testing the Pythagorean Theorem on non-right triangles to see that it only applies to right triangles. An application of the converse of the Pythagorean Theorem is provided below.

• A triangular section on a map has sides with lengths of 5 in, 6 in, and 9 in.
b. Is the section in the shape of a right triangle? Explain how you determined your answer?
c. Determine if your answer is correct making the triangle:
o Draw a segment that is 9 inches long on a sheet of paper.
o Cut a 5 inch piece of pipe cleaner*. Place one end of the pipe cleaner on one endpoint of the 9 inch segment.
o Cut a 6 inch piece of pipe cleaner. Place one end of the pipe cleaner on the second endpoint of the 9 inch segment.
o Carefully adjust the pipe cleaners so that a triangle is formed. (See diagram to the right.)
o Did you make a right triangle? How does this answer compare with the answer to Part a?


*Other materials such as narrow strips of construction paper can be substituted.</td>
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<tr>
<td>8.G.B.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.</td>
<td>Remediation - Previous Grade(s) Standard: none
8th Grade Standard Taught in Advance: none
8th Grade Standard Taught Concurrently: 8.G.B.6
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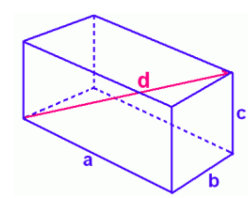
Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.

Examples:
• The Irrational Club wants to build a tree house. They have a 9-foot ladder that must be propped diagonally against the tree. If the base of the ladder is 5 feet from the bottom of the tree, how high will the tree house be off the ground?

• Find the length of d in the figure to the right if a = 8 in., b = 3 in. and c = 4in.

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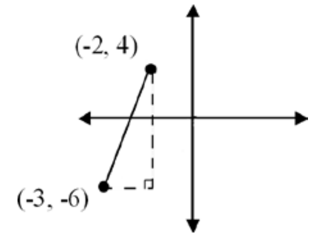
8.G.B.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system.	**Component(s) of Rigor:** Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** 6.G.A.3 8th **Grade Standard Taught in Advance:** 8.G.B.7 8th **Grade Standard Taught Concurrently:** none One application of the Pythagorean Theorem is finding the distance between two points on the coordinate plane. Students build on work from sixth 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.  **Examples**: • Students will create a right triangle from the two points given (as shown in the diagram) and then use the Pythagorean Theorem to find the distance between the two given points. • Find the distance between (9, -7) and (-5, 2).

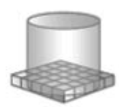
Geometry (G)

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

In this cluster, the terms students should learn to use with increasing precision are **cone, cylinder, sphere, radius, volume, height, pi, depth.**

Louisiana Standard	Explanations and Examples
8.G.C.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency, Application **Remediation - Previous Grade(s) Standard:** none **8th Grade Standard Taught in Advance:** 8.EE.A.2 **8th Grade Standard Taught Concurrently:** none

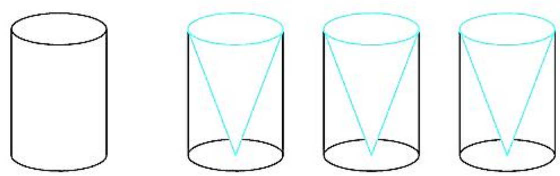
Students build on understandings of circles and volume from seventh grade to find the volume of cylinders, finding the area of the base πr^2 and multiplying by the number of layers (the height).



$V = \pi r^2 h$

find the area of the base and multiply by the number of layers

Students understand that the volume of a cylinder is 3 times the volume of a cone having the same base area and height or that the volume of a cone is $\frac{1}{3}$ the volume of a cylinder having the same base area and height.



$V = \frac{1}{3}\pi r^2 h$ or $V = \frac{\pi r^2 h}{3}$

As demonstrated in the video posted at https://www.youtube.com/watch?v=aLyQddyY8ik, students understand that the volume of a sphere is $\frac{2}{3}$ the volume of a cylinder which has the same height and same diameter as the sphere. (Teachers are encouraged to have students explore this relationship if manipulatives are available.) Teachers should guide students to algebraically develop the formula for the volume of the sphere. Volume of Sphere = $\frac{2}{3}$ (Volume of Cylinder) = $\frac{2}{3}\pi r^2 h$. The height of the cylinder and the height of the sphere are the same; therefore, $h = d = 2r$. Using substitution, Volume of Sphere = $\frac{2}{3}\pi r^2 h =$ $\frac{2}{3}\pi r^2 2r$ = $\frac{4}{3}\pi r^3$.

Students then use these formulas to solve real-world and mathematical problems.

Statistics and Probability (SP)

A. Investigate patterns of association in bivariate data.

In this cluster, the terms students should learn to use with increasing precision are **bivariate data, scatter plot, linear model, clustering, linear association, non-linear association, outliers, positive association, negative association, categorical data, two-way table,** and **relative frequency**.

Louisiana Standard	Explanations and Examples
8.SP.A.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.	**Component(s) of Rigor:** Conceptual Understanding, Procedural Skill and Fluency **Remediation - Previous Grade(s) Standard:** 6.NS.C.8 **8th Grade Standard Taught in Advance:** none **8th Grade Standard Taught Concurrently:** none

Students analyze scatterplots to determine positive and negative associations, the degree of association, and type of association. Students examine outliers to determine if data points are valid or represent a recording or measurement error. Use of the formula to identify outliers is **not** expected at this level. Students can use tools such as those at the National Center for Educational Statistics to create a graph or generate data sets. (http://nces.ed.gov/nceskids/createagraph/default.aspx)

Examples:

- Data for 10 students' Math and Science scores are provided in the table below. Describe the association between the Math and Science scores.

Student	1	2	3	4	5	6	7	8	9	10
Math	64	50	85	34	56	24	72	63	42	93
Science	68	70	83	33	60	27	74	63	40	96

- Data for 10 students' Math scores and the distance they live from school are provided in the table below. Describe the association between the Math scores and the distance students live from school.

Student	1	2	3	4	5	6	7	8	9	10
Math score	64	50	85	34	56	24	72	63	42	93
Distance from school (miles)	0.5	1.8	1	2.3	3.4	0.2	2.5	1.6	0.8	2.5

8.SP.A.1 *continued*

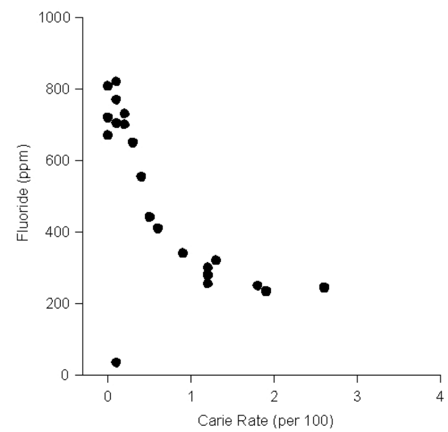
- Data from a local fast food restaurant showing the number of staff members and the average time for filling an order are provided in the table below. Describe the association between the number of staff and the average time for filling an order.

Number of staff	3	4	5	6	7	8
Average time to fill order (seconds)	180	138	120	108	96	84

- The table below lists the life expectancy in years for people in the United States every five years from 1970 to 2005. What would you expect the life expectancy of a person in the United States to be in 2010, 2015, and 2020 based upon this data? Explain how you determined your values.

Date	1970	1975	1980	1985	1990	1995	2000	2005
Life Expectancy (in years)	70.8	72.6	73.7	74.7	75.4	75.8	76.8	77.4

Students recognize that not all data will have a linear association. Some associations will be non-linear as in the example below:



<table>
<tr>
<td>8.SP.A.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.</td>
<td>Component(s) of Rigor: Conceptual Understanding
Remediation - Previous Grade(s) Standard: none
8th Grade Standard Taught in Advance: 8.SP.A.1
8th Grade Standard Taught Concurrently: 8.F.B.4

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.

Example:

• The capacity of the fuel tank in a car is 13.5 gallons. The table below shows the number of miles traveled and how many gallons of gas have been used. Describe the relationship between the variables. If the data has a linear association, determine a line of best fit. Do you think the line represents a good fit for the data set? Why or why not? What is the average fuel efficiency of the car in miles per gallon?

<table>
<tr><td>Miles Traveled</td><td>0</td><td>75</td><td>120</td><td>160</td><td>250</td><td>300</td></tr>
<tr><td>Gallons Used</td><td>0</td><td>2.3</td><td>4.5</td><td>5.7</td><td>9.7</td><td>10.7</td></tr>
</table>
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<tr>
<td>8.SP.A.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. 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.</td>
<td>Component(s) of Rigor: Conceptual Understanding, Application
Remediation - Previous Grade(s) Standard: none
8th Grade Standard Taught in Advance: 8.SP.A.2
8th Grade Standard Taught Concurrently: 8.F.B.4

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.

Examples:
• Given data from students' math scores and absences, make a scatterplot.</td>
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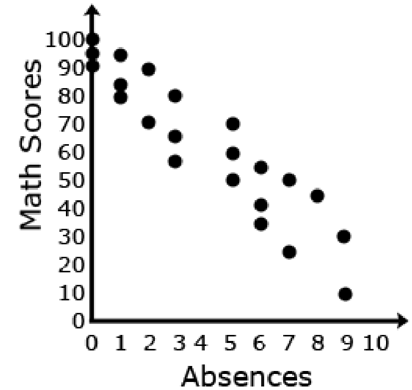
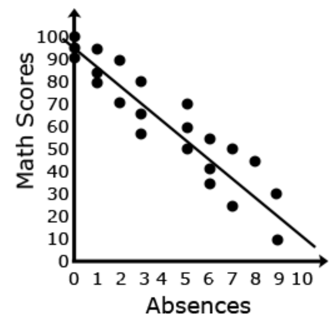
8.SP.A.3 *continued*

Absences	Math Scores
3	65
5	50
1	95
1	85
3	80
6	34
5	70
3	56
0	100
7	24
8	45
2	71
9	30
0	95
6	55
6	42
2	90
0	92
5	60
7	50
9	10
1	80



- Draw a line of best fit, paying attention to the closeness of the data points on either side of the line.



- From the line of best fit, determine an approximate linear equation that models the given data (about $y = -\frac{25}{3}x + 95$)
- Students should recognize that 95 represents the approximate score of a student with 0 absences and $-\frac{25}{3}$ represents the approximate amount of points (25) a student's score decreases for every 3 absences.

Students can use this linear model to solve problems. For example, through substitution, they can use the equation to determine that a student with 4 absences should expect to receive a math score of about 62. They can then compare this value to their line.

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

Component(s) of Rigor: Conceptual Understanding, Procedural Skill and Fluency, Application
Remediation - Previous Grade(s) Standard: none
8th Grade Standard Taught in Advance: none
8th Grade Standard Taught Concurrently: none

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.

Examples:

- The table illustrates the results when 100 students were asked the survey questions: "Do you have a curfew?" and "Do you have assigned chores?" Is there evidence that those who have a curfew also tend to have chores?

Curfew

Chores		Yes	No
	Yes	40	10
	No	10	40

Solution: Of the students who answered that they had a curfew, 40 had chores and 10 did not. Of the students who answered they did not have a curfew, 10 had chores and 40 did not. From this sample, there appears to be a positive correlation between having a curfew and having chores.

- Twenty-five students were surveyed and asked if they received an allowance and if they did chores. The table below summarizes their responses.

	Receive Allowance	**No Allowance**
Do Chores	15	5
Do Not Do Chores	3	2

Of the students who do chores, what percent do not receive an allowance?

Solution: 5 of the 20 students who do chores do not receive an allowance, which is 25%.

Grade 4 Standards

4.OA.A.2 Multiply or divide to solve word problems involving multiplicative comparison, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem, distinguishing multiplicative comparison from additive comparison (Example: 6 times as many vs. 6 more than).
Return to 8.EE.A.3

Grade 5 Standards

5.NBT.A.2 Explain and apply patterns in the number of zeros of the product when multiplying a number by powers of 10. Explain and apply patterns in the values of the digits in the product or the quotient, when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10. *For example,* $10^0 = 1$, $10^1 = 10$ ... *and* $2.1 \times 10^2 = 210$. *Return to* 8.EE.A.3

Grade 6 Standards

6.NS.C.8 Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate. *Return to* 8.SP.A.1

6.EE.A.1 Write and evaluate numerical expressions involving whole-number exponents. *Return to* 8.EE.A.1

6.EE.B.5 Understand solving an equation or inequality as a process of answering a question: which values from a specified set, if any, make the equation or inequality true? Use substitution to determine whether a given number in a specified set makes an equation or inequality true. *Return to* 8.EE.A.2, 8.EE.C.8

6.G.A.3 Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.
Return to 8.G.A.3, 8.G.B.8

Grade 7 Standards

7.RP.A.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.

Return to 8.EE.B.5, 8.EE.B.6, 8.F.A.1, 8.F.A.2, 8.F.B.4

7.NS.A.3 Solve real-world and mathematical problems involving the four operations with rational numbers. *Return to* 8.EE.A.2

7.EE.A.1 Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients to include multiple grouping symbols (e.g., parentheses, brackets, and braces). *Return to* 8.EE.C.7

7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *For example: If a woman making $25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or $2.50, for a new salary of $27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.* *Return to* 8.EE.A.4

7.G.A.2 Draw (freehand, with ruler and protractor, or with technology) geometric shapes with given conditions. (Focus is on triangles from three measures of angles or sides, noticing when the conditions determine one and only one triangle, more than one triangle, or no triangle. *Return to* 8.EE.B.6, 8.G.A.1

7.G.B.5 Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve simple equations for an unknown angle in a figure. *Return to* 8.G.A.1

7.G.B.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. (Pyramids limited to surface area only.) *Return to* 8.G.B.6