6th Grade

The nine standards listed below are the key content competencies students will be expected to master in sixth grade. Additional clarity and details are provided through the classroom-level learning objectives and evidence of student learning details for each grade-level standard found on subsequent pages of this document. As teachers are planning instruction and assessing mastery of the content at the grade level, the focus should remain on the key competencies listed in the table below.

COURSE STANDARDS
6.MP: **Display perseverance and patience in problem-solving. Demonstrate skills and strategies needed to succeed in mathematics, including critical thinking, reasoning, and effective collaboration and expression. Seek help and apply feedback. Set and monitor goals.**
6.NR.1: **Solve relevant, mathematical problems involving operations with whole numbers, fractions, and decimal numbers.**
6.NR.2: **Apply operations with whole numbers, fractions and decimals within relevant applications.**
6.NR.3: **Solve a variety of problems involving whole numbers and their opposites; model rational numbers on a number line to describe problems presented in relevant, mathematical situations.**
6.NR.4: **Solve a variety of contextual problems involving ratios, unit rates, equivalent ratios, percentages, and conversions within measurement systems using proportional reasoning.**
6.GSR.5: **Solve relevant problems involving area, surface area, and volume.**
6.PAR.6: **Identify, write, evaluate, and interpret numerical and algebraic expressions as mathematical models to explain relevant situations.**
6.PAR.7: **Write and solve one-step equations and inequalities as mathematical models to explain authentic, realistic situations.**
6.PAR.8: **Graph rational numbers as points on the coordinate plane to represent and solve contextual, mathematical problems; draw polygons using the coordinates for their vertices and find the length of a side of a polygon.**

Georgia's K-12 Mathematics Standards – 2021

6TH GRADE

<table>
<tr><td colspan="6">NUMERICAL REASONING – multiplication and division of whole numbers and fractions, and all four operations with decimal numbers</td></tr>
<tr><td colspan="6">6.NR.1: Solve relevant, mathematical problems involving operations with whole numbers, fractions, and decimal numbers.</td></tr>
<tr><th colspan="2">Expectations</th><th colspan="4">Evidence of Student Learning
(not all inclusive; see Grade Level Overview for more details)</th></tr>
<tr><td>6.NR.1.1</td><td>Fluently add and subtract any combination of fractions to solve problems.</td><td>Terminology
Fluently/Fluency – Students choose flexibly among methods and strategies to solve mathematical problems accurately and efficiently.</td><td colspan="2">Strategies and Methods
Students should be able to use numerical reasoning to interpret applicable, mathematical situations involving fractions.
Students should be given the opportunity to apply reasoning strategies while solving problems.
Students may solve problems in different ways and have the flexibility to choose a mathematical strategy that allows them to make sense of and strategically solve problems using efficient methods that are most comfortable for and makes sense to them.</td><td>Age/Developmentally Appropriate
Students should be allowed to choose an appropriate strategy to demonstrate fluency.</td></tr>
<tr><td>6.NR.1.2</td><td>Multiply and divide any combination of whole numbers, fractions, and mixed numbers using a student-selected strategy. Interpret products and quotients of fractions and solve word problems.</td><td colspan="2">Strategies and Methods
Students should be able to utilize fractions with denominators including 2, 3, 4, 5, 6, 8, 10, and 12.
Students should be able to use numerical reasoning to interpret applicable, mathematical situations involving fractions.
Students can use a variety of strategies, including but not limited to concrete models, visual fraction models, student-generated strategies, a standard algorithm, or other strategies based on numerical reasoning to represent and solve problems.
Students should be given the opportunity to apply reasoning strategies and use written methods that make sense to them.
Students should use flexible, accurate, and efficient written methods to express computational thinking based on numerical reasoning and sense-making developed from learning experiences that focus on the numbers as quantities.
Students may solve problems in different ways and have the flexibility to choose a mathematical strategy that allows them to make sense of and strategically solve problems using efficient methods that are most comfortable for and makes sense to them.</td><td>Fundamentals
Students should use their understanding of equivalency to flexibly reason with equivalent fractions based on the context of the problem. Simplifying fractions is not an expectation of this grade level.
Students should be able to use the meanings of fractions, multiplication, division and the inverse relationship between multiplication and division to make sense of multiplying and dividing fractions.</td><td>Example
How many $\frac{3}{4}$-cup servings are in $\frac{2}{3}$ of a cup of yogurt?</td></tr>
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<tr>
<td>6.NR.1.3</td>
<td>Perform operations with multi-digit decimal numbers fluently using models and student-selected strategies.</td>
<td>Fundamentals
Fluently/Fluency – Students choose flexibly among methods and strategies to solve mathematical problems accurately and efficiently.</td>
<td colspan="2">Strategies and Methods
Students should be able to use a variety of part-whole strategies to compute efficiently (area model, partial product, partial quotient).
The part-whole strategies used should be flexible and extend from previous computation strategies and future work with computation.
Students should use models and student-selected strategies as an efficient written method of demonstrating place value understanding for each operation (addition, subtraction, multiplication, and division).
Students may solve problems in different ways and have the flexibility to choose a mathematical strategy that allows them to make sense of and strategically solve problems using efficient methods that are most comfortable for and makes sense to them.</td>
<td>Terminology
Decimal number – a number whose whole number part and fractional part are separated by a decimal point.</td>
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<tr><td colspan="6"></td></tr>
<tr><td colspan="6">6.NR.2: Apply operations with whole numbers, fractions and decimals within relevant applications.</td></tr>
<tr>
<td colspan="2">Expectations</td>
<td colspan="4">Evidence of Student Learning
(not all inclusive; see Grade Level Overview for more details)</td>
</tr>
<tr>
<td>6.NR.2.1</td>
<td>Describe and interpret the center of the distribution by the equal share value (mean).</td>
<td colspan="2">Age/Developmentally Appropriate
The concept of mean should be explored visually and conceptually before introducing the formula.
This is the beginning of the progression of the concept of measures of center and will continue to be developed in 6th grade.</td>
<td>Strategies and Methods
Students should be given the opportunity to use manipulatives such as: snap cubes, tiles, etc...to model equal share value.</td>
<td>Example
“If we combined all of the 5th grade students’ candies and shared them equally with each student so everyone has the same number of candies.” (This is the mean or equal share value.)</td>
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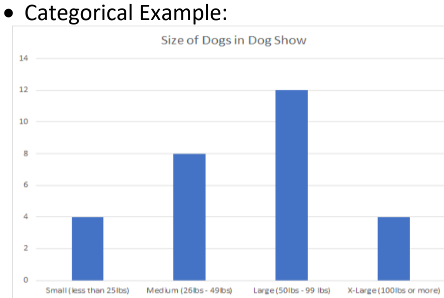
<tr>
<td>6.NR.2.2</td>
<td>Summarize categorical and quantitative (numerical) data sets in relation to the context: display the distributions of quantitative (numerical) data in plots on a number line, including dot plots, histograms, and box plots and display the distribution of categorical data using bar graphs.</td>
<td>Fundamentals
Students have experience with displaying categorical data using bar graphs from elementary grades. In sixth grade, students are extending their understanding of analyzing categorical data</td>
<td>Strategies and Methods
As a result of an investigation, students should summarize categorical and quantitative (numerical) data sets in relation to the context.
Students should be able to describe the</td>
<td>Age/Developmentally Appropriate
Sixth grade students should be able to create dot plots and box plots to analyze the results of an investigation.
Sixth grade students should focus on describing and interpreting data displayed.
Students should be able to identify that each quartile presented in a box plot</td>
<td>Examples
Categorical Example:

What could be the weight of the smallest dog? The largest?</td>
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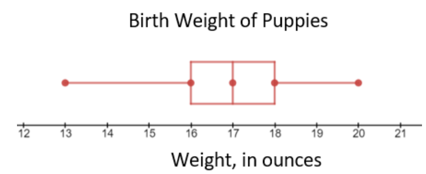
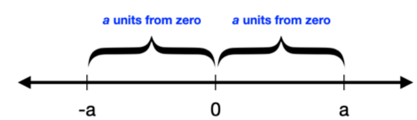
		displayed on histograms.	nature of the attribute under investigation, including how it was measured and its units of measurement.	represents 25% of the data set.	● Quantitative (Numerical) Example: Here are the birth weights, in ounces, of all the puppies born at a kennel in the past month.  What do you notice and wonder about the distribution of the puppy weights?
6.NR.2.3	Interpret numerical data to answer a statistical investigative question created. Describe the distribution of a quantitative (numerical) variable collected, including its center, variability, and overall shape.	***Fundamentals*** ● In sixth grade, students should explore the conceptual idea of MAD – not the formula. ● Students should be able to determine the number of observations from a context or diagram. ● Students should be able to describe the distribution of a quantitative (numerical) variable collected, including its center (median, mean), variability (interquartile range (IQR), mean absolute deviation (MAD), and range), and overall shape (symmetrical vs non-symmetrical).	***Terminology*** ● Students should be able to apply their understanding of absolute value (rather than use operations on negative integers) in the context of MAD.	***Strategies and Methods*** ● Students should explore conceptually the measures of center (mean, median) and variability (interquartile range and range) for a set of numerical data gathered from relevant, mathematical situations and use these measures to describe the shape of the data presented in various forms.	***Example*** ● Arthur and Aaron are on the same 6th grade basketball team. Both players have scored an average of ten points over the past ten games. Here are the students' number of points scored during each of the last ten games. Arthur: 9, 10, 10, 11, 11, 9, 10, 10, 10, 10 Aaron: 16, 18, 4, 3, 5, 13, 18, 3, 13, 7 Which student is more consistent? Possible Student Response/Solution: Arthur is more consistent because his MAD is smaller than Aaron's MAD; Arthur has less variability than Aaron.

		● Data sets can be limited to no more than 10 data points when exploring the mean absolute deviation. ● Students should be able to describe the nature of the attribute under investigation, including how it was measured and its units of measurement.			
6.NR.2.4	Design simple experiments and collect data. Use data gathered from realistic scenarios and simulations to determine quantitative measures of center (median and/or mean) and variability (interquartile range and range). Use these quantities to draw conclusions about the data, compare different numerical data sets, and make predictions.	***Fundamentals*** ● Students should be able to use quantitative measures of center and variability to draw conclusions about data sets and make predictions based on comparisons. ● Students should be able to identify that each quartile represents 25% of the data set.		***Strategies and Methods*** ● Students should apply understanding of the measures of center (mean, median) and variability (interquartile range and range) to determine quantitative measures of center and variability, draw conclusions about the data, compare different-numerical data sets and make predictions using data gathered from realistic scenarios and simulations.	
6.NR.2.5	Relate the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.	***Fundamentals*** ● Students should understand the concept of outliers.		***Strategies and Methods*** ● Students should be able to analyze the shape of a data distribution and determine which measure of center and variability best describes the data based on the shape of the data and the context in which the data was gathered.	
6.NR.2.6	Describe the impact that inserting or deleting a data point has on the mean and the median of a data set. Create data displays using a dot plot or box plot to examine this impact.	***Strategies and Methods*** ● Students should be able to analyze the shape of a data distribution and determine the impact single data points have on the data set represented visually.			

6.NR.3: Solve a variety of problems involving whole numbers and their opposites; model rational numbers on a number line to describe problems presented in relevant, mathematical situations.		
Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**
6.NR.3.1	Identify and compare integers and explain the meaning of zero based on multiple authentic situations.	***Relevance and Application*** ● Students should be able to use numerical reasoning to explain that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, debits/credits, positive/negative electric charge). ● Students should be able to use positive and negative numbers to represent quantities in authentic situations and explain the meaning of zero based on each situation. ● Students should be able to interpret relevant, mathematical problems related to positive and negative numbers. ***Example*** ● Write –5°C > –9°C to express the fact that –5°C is warmer than –9°C.
6.NR.3.2	Order and plot integers on a number line and use distance from zero to discover the connection between integers and their opposites.	***Strategies and Methods*** ● Students should have opportunities to explore this concept using visual models to develop a deeper understanding. ● Number lines should be indicated both vertically and horizontally. ***Example*** ● Students should be able to recognize that -a is the same distance from zero as a, and therefore, are opposites of each other. 
6.NR.3.3	Recognize and explain that opposite signs of integers indicate locations on opposite sides of zero on the number line; recognize and explain that the opposite of the opposite of a number is the number itself.	***Fundamentals*** ● Students should be able to explain that zero is its own opposite. ● Students should be able to explain that the sign of an integer represents its position relative to zero on a number line. ● Students should be able to show and explain why –(–a) = a. Which is read as, "The opposite of the opposite of a is the same as a."
6.NR.3.4	Write, interpret, and explain statements of order for rational numbers in authentic, mathematical situations. Compare rational	***Strategies and Methods*** ● Students should be able to use numerical reasoning to interpret and explain the meaning of numerical statements of inequality as the ***Terminology*** ● Rational numbers are numbers that can be written as a fraction where the numerator and denominator are integers. ***Examples*** ● Write –3 degrees Celsius > –7 degrees Celsius to express the fact that –3 degree Celsius is warmer than –7 degrees Celsius.

	numbers, including integers, using equality and inequality symbols.	relative position of two integers positioned on a number line. ● Students are introduced to rational numbers. Students should connect their understanding of fractions and integers to comprehend rational numbers as numbers that can be written as a fraction where the numerator and denominator are integers.		● Interpret –8.3 > –12.3 as a statement that –8.3 is located to the right of –12.3 on a number line oriented from left to right.
6.NR.3.5	Explain the absolute value of a rational number as its distance from zero on the number line; interpret absolute value as distance for a positive or negative quantity in a relevant situation.	***Terminology*** ● Absolute value is a number's distance from zero (0) on a number line.	***Fundamentals*** ● Students should be introduced to the absolute value symbol with this learning objective, i.e., $\lvert -\frac{3}{4} \rvert$. ● Students should conclude through exploration that absolute value and distance are always expressed as a positive value.	***Example*** For an account balance of –51.25 dollars, write $\lvert -51.25 \rvert = 51.25$ to describe the size of the debt in dollars.
6.NR.3.6	Distinguish comparisons of absolute value from statements about order.	***Example*** ● Recognize that an account balance less than –30 dollars represents a debt greater than 30 dollars.		

<table>
<tr><th colspan="14">6.NR.4: Solve a variety of contextual problems involving ratios, unit rates, equivalent ratios, percentages, and conversions within measurement systems using proportional reasoning.</th></tr>
<tr><th colspan="2">Expectations</th><th colspan="12">Evidence of Student Learning
(not all inclusive; see Grade Level Overview for more details)</th></tr>
<tr><td>6.NR.4.1</td><td>Explain the concept of a ratio, represent ratios, and use ratio language to describe a relationship between two quantities.</td><td colspan="4">Strategies and Methods
● Students should be able to solve problems involving ratios found in everyday situations.
● Students should be given the opportunity to represent and explain the concept of a ratio and the relationship between two quantities using concrete materials, drawings, tape diagrams (bar models), double number line diagrams, equations, and standard fractional notation.</td><td colspan="4">Fundamentals
● Students should be able to explain the concept of a ratio, such as using part-to-part or part-to-whole.
● Students should be able to fluently use ratio language to describe a ratio relationship between two quantities.
● Students should be able to identify standard fractional notation to compare.</td><td colspan="4">Example
● The ratio of wings to beaks in the bird house at the zoo was 2:1, because for every 2 wings there was 1 beak.
● For every vote candidate A received, candidate C received nearly three votes.</td></tr>
<tr><td>6.NR.4.2</td><td>Make tables of equivalent ratios relating quantities with whole-number measurements, find missing values in the tables, and plot the pairs of values on the coordinate plane. Use tables to compare ratios.</td><td colspan="12">Strategies and Methods
● Students should be able to solve problems involving ratios found in realistic situations.</td></tr>
<tr><td>6.NR.4.3</td><td>Solve problems involving proportions using a variety of student-selected strategies.</td><td colspan="12">Strategies and Methods
● Students should be given opportunities to utilize student-selected strategies to solve applicable, mathematical problems involving proportions.
● Students should be given the opportunity to use concrete materials, drawings, tables of equivalent ratios, tape diagrams (bar models), double number line diagrams, and equations when solving problems.
● Students can choose a strategy from a variety of strategies developed to solve a specific problem depending on the situation presented in the problem.</td></tr>
<tr><td>6.NR.4.4</td><td>Describe the concept of rates and unit rate in the context of a ratio relationship.</td><td colspan="3">Strategies and Methods
● Students should create a table of values displaying the ratio relationships to graph ordered pairs of distances and times.
● Students should write equations to represent</td><td colspan="3">Fundamentals
● When asked practical, mathematical questions, students should demonstrate an understanding of</td><td colspan="3">Terminology
● Students should understand a unit rate as a relationship of a:b where b = 1 ($\frac{a}{b}$ associated</td><td colspan="3">Examples
● We paid $75 for 15 hamburgers, which is a rate of $5 per one hamburger?
● In a problem involving motion at a constant speed, list and graph</td></tr>
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<table>
<tr><td></td><td></td><td>the relationship between distance and time where the unit rate is the simple multiplicative relationship.
● Students should be able to determine the independent and dependent relationship of rate relationships within authentic, mathematical situations.</td><td>simple multiplicative relationships involving unit rates.</td><td>with a ratio a: b with b ≠ 0 (b not equal to zero), and use rate language).</td><td>ordered pairs of distances and times, and write an equation such as d = 65t to represent the relationship between distance and time. In this example, 65 is the unit rate or simple multiplicative relationship.</td></tr>
<tr><td>6.NR.4.5</td><td>Solve unit rate problems including those involving unit pricing and constant speed.</td><td colspan="4">Example
● If it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?</td></tr>
<tr><td>6.NR.4.6</td><td>Calculate a percent of a quantity as a rate per 100 and solve everyday problems given a percent.</td><td colspan="2">Strategies and Methods
● Students should be able to calculate the percentage of a number using proportional reasoning developed through working with ratios and rates.
● Students should be able to solve contextual problems involving finding the whole given a part and the part given the whole.
● Students should determine what percent one number is of another number to solve authentic, mathematical problems.</td><td colspan="2">Fundamentals
● Students should have opportunities to explore the concept of percentage and recognize the connection between fractions, decimal numbers, and percentages, such as, 25% of a quantity means $\frac{25}{100}$ or .25 times the quantity.
● Students should be able to convert fractions with denominators of 2, 4, 5 and 10 to the decimal notation.</td></tr>
<tr><td>6.NR.4.7</td><td>Use ratios to convert within measurement systems (customary and metric) to solve authentic problems that exist in everyday life.</td><td colspan="2">Strategies and Methods
● Students should be able to use flexible, strategic thinking to manipulate and transform units appropriately when multiplying or dividing quantities to solve practical, mathematical problems.
● Students should be able to convert measurement units when given a conversion factor within one system of measurement and between two systems of measurement (customary and metric) using proportional reasoning developed through working with ratios and rates.</td><td colspan="2">Example
● Given 1 in. = 2.54 cm, how many centimeters are in 6 inches?</td></tr>
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GEOMETRIC & SPATIAL REASONING *– area of polygons, volume of right rectangular prisms, surface area of 3-D figures*				
6.GSR.5: Solve relevant problems involving area, surface area, and volume.				
Expectations		**Evidence of Student Learning** (not all inclusive; see Grade Level Overview for more details)		
6.GSR.5.1	Explore area as a measurable attribute of triangles, quadrilaterals, and other polygons conceptually by composing or decomposing into rectangles, triangles, and other shapes. Find the area of these geometric figures to solve problems.	***Age and Developmentally Appropriate*** ● Students should build on prior knowledge of area to investigate the area of other polygons through geometric and spatial reasoning tasks.	***Strategies and Methods*** ● Students should be able to use knowledge of area of a rectangle to determine the area of a triangle. ● Students should have opportunities to find the area of a triangle by decomposing the rectangle into two triangles. ● Students should conclude the area of the triangle is half the area of the rectangle and the area of the rectangle is twice the area of the triangle. Therefore, the formula for the area of a triangle is $\frac{1}{2}$ x base x height or $\frac{base\ x\ height}{2}$. ● Students should be able to use geometric and spatial reasoning to calculate the area of a triangle, quadrilateral, and regular polygon by composing or decomposing into shapes, such as, but not limited to triangles, rectangles, trapezoids, rhombi, etc. ● Students should be presented with mathematical problems found in the real world. ● Students should be able to decompose regular and irregular polygons into triangles and quadrilaterals in a way that makes sense from their perspective.	***Terminology*** ● A polygon is a closed figure with at least three straight sides and angles; a polygon is regular only when all sides are equal and all angles are equal; and a polygon is irregular when all sides are not equal or all angles are not equal.

6.GSR.5.2	Given the net of three-dimensional figures with rectangular and triangular faces, determine the surface area of these figures.	***Strategies and Methods*** ● Students should use various tools and strategies including a picture or physical model of a net to measure the surface area of three-dimensional figures that are composed of rectangular and triangular faces when solving practical, mathematical problems.	***Age and Developmentally Appropriate*** ● Students should be provided the net of three-dimensional figures to ensure developmental appropriateness.	
6.GSR.5.3	Calculate the volume of right rectangular prisms with fractional edge lengths by applying the formula, V = (area of base) x (height).	***Age and Developmentally Appropriate*** ● Fractional edge lengths should be limited to fractions with a denominator of 2, 3, and 5. ● At this grade level, problems should not include volume displacement.	***Fundamentals*** ● Students should make the connection between (length) x (width) and the area of the base to connect this formula to other three-dimensional volume formulas.	***Strategies and Methods*** ● Students should be able to calculate the volume of a right rectangular prism with fractional edge lengths and show that the volume is the same as would be found by multiplying the edge lengths of the prism. ● Students should apply the formula for the volume of a right rectangular prism in the context of solving authentic, mathematical problems to meet this learning objective.

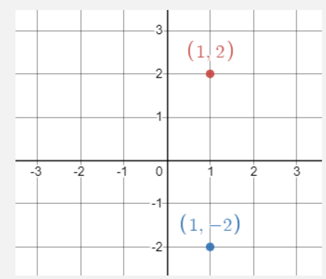
PATTERNING & ALGEBRAIC REASONING *– numerical and algebraic expressions, factors, multiples, algebraic expressions, plotting points in all four quadrants, rational numbers on a number line, polygons in the coordinate plane*

6.PAR.6: Identify, write, evaluate, and interpret numerical and algebraic expressions as mathematical models to explain authentic situations.

Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**		
6.PAR.6.1	Write and evaluate numerical expressions involving rational bases and whole-number exponents.	***Strategies and Methods*** ● Students should interpret relevant, mathematical situations to write and evaluate numerical expressions.		
6.PAR.6.2	Determine greatest common factors and least common multiples using a variety of strategies to make sense of applicable problems.	***Strategies and Methods*** ● Investigate the distributive property using sums and its use in adding numbers 1-100 with a common factor. ● Students should apply these strategies to solve applicable, mathematical problems.	***Age/Developmentally Appropriate*** ● Students should also be able to apply the least common multiple of two whole numbers less than or equal to 12 to solve applicable, mathematical problems. ● Students should be able to determine the greatest common factor of 2 whole numbers (from	***Example*** ● Hotdogs come in a package of 8 and buns in a package of 12. How many packages of hot dogs and packages of buns would you need to purchase to have an equal number of hot dogs and buns?

		1-100) and use the distributive property to express a sum of two whole numbers with a common factor as a multiple of a sum of two whole numbers with no common factors (GCF).	
6.PAR.6.3	Write and read expressions that represent operations with numbers and variables in realistic situations.	***Strategies and Methods*** ● Students should identify parts of an expression using mathematical terms (sum, difference, term, product, factor, quotient, coefficient, variable, constant); view one or more parts of an expression as a single entity. ● Students should translate from a word form into variable expression. ● Students should understand letters called variables represent unknown numbers and the same rules apply in operations with numbers also apply in operations with variables.	***Examples*** ● Express the calculation "Subtract x from 9" as 9 – x. ● Describe the expression 2(8+7) as a product of two factors; view (8+7) as both a single entity and a sum of two terms. ● Some of the students at Georgia Middle School like to walk to and from school. They always walk unless it rains. Let d be the distance in miles from a student's home to the school. Write two different expressions that represent how far a student travels by walking in a two-week period if there is one rainy day each week. ● Possible Solution: The distance to school, and therefore home, is d. Thus, the student rides (d + d) miles in one day. Equivalently, she rides (2d) miles in one day. Repeatedly adding the distance traveled in one day for each school day of the week, we find that in one week the student travels (2d + 2d + 2d + 2d + 2d) miles. Equivalently, she travels 5(2d) or (10d) miles in a normal, rain free week.
6.PAR.6.4	Evaluate expressions when given values for the variables, including expressions that arise in everyday situations.	***Fundamentals*** ● Students should evaluate algebraic expressions for a given value of a variable, using the order of operations. ● Students should perform arithmetic operations, including those involving whole-number exponents, in the conventional order when there are no parentheses to specify a particular order (Order of Operations).	
6.PAR.6.5	Apply the properties of operations to identify and generate equivalent expressions.	***Example*** ● Apply the distributive property to the expression 3(2 + x) to produce the equivalent expression 6 + 3x; apply the distributive property to the expression 24x + 18y to produce the equivalent expression 6(4x + 3y); apply properties of operations to y + y + y to produce the equivalent expression 3y.	***Age/Developmentally Appropriate*** ● This standard includes distributive property and combining like terms.

6.PAR.7: *Write and solve one-step equations and inequalities as mathematical models to explain authentic, realistic situations.*		
Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**
6.PAR.7.1	Solve one-step equations and inequalities involving variables when values for the variables are given. Determine whether an equation and inequality involving a variable is true or false for a given value of the variable.	***Strategies and Methods*** ● Students should be able to use algebraic reasoning to solve an equation as a process of answering an authentic question and explain their reasoning. ● When solving an equation or inequality as a process of answering a question, students should be able to explain why specific values from a specified set, if any, make the equation or inequality true. ● Students should use substitution to determine whether a given number in a specified set makes an equation or inequality true.
6.PAR.7.2	Write one-step equations and inequalities to represent and solve problems; explain that a variable can represent an unknown number or any number in a specified set.	***Age/Developmentally Appropriate*** ● Students should be able to represent equations involving positive variables and rational numbers. ● Students should have opportunities to solve relevant, mathematical problems. ***Strategies and Methods*** ● Students should have an opportunity to solve problem situations with variables in all positions. ● Students should be able to explain that a variable can represent an unknown number, or depending on the purpose at hand, any number in a specified set.
6.PAR.7.3	Solve problems by writing and solving equations of the form $x \pm p = q$, $px = q$ and $\frac{x}{p} = q$ for cases in which p, q and x are all nonnegative rational numbers.	***Strategies and Methods*** ● Students should have opportunities to use concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction and multiplication and division when solving one-step equations. ● Students should be able to solve equations presented in applicable, mathematical problems involving positive rational numbers using number sense, properties of arithmetic and the idea of maintaining equality on both sides of the equation. ● Students should be able to interpret a solution in the original context and assess the reasonableness of results.
6.PAR.7.4	Recognize and generate inequalities of the form $x > c$, $x \geq c$, $x < c$, or $x \leq c$ to explain situations that have infinitely many solutions; represent solutions of such inequalities on a number line.	***Strategies and Methods*** ● Students should represent authentic, mathematical situations using inequalities involving variables. ● Students should be able to create practical, mathematical situations corresponding to specific inequalities. ● This objective includes the use of the symbols: $<, >, =, \leq, \geq$.

6.PAR.8: Graph rational numbers as points on the coordinate plane to represent and solve contextual, mathematical problems; draw polygons using the coordinates for their vertices and find the length of a side of a polygon.				
Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**		
6.PAR.8.1	Locate and position rational numbers on a horizontal or vertical number line; find and position pairs of integers and other rational numbers on a coordinate plane.	***Fundamentals*** ● Students should use numerical and graphical reasoning to plot points in all four quadrants on the coordinate plane.	***Strategies and Methods*** ● Students should extend understanding of number lines and coordinate axes from previous grades to represent points on the line and in the plane with negative number coordinates.	
6.PAR.8.2	Show and explain that signs of numbers in ordered pairs indicate locations in quadrants of the coordinate plane and determine how two ordered pairs may differ based only on the signs.	***Fundamentals*** ● Students should use numerical and graphical reasoning to interpret points in all four quadrants on the coordinate plane based on the signs.	***Strategies and Methods*** ● Students should use numerical and graphical reasoning to show and explain the relationship between ordered pairs and location in quadrants of the coordinate plane.	***Example*** ● A student is able to compare and explain that (1, 2) is in the first quadrant whereas (1, -2) is in the fourth quadrant because the y-coordinate is negative and the two points are the same distance from the horizontal axes in different directions. 
6.PAR.8.3	Solve 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 x-coordinate or the same y-coordinate.	***Relevance and Application*** ● Students should be able to solve relevant, mathematical problems when graphing points.	***Strategies and Methods*** ● Students should be expected to solve relevant problems within the context of a graph only.	
6.PAR.8.4	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 x-coordinate or the same y-coordinate.	***Relevance and Application*** ● Students should apply the techniques of graphing in the coordinate plane to solve relevant problems involving the application of algebra through geometry.	***Strategies and Methods*** ● Students should be able to solve problems with polygons when given coordinate pairs with or without a coordinate grid.	

7th Grade

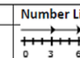
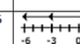
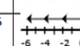
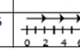
The seven standards listed below are the key content competencies students will be expected to master in seventh grade. Additional clarity and details are provided through the classroom-level learning objectives and evidence of student learning details for each grade-level standard found on subsequent pages of this document. As teachers are planning instruction and assessing mastery of the content at the grade level, the focus should remain on the key competencies listed in the table below.

COURSE STANDARDS
7.MP: **Display perseverance and patience in problem-solving. Demonstrate skills and strategies needed to succeed in mathematics, including critical thinking, reasoning, and effective collaboration and expression. Seek help and apply feedback. Set and monitor goals.**
7.NR.1: **Solve relevant, mathematical problems, including multi-step problems, involving the four operations with rational numbers and quantities in any form (integers, percentages, fractions, and decimal numbers).**
7.PAR.2: **Use properties of operations, generate equivalent expressions and interpret the expressions to explain relevant situations.**
7.PAR.3: **Represent authentic situations using equations and inequalities with variables; solve equations and inequalities symbolically, using the properties of equality.**
7.PAR.4: **Recognize proportional relationships in relevant, mathematical problems; represent, solve, and explain these relationships with tables, graphs, and equations.**
7.GSR.5: **Solve practical problems involving angle measurement, circles, area of circles, surface area of prisms and cylinders, and volume of cylinders and prisms composed of cubes and right prisms.**
7.PR.6: **Using mathematical reasoning, investigate chance processes and develop, evaluate, and use probability models to find probabilities of simple events presented in authentic situations.**

Georgia's K-12 Mathematics Standards – 2021

7TH Grade

<table>
<tr><td colspan="4">NUMERICAL REASONING – integers, percentages, fractions, decimal numbers</td></tr>
<tr><td colspan="4">7.NR.1: Solve relevant, mathematical problems, including multi-step problems, involving the four operations with rational numbers and quantities in any form (integers, percentages, fractions, and decimal numbers).</td></tr>
<tr><th colspan="2">Expectations</th><th colspan="2">Evidence of Student Learning
(not all inclusive; see Grade Level Overview for more details)</th></tr>
<tr><td>7.NR.1.1</td><td>Show that a number and its opposite have a sum of 0 (are additive inverses). Describe situations in which opposite quantities combine to make 0.</td><td>Terminology
● In the equation 3 + −3 = 0, 3 and −3 are additive inverses of each other.</td><td>Example
● Your bank account balance is − $25.00. You deposit $25.00 into your account. The net balance is $0.00.</td></tr>
<tr><td>7.NR.1.2</td><td>Show and explain 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. Interpret sums of rational numbers by describing applicable situations.</td><td>Strategies and Methods
● Students should be able to add and subtract integers and other rational numbers presented within relevant, mathematical problems, using strategic thinking and a variety of tools.</td><td>Example
● 6 + (–4) is 4 units to the left of 6 on a horizontal number line or 4 units down from 6 on a vertical number line.</td></tr>
<tr><td>7.NR.1.3</td><td>Represent addition and subtraction with rational numbers on a horizontal or a vertical number line diagram to solve authentic problems.</td><td colspan="2">Strategies and Methods
● Students should represent a variety of types of rational numbers on a number line diagram presented both horizontally and vertically.</td></tr>
<tr><td>7.NR.1.4</td><td>Show and explain subtraction of rational numbers as adding the additive inverse, p – q = p + (–q). Show that the distance between two rational numbers on the number line is the absolute value of their difference and apply this principle in contextual situations.</td><td colspan="2">Examples
● Find the distance between a submarine submerged at a depth of 27 $\frac{3}{4}$ feet below sea level and an airplane flying at an altitude of 1262 $\frac{1}{2}$ feet above sea level.
● $-\frac{1}{2}-(-2)$ is the same expression as $-\frac{1}{2}+-(-2)$, which is 2 units to the right of $-\frac{1}{2}$ on a horizontal number line or 2 units up from $-\frac{1}{2}$ on a vertical number line.</td></tr>
<tr><td>7.NR.1.5</td><td>Apply properties of operations, including part-whole reasoning, as strategies to add and subtract rational numbers.</td><td colspan="2">Fundamentals
● Students should be allowed to explore the signs of integers and what they really mean to discover integer rules.
Strategies and Methods
● Students should be able to use the Commutative and Associative properties to combine more than two rational numbers flexibly.
Terminology
● Part-whole reasoning refers to how numbers can be split into parts to add and subtract numbers more efficiently.
Example
● (–8) + 5 + (–2) may be solved as (–8) +(–2) + 5 to first make –10 by using the Commutative Property.</td></tr>
</table>

<table>
<tr><td>7.NR.1.6</td><td>Make sense of multiplication of rational numbers using realistic applications.</td><td colspan="2">Strategies and Methods
● Student should have opportunities to use concepts of repeated addition and the meaning of a negative sign as the “opposite of,” with both models and representations, leading to deriving the rules for multiplying signed numbers.
● Models may include, but are not limited to, number lines and counters.</td><td colspan="2">Examples
● 4 * (–5) is 4 groups of (–5) and (–4) * (–3) is the opposite of 4 * (–3).
● If yellow counters represent positive amounts and red counters represent negative amounts, you can model 3 * (–2) as three groups of two red counters.
● David has a $0.00 balance in his bank account. He makes three withdrawals of $1.46 each. What is his bank account balance after the three withdrawals?</td></tr>
<tr><td>7.NR.1.7</td><td>Show and explain that integers can be divided, assuming the divisor is not zero, and every quotient of integers is a rational number.</td><td colspan="2">Fundamentals
● If p and q are integers (q ≠ 0), then $-\left(\frac{p}{q}\right)$= $\frac{(-p)}{q}$ = $\frac{p}{(-q)}$.</td><td colspan="2">Example
● $-\left(\frac{20}{5}\right) = -4$ is the same as $\frac{(-20)}{5} = -4$ and $\frac{20}{(-5)}$ = -4</td></tr>
<tr><td>7.NR.1.8</td><td>Represent the multiplication and division of integers using a variety of strategies and interpret products and quotients of rational numbers by describing them based on the relevant situation.</td><td>Fundamentals
● Students should be allowed to explore the signs of integers and what they really mean to discover integer rules.</td><td>Strategies and Methods
● Students can represent multiplication and division using number lines, counters, etc.</td><td colspan="2">Example
● Create a model and realistic situations for each of the products. Write and model the family of equations related to 2 × 3 = 6.
<table><tr><th>Equation</th><th>Number Line Model</th><th>Context</th></tr><tr><td>$2 \times 3 = 6$</td><td></td><td>Selling two packages of apples at $3.00 per pack</td></tr><tr><td>$2 \times -3 = -6$</td><td></td><td>Spending 3 dollars each on 2 packages of apples</td></tr><tr><td>$-2 \times 3 = -6$</td><td></td><td>Owing 2 dollars to each of your three friends</td></tr><tr><td>$-2 \times -3 = 6$</td><td></td><td>Forgiving 3 debts of $2.00 each</td></tr></table></td></tr>
<tr><td>7.NR.1.9</td><td>Apply properties of operations as strategies to solve multiplication and division problems involving rational numbers represented in an applicable scenario.</td><td colspan="2">Fundamentals
● Students should be allowed to explore the signs of integers and what they really mean to discover integer rules.
● Students should be able to reason about direction on a number line when representing multiplication and division using the tool.</td><td>Strategies and Methods
● Students should be able to use the Commutative and Associative properties to combine more than two rational numbers flexibly.</td><td>Example
● (– 8) * 2 * (–5) may be solved as (– 8) * (2*(–5)) to multiply by negative ten, using the Associative Property.</td></tr>
<tr><td>7.NR.1.10</td><td>Convert rational numbers between forms to include fractions, decimal numbers and percentages, using understanding of the part divided by the whole. Know that the decimal form of a rational number terminates in 0s or eventually repeats.</td><td colspan="2">Fundamentals
● This is an extension of previous understanding from 6th grade of writing common fractions as decimal numbers and percentages.</td><td colspan="2">Age/Developmentally Appropriate
● Students should know that every rational number can be written as the ratio of two integers, terminating decimal numbers, or repeating decimal numbers.</td></tr>
</table>

7.NR.1.11	Solve multi-step, contextual problems involving rational numbers, converting between forms as appropriate, and assessing the reasonableness of answers using mental computation and estimation strategies.	***Example*** ● If Sara makes \$25 an hour gets a 10% raise, she will make an additional $\frac{1}{10}$ of her salary an hour, or \$2.50, for a new salary of \$27.50.

***PATTERNING & ALGEBRAIC REASONING** – linear expressions with rational coefficients, complex unit rates, proportional relationships*

7.PAR.2: Use properties of operations, generate equivalent expressions and interpret the expressions to explain relevant situations.

Expectations		Evidence of Student Learning (not all inclusive; see Grade Level Overview for more details)	
7.PAR.2.1	Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.	***Fundamentals*** ● Building on work in Grade 6, where students used conventions about the order of operations to rewrite simple expressions such as 2(3 + 8x) as 6 +16x and 10p-2 as 2(5p-1), students now encounter linear expressions with more operations that require an understanding of integers, such as 7 - 2(3 - 8x).	***Examples*** ● A rectangle is twice as long as it is wide. One way to write an expression to find the perimeter would be w + w + 2w + 2w. Write the expression in two other ways. ● Write an equivalent expression for 9 – 7(2x + 4).
7.PAR.2.2	Rewrite an expression in different forms from a contextual problem to clarify the problem and show how the quantities in it are related.	***Example*** ● If Madison and Brenda both get paid a wage of \$11 per hour, but Madison was paid an additional \$55 for overtime, the expression 11(M+B) + 55 may be more clearly interpreted as 11M+55+11B for purposes of understanding Brenda's pay separated from Madison's pay.	

7.PAR.3: Represent authentic situations using equations and inequalities with variables; solve equations and inequalities symbolically, using the properties of equality.

Expectations		Evidence of Student Learning (not all inclusive; see Grade Level Overview for more details)				
7.PAR.3.1	Construct algebraic equations to solve practical problems leading to equations of the form px + q = r and p(x + q) = r, where p, q, and r are specific rational numbers. Interpret the solution based on the situation.	***Strategies and Methods*** ● Students should be able to represent relationships in various practical, mathematical situations with equations involving variables and positive and negative rational numbers and explain the	***Fundamentals*** ● Students should be able to fluently solve equations of the specified forms presented in	***Terminology*** ● Fluently/Fluency – Students choose flexibly among methods and strategies to solve mathematical problems accurately and efficiently.	***Age/Developmentally Appropriate*** ● Continue to build on 6th grade objectives of writing and solving one-step equations from a problem situation to multi-step	***Examples*** ● Vicky and Bob went to a store to buy school supplies. Vicky spent a total of \$22 on school supplies. She spent \$13 on a book and spent the rest of the money on notebooks. The store sells notebooks for \$1.50 each. Without using a variable,

		meaning of the solution based on the situation. • Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach.	the learning objective. • Students should use the properties of equality to solve for the value of a variable.		problem situations. This is another opportunity for students to practice using rational numbers including: integers, and positive and negative fractions and decimal numbers.	determine the number of notebooks Vicky bought. • Write an equation that can be used to find the number of notebooks Vicky bought. Use the variable v for the number of notebooks. Solve the equation. Explain the similarities and differences between finding the number of notebooks Vicky bought with and without a variable, paying attention to the sequence of your operations.

7.PAR.3.2	Construct algebraic inequalities to solve problems, leading to inequalities of the form $px \pm q > r$, $px \pm q < r$, $px \pm q \le r$, or $px \pm q \ge r$, where p, q, and r are specific rational numbers. Graph and interpret the solution based on the realistic situation that the inequalities represent.	***Strategies and Methods*** • Students should be able to represent relationships in various authentic, mathematical situations with inequalities involving variables and positive and negative rational numbers. • Students should be able to fluently solve inequalities of the specified forms. To achieve fluency, students should be able to choose flexibly among methods and strategies to solve mathematical problems accurately and efficiently. • Students should use the properties of inequality to solve for the value of a variable. • When identifying a specific value for p, q, and r, any rational number can be used. • Students should be able to graph and interpret the solution of an inequality used as a model to explain real phenomena.	***Example*** • As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make and describe the solutions.

7.PAR.4: Recognize proportional relationships in relevant, mathematical problems; represent, solve, and explain these relationships with tables, graphs, and equations.

Expectations		Evidence of Student Learning **(not all inclusive; see Grade Level Overview for more details)**	
7.PAR.4.1	Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units presented in realistic problems.	***Strategies and Methods*** • Students should be able to solve problems involving unit rate presented in practical, everyday situations.	***Example*** • If a person walks $\frac{1}{2}$ mile in each $\frac{1}{4}$ hour, compute the unit rate as the complex fraction $(\frac{1}{2})/(\frac{1}{4})$ miles per hour, equivalently 2 miles per hour.

7.PAR.4.2	Determine the unit rate (constant of proportionality) in tables, graphs (1, r), equations, diagrams, and verbal descriptions of proportional relationships to solve realistic problems.	***Age/Developmentally Appropriate*** ● In seventh grade, students are expected to understand that unit rate and constant of proportionality are the same.	***Examples*** ● Jennifer rides on a train for 6 hours and travels 360 miles. How many miles per hour does she travel? ● Mary deposits $115 into her bank account every month, represented by the equation d = 115m. Identify the unit rate from this situation.
7.PAR.4.3	Determine whether two quantities presented in authentic problems are in a proportional relationship.	***Strategies and Methods*** ● Students should be able to analyze and make decisions about relationships using proportional reasoning strategies, which may include but not limited to graphing on a coordinate plane and/or observing whether a graph is a straight line passing through the origin.	***Examples*** ● If Tina uses 2 eggs to make 6 pancakes and Allison uses 4 eggs to make 12 pancakes, is this proportional? ● Jane runs 12 miles in 2.5 hours. Sarah runs 14 miles 3.5 hours. Are Jane and Sarah running at the same rate? Justify your answer.
7.PAR.4.4	Identify, represent, and use proportional relationships.	***Strategies and Methods*** ● Student should be able to identify, represent, and use proportional relationships between quantities using verbal descriptions, tables of values, equations, and graphs to model applicable, mathematical problems: translate from one representation to another. ● Students should be able to model authentic, mathematical relationships involving constant rates where the initial condition starts at 0 using tables of values and graphs. ● Students should be able to represent proportional relationships using equations.	***Example*** ● If the 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 = np.
7.PAR.4.5	Use context to 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.	***Example*** ● Erik feeds stray cats near his house. A graph shows different amounts of cat food he puts out based on the number of cats near his house. Erik graphs point P to represent the unit rate. What does point P mean in terms of the situation? Cups of cat food per cat.	
7.PAR.4.6	Solve everyday problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.	***Strategies and Methods*** ● Students should have opportunities to use proportional reasoning to compute unknown lengths by setting up proportions in tables or equations, or they can reason about how the lengths compare multiplicatively. ● Students should be able to determine the dimensions of figures when given a scale and identify the impact of a scale on actual length (one-dimension) and area (two–dimensions). Students should be able to identify the scale factor given two figures.	***Fundamentals*** ● Students should be given opportunities to explore the concept of similarity informally when learning about scale drawings of geometric figures. They should be able to make informal connections between scale drawings and similarity.

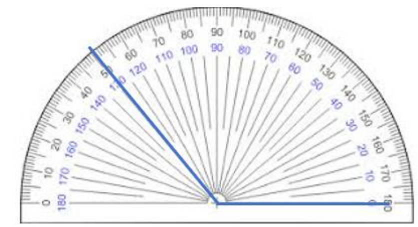
<table>
<tr>
<td></td>
<td></td>
<td>Using a given scale drawing, students should be able to reproduce the drawing at a different scale. Students should understand that the lengths will change by a factor equal to the product of the magnitude of the two size transformations.
Students should be given opportunities to explore the concept of similarity by exploring the congruence of corresponding angles and the proportions of corresponding side lengths of geometric figures using hands-on, concrete tools to understand similarity (i.e., patty paper, geometric software).</td>
<td></td>
</tr>
<tr>
<td>7.PAR.4.7</td>
<td>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.</td>
<td colspan="2">Strategies and Method
Students should be able to use proportional reasoning to explain why the slope, m, is the same between any two distinct points.</td>
</tr>
<tr>
<td>7.PAR.4.8</td>
<td>Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.</td>
<td>Fundamentals
Students should demonstrate a conceptual understanding of slope.
Students should be able to use graphical reasoning to represent proportional relationships. The proportional relationships explored by students should represent practical, realistic situations.</td>
<td>Examples
Compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.
Mark was looking to fertilize his lawn, which is 432 sq. ft. He read the packages of 2 different fertilizer bags to see how much should be used. Bag A stated 2 ounces per 4 square feet and Bag B can be represented using the table below:
<table>
<tr><td>Ounces</td><td>2</td><td>4</td><td>12</td></tr>
<tr><td>Square Feet</td><td>3</td><td>6</td><td>18</td></tr>
</table>
What is the unit rate for each bag? Which bag should Mark purchase for his lawn? Why?</td>
</tr>
<tr>
<td>7.PAR.4.9</td>
<td>Use proportional relationships to solve multi-step ratio and percent problems presented in applicable situations.</td>
<td>Strategies and Methods
Students may use flexible strategies such as a + 0.05a = 1.05a with the understanding that adding a 5% tax to a total is the same as multiplying the total by 1.05.</td>
<td>Terminology
Simple interest – a quick and easy method of calculating the interest charge on a loan. Simple interest is determined by multiplying the daily interest rate by the principal by the number of days that elapse between payments. Simple Interest = (principal) * (rate) * (# of periods)
Tax – money that people must pay to the government
Markups and markdowns - increase and decrease in the amount of a quantity
Gratuities - a tip given to a waiter, taxicab driver, etc.
Commissions - a fee paid to an agent as compensation for completing a transaction</td>
</tr>
<tr>
<td>7.PAR.4.10</td>
<td>Predict characteristics of a population by examining the characteristics of a representative sample. Recognize the potential limitations and scope of the sample to the population.</td>
<td colspan="2">Strategies and Methods
Students can generate questions about things they notice and wonder from a relevant situation. Questions posed should be ones that requires data that will vary.
Students should have opportunities to create and answer statistical investigative questions about a population by collecting data from a representative sample, using random sampling techniques to collect the data.
Students should be able to create a statistical investigative question that can be answered by gathering data from practical situations and determine strategies for gathering data to answer the statistical investigative question.
Potential limitations may include how the sample was selected and/or how the questions were asked.</td>
</tr>
</table>

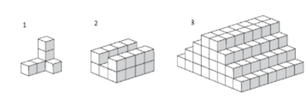
7.PAR.4.11	Analyze sampling methods and conclude that random sampling produces and supports valid inferences.	***Strategies and Methods*** ● Students should have opportunities to critique examples of sampling techniques. ● Students should conclude when conditions of sampling methods may be biased, random, and not representative of the population.	
7.PAR.4.12	Use data from repeated random samples to evaluate how much a sample mean is expected to vary from a population mean. Simulate multiple samples of the same size.	***Fundamentals*** ● Students should use sample data collected to draw inferences.	***Examples*** ● Estimate the mean word length in a book by randomly sampling words from the book. Gauge how far off the estimate is from the actual mean. ● Predict the winner of a school election based on randomly sampled survey data. Gauge how far off the prediction might be.

GEOMETRIC & SPATIAL REASONING *– vertical, adjacent, complementary, and supplementary angles, circumference and area of circles, area and surface area, volume of cubes, right prisms, and cylinders*

7.GSR.5: Solve practical problems involving angle measurement, circles, area of circles, surface area of prisms and cylinders, and volume of cylinders and prisms composed of cubes and right prisms.

Expectations		Evidence of Student Learning **(not all inclusive; see Grade Level Overview for more details)**			
7.GSR.5.1	Measure angles in whole non-standard units.	***Fundamentals*** ● Students should be able to recognize angles as geometric shapes formed when two rays share a common endpoint. In previous grades, students learned to draw and measure right, acute, and obtuse angles. ● To understand measurement, students should measure in non-standard units, such as unit angles or wedges, before being introduced to tools with abstract units such as degrees. ● Students should also be able to explore this learning objective by investigating angles within circles.	***Example*** ● Fold a circle of patty paper or waxed paper in half four times to create an angle measuring tool with 16 wedges. This protractor can be used to determine the number of units (wedges) in an angle.		
7.GSR.5.2	Measure angles in whole number degrees using a protractor.	***Age/Developmentally Appropriate*** ● Students should be able to use a 180° protractor to draw or measure an angle to the nearest whole degree.	***Fundamentals*** ● In previous grades, students measured angles in reference to a circle with the center at the common endpoint of two rays. They should be able to use this knowledge to determine an angle's measure in relation to the 360	***Strategies and Methods*** ● Students should be able to use hand-held and virtual protractors. ● Student should be able to use angle measurement tools that help them connect non-standard units (wedges, unit angles, etc.) to standard units of angle measurement (degrees).	***Examples*** ● Students may be given angles to find precise measurements of angles. Here is an example of how students may use a protractor and measurement reasoning to determine precise angle measurements.

			degrees in a circle through division or as a missing factor problem.		 *Sample student response:* *The angle measures 130 degrees.*
7.GSR.5.3	Use facts about supplementary, complementary, vertical, and adjacent angles in a multi-step problem to write and solve equations for an unknown angle in a figure.	***Age and Developmentally Appropriate*** ● Students should be able to use a 180° protractor to draw or measure an angle to the nearest whole degree to write and solve equations. ● Reflex angles are not an expectation at this grade level.	***Fundamentals*** ● In previous grades, students have studied angles by type according to size: acute, obtuse, and right, and their role as an attribute in polygons. Now angles are considered based upon the special relationships that exist among them: supplementary, complementary, vertical, and adjacent angles. ● Students should be able to use relationships to write and solve equations for multi-step problems.	***Terminology*** ● Supplementary angles – two angles add up to 180 degrees ● Complementary angles – two angles add up to 90 degrees ● Vertical angles – angles opposite each other when two lines intersect. ● Adjacent angles – Two angles that have a common side and a common vertex (corner point), and do not overlap.	
7.GSR.5.4	Explore and describe the relationship between pi, radius, diameter, circumference, and area of a circle to derive the formulas for the circumference and area of a circle.	***Strategies and Methods*** ● Students should use proportional reasoning to explain the relationship between the diameter and circumference of a circle and that the unit rate (constant of proportionality) is π in order to derive the formulas for the circumference and area of a circle.	***Age/Developmentally Appropriate*** ● Square roots are an 8th grade expectation.	***Terminology*** ● ***Special Note:*** The terms pi, radius, diameter, and circumference are new academic vocabulary for students. ● Pi - The ratio of a circle's circumference to its diameter. ● Radius - The distance from the center to the circumference of a circle. ● Diameter - The distance from one point on a circle through the center to another point on the circle. ● Circumference - The distance around the edge of a circle.	
7.GSR.5.5	Given the formula for the area and circumference of a circle, solve problems that exist in everyday life.	***Age/Developmentally Appropriate*** ● Students should be given the formula for area and circumference of a circle when solving problems.	***Example*** ● The seventh-grade class is building a mini golf game for the school carnival. The end of the putting green will be a circle. If the circle is 10 feet in diameter, how many square feet of grass carpet will they need to buy to cover the circle? How might you communicate this information to the salesperson to make sure you receive a piece of carpet that is the correct size? $A = \pi r^2$ OR $C = 2\pi r$		

7.GSR.5.6	Solve realistic problems involving surface area of right prisms and cylinders.	***Age/Developmentally Appropriate*** ● Students should solve problems involving surface areas of prisms with triangles, rectangles, and other polygons as bases. ● Students are not expected to memorize formulas to solve problems involving surface area.	***Strategies and Methods*** ● Students should have an opportunity to solve single to multi-step authentic, mathematical problems. ● Students should have opportunities to apply knowledge of the area of triangles, rectangles, and other polygons to solve problems involving surface area of prisms. ● Students should have opportunities to discover the surface area of a cylinder by decomposing the figure into circles and rectangles. ● Students should use geometric and spatial reasoning to solve problems involving surface area.	***Terminology*** ● Cylinder – any three-dimensional figure with two congruent, opposite faces called bases connected by adjacent curved or flat faces (bases can include circles, triangles, rectangles, or other shapes). The bases can be connected by two lines that are parallel to each other. ● Right prism – any three-dimensional figure with two polygons for bases that are opposite, congruent, and perpendicular to the adjacent faces ● The inclusive definition of a cylinder classifies prisms as special types of cylinders used to derive formulas that apply to all types of cylinders and prisms alike. (Van de Walle, Karp, & Bay-Williams, 2010) ● All prisms are cylinders, but not all cylinders are prisms. (Van de Walle, Karp, Lovett & Bay-Williams, 2010)	***Example*** ● Cole is planning to cover a cylindrical drum in leather. The diameter of the drum is 10 inches, and its height is 16 inches. What is the minimum amount of leather Cole will need? 
7.GSR.5.7	Describe the two-dimensional figures (cross sections) that result from slicing three-dimensional figures, as in the plane sections of right rectangular prisms, right rectangular pyramids, cones, cylinders, and spheres.	***Age/Developmentally Appropriate*** ● Cross-sections should be limited to horizontal and vertical slices.	***Strategies and Methods*** ● Students should have opportunities to explore models of right rectangular prisms, right rectangular pyramids, cones, cylinders, and spheres that can be sliced. ● Students should determine the different planes that can be created with the slices.	***Fundamentals*** ● Students should conclude the resulting two-dimensional shape created after the slice is not the entire three-dimensional shape that remains. ● In seventh grade, cross sections should be limited to horizontal and vertical slices.	***Terminology*** ● Prism – a solid figure that has the same cross section all along its length
7.GSR.5.8	Explore volume as a measurable attribute of cylinders and right prisms. Find the volume of these geometric figures using concrete problems.	***Strategies and Methods*** ● Students should apply knowledge of cross sections as a strategy for revealing a base of cylinders including right prisms.	***Terminology*** ● Cylinder – any three-dimensional figure with two congruent, opposite faces called bases connected by adjacent curved or flat	***Age/Developmentally Appropriate*** ● Cylinders explored in Grade 7 should be limited to right circular	***Examples*** ● Identical toy building cubes were used to make the stacks shown below. 	

		• Students should apply reasoning about the volume of rectangular prisms to explore the volume of cylinders and other three-dimensional objects composed of cubes and right prisms. • Students should apply their knowledge of area of a circle when finding the volume of a cylinder. • Students should use the formula Volume = area of the base times height or V = B x h to find the volume of a cylinder.	faces (bases can include circles, triangles, rectangles, or other shapes). The bases can be connected by two lines that are parallel to each other. • Right prism – any three-dimensional figure with two polygons for bases that are opposite, congruent, and perpendicular to the adjacent faces. • The inclusive definition of a cylinder classifies prisms as special types of cylinders used to derive formulas that apply to all types of cylinders and prisms alike. (Van de Walle, et.al., 2010) • All prisms are cylinders, but not all cylinders are prisms. (Van de Walle, Karp, Lovett & Bay-Williams, 2010) • The formula for volume used in Grade 7 is V = B (area of the base) x h (height), where B=area of the base, h = height.	cylinders. Right circular cylinders are three-dimensional solid figures with two congruent, parallel, circular bases that are connected by a curved face that is perpendicular to each base. • Students should explore experimentally and conceptually the hierarchy of cylinders and prisms.	Which stack takes up the least space? Which stack takes up the most space? Order the stacks from the one that takes up the least space to the one that takes up the most space. • A farmer is storing ground corn in a silo during the winter months. What is the maximum capacity of the cylindrical part of each silo that has a 20-foot diameter and a 55-foot height for which the farmer can store the ground corn? 

***PROBABILITY REASONING** – likelihood, theoretical and experimental probability*

7.PR.6: Using mathematical reasoning, investigate chance processes and develop, evaluate, and use probability models to find probabilities of simple events presented in authentic situations.

Expectations		Evidence of Student Learning (not all inclusive; see Grade Level Overview for more details)		
7.PR.6.1	Represent the probability of a chance event as a number between 0 and 1 that expresses the likelihood of the event occurring. Describe that a probability near 0 indicates an unlikely event, a probability around $\frac{1}{2}$ indicates an event that is neither unlikely nor likely, and a probability near 1 indicates a likely event.	***Strategies and Methods*** ● Students should be able to represent the probability as a fraction, decimal numbers, or percentage.	***Terminology*** ● Descriptions may include impossible, unlikely, equally likely, likely, and certain.	
7.PR.6.2	Approximate the probability of a chance event by collecting data on an event and observing its long-run relative frequency will approach the theoretical probability.	***Strategies and Methods*** ● Students should be able to predict the approximate, relative frequency given the theoretical probability.	***Example*** ● When rolling a number cube 600 times, predict that a 3 or 6 would be rolled roughly 200 times, but probably not exactly 200 times.	
7.PR.6.3	Develop a probability model and use it to find probabilities of simple events. Compare experimental and theoretical probabilities of events. If the probabilities are not close, explain possible sources of the discrepancy.	***Strategies and Methods*** ● Probability models may include various random generation devices including, but not limited to, bag pulls, spinners, number cubes, coin toss, and colored chips. ● Students should have multiple opportunities to collect data using physical objects, graphing calculators, or web-based simulations.	***Example*** ● Kim calculates the probability of landing on heads when tossing a coin to be 50%. She uses this to predict that when Tiffany tosses a coin 20 times, the coin will land on heads 10 times. When Tiffany performed the experiment, the coin landed on heads 7 times. Explain possible reasons why Kim's prediction and Tiffany's results do not match.	
7.PR.6.4	Develop a uniform probability model by assigning equal probability to all outcomes and use the model to determine probabilities of events.	***Example*** ● If a student is selected at random from a class, find the probability a student with long hair will be selected.		
7.PR.6.5	Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process.	***Terminology*** ● Uniform probability models are those where the likelihood of each outcome is equal.	***Examples*** ● Find the approximate probability of each outcome in a spinner with unequal sections. ● Find the approximate probability that a spinning penny will land heads up or that a tossed paper cup will land open-end down. Do the outcomes for the spinning penny appear to be equally likely based on the observed frequencies?	
7.PR.6.6	Use appropriate graphical displays and numerical summaries from data distributions with categorical or quantitative (numerical) variables as probability models to draw	***Strategies and Methods*** ● Students should use side by side bar graphs or segmented bar graphs to compare categorical data distributions	***Age/Developmentally Appropriate*** ● Limit category counts to be less than or equal to ten.	***Example*** ● Compare the heights of the basketball and the tennis teams.

	informal inferences about two samples or populations.	of samples from two populations. ● Students should compare data of two samples or populations displayed in box plots and dot plots to make inferences using probabilistic reasoning. ● Students should be able to draw inferences using measures of central tendency (mean, median, mode) and/or variability (range, mean absolute deviation and interquartile range) from random samples. ● Conclusions should be made related to a population, using a random sample, by describing a distribution using measures of central tendency (mean, median, mode) and/or variability (range, mean absolute deviation, and interquartile range). ● Students should be given multiple opportunities to compare quantitative data distributions of samples from two populations.	● Limit quantitative variables to less than or equal to 20.	Basketball team's heights (in inches): 72, 75, 76, 76, 79, 79, 80, 80, 81, 81, 81 Tennis team's height (in inches): 67, 67, 68, 70, 70, 71, 72, 75, 76, 76, 77 1) How much taller is the basketball team than the tennis team? 2) Two students are trying out for the basketball team. What is the probability their height will be greater than 79 inches?

8th Grade

The eight standards listed below are the key content competencies students will be expected to master in eighth grade. Additional clarity and details are provided through the classroom-level learning objectives and evidence of student learning details for each grade-level standard found on subsequent pages of this document. As teachers are planning instruction and assessing mastery of the content at the grade level, the focus should remain on the key competencies listed in the table below.

COURSE STANDARDS
8.MP: **Display perseverance and patience in problem-solving. Demonstrate skills and strategies needed to succeed in mathematics, including critical thinking, reasoning, and effective collaboration and expression. Seek help and apply feedback. Set and monitor goals.**
8.NR.1: **Solve problems involving irrational numbers and rational approximations of irrational numbers to explain realistic applications.**
8.NR.2: **Solve problems involving radicals and integer exponents including relevant application situations; apply place value understanding with scientific notation and use scientific notation to explain real phenomena.**
8.PAR.3: **Create and interpret expressions within relevant situations. Create, interpret, and solve linear equations and linear inequalities in one variable to model and explain real phenomena.**
8.PAR.4: **Show and explain the connections between proportional and non-proportional relationships, lines, and linear equations; create and interpret graphical mathematical models and use the graphical, mathematical model to explain real phenomena represented in the graph.**
8.FGR.5: **Describe the properties of functions to define, evaluate, and compare relationships, and use functions and graphs of functions to model and explain real phenomena.**
8.FGR.6: **Solve practical, linear problems involving situations using bivariate quantitative data.**
8.FGR.7: **Justify and use various strategies to solve systems of linear equations to model and explain realistic phenomena.**
8.GSR.8: **Solve contextual, geometric problems involving the Pythagorean Theorem and the volume of geometric figures to explain real phenomena.**

Georgia’s K-12 Mathematics Standards - 2021

8^{TH} Grade

<table>
<tr><td colspan="6">NUMERICAL REASONING – rational and irrational numbers, decimal expansion, integer exponents, square and cube roots, scientific notation</td></tr>
<tr><td colspan="6">8.NR.1: Solve problems involving irrational numbers and rational approximations of irrational numbers to explain realistic applications.</td></tr>
<tr><th colspan="2">Expectations</th><th colspan="4">Evidence of Student Learning
(not all inclusive; see Grade Level Overview for more details)</th></tr>
<tr>
<td>8.NR.1.1</td>
<td>Distinguish between rational and irrational numbers using decimal expansion. Convert a decimal expansion which repeats eventually into a rational number.</td>
<td>Strategies and Methods
● Students should be provided with experiences to use numerical reasoning when describing decimal expansions.
● Students should be able to classify real numbers as rational or irrational.
● Students should know that when a square root of a positive integer is not an integer, then it is irrational.
● Students should use prior knowledge about converting fractions to decimals learned in 6th and 7th grade to connect changing decimal expansion of a repeating decimal into a fraction and a fraction into a repeating decimal.
● Emphasis is placed on how all rational numbers can be written as an equivalent decimal. The end behavior of the decimal determines the classification of the number.</td>
<td>Age/Developmentally Appropriate
● This specific example is limited to the tenths place; however, the concept for this grade level extends to the hundredths place.</td>
<td>Terminology
● Rational numbers are those with decimal expansions that terminate in zeros or eventually repeat.
● Irrational numbers are non-terminating, non-repeating decimals.</td>
<td>Example
● Change $0.\overline{4}$ to a fraction
1. Let x = 0.4444444 …
2. 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 …

3. Subtract the original equation from the new equation.

$10x$ = 4.4444444 …
x = 0.44444 …
$9x = 4$
4. Solve the equation to determine the equivalent fraction.
$9x = 4$
$x = 4/9$</td>
</tr>
<tr>
<td>8.NR.1.2</td>
<td>Approximate irrational numbers to compare the size of irrational numbers, locate them approximately on a number line, and estimate the value of expressions.</td>
<td>Strategies and Methods
● Students should use visual models and numerical reasoning to approximate irrational numbers.</td>
<td colspan="3">Example
● By estimating the decimal expansion of $\sqrt{17}$, show that $\sqrt{17}$ is between 4 and 5 and closer to 4 on a number line.</td>
</tr>
</table>

8.NR.2: Solve problems involving radicals and integer exponents including relevant application situations; apply place value understanding with scientific notation and use scientific notation to explain real phenomena.				
Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**		
8.NR.2.1	Apply the properties of integer exponents to generate equivalent numerical expressions.	***Strategies and Methods*** ● Students should use numerical reasoning to identify patterns associated with properties of integer exponents. ● The following properties should be addressed: product rule, quotient rule, power rule, power of product rule, power of a quotient rule, zero exponent rule, and negative exponent rule.		***Example*** $3^2 \times 3^{(-5)} = 3^{(-3)} = \frac{1}{(3^3)} = \frac{1}{27}$
8.NR.2.2	Use square root and cube root symbols to represent solutions to equations. Recognize that $x^2 = p$ (where p is a positive rational number and $\lvert x \rvert \leq 25$) has two solutions and $x^3 = p$ (where p is a negative or positive rational number and $\lvert x \rvert \leq 10$) has one solution. Evaluate square roots of perfect squares ≤ 625 and cube roots of perfect cubes ≥ -1000 and ≤ 1000.	***Strategies and Methods*** ● Students should be able to find patterns within the list of square numbers and then with cube numbers. ● Students should be able to 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.	***Fundamentals*** ● Equations should include rational numbers such as $x^2 = \frac{1}{4}$.	***Example*** ● $\sqrt{64} = \sqrt{8^2} = 8$ and $\sqrt[3]{(5^3)} = 5$. Since $\sqrt{p}$ is defined to mean the positive solution to the equation $x^2 = p$ (when it exists). It is not mathematically correct to say $\sqrt{64} = \pm 8$ (as is a common misconception). In describing the solutions to $x^2 = 64$, students should write $x = \pm\sqrt{64} = \pm 8$.
8.NR.2.3	Use numbers expressed in scientific notation to estimate very large or very small quantities, and to express how many times as much one is than the other.	***Strategies and Methods*** ● Students should use the magnitude of quantities to compare numbers written in scientific notation to determine how many times larger (or smaller) one number written in scientific notation is than another. ● Students should have opportunities to compare numbers written in scientific notation in contextual, mathematical problems, including scientific situations.		***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.NR.2.4	Add, subtract, multiply and divide numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Interpret scientific notation that has been generated by technology (e.g., calculators or online technology tools).	***Fundamentals*** ● Students should use place value reasoning which supports the understanding of digits shifting to the left or right when multiplied by a power of 10.		***Strategies and Methods*** ● Students combine knowledge of integer exponent rules and scientific notation to perform operations with numbers expressed in scientific notation. ● Students should solve realistic problems involving scientific notation.

PATTERNING & ALGEBRAIC REASONING *– expressions, linear equations, and inequalities*			
8.PAR.3: Create and interpret expressions within relevant situations. Create, interpret, and solve linear equations and linear inequalities in one variable to model and explain real phenomena.			
Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**	
8.PAR.3.1	Interpret expressions and parts of an expression, in context, by utilizing formulas or expressions with multiple terms and/or factors.	***Fundamentals*** ● Students should build on their prior knowledge of understanding the parts of an expression to extend their understanding to more complex expressions with multiple terms and/or factors.	***Terminology*** ● Parts of an expression include terms, factors, coefficients, and operations.
8.PAR.3.2	Describe and solve linear equations in one variable with one solution (x = a), infinitely many solutions (a = a), or no solutions (a = b). 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).	***Strategies and Methods*** ● Students should use algebraic reasoning in their descriptions of the solutions to linear equations. ● Building upon skills from grade 7, students combine like terms on the same side of the equal sign and use the distributive property to simplify the equation when solving. Emphasis in this standard is also on using rational coefficients. Solutions of certain equations may elicit infinitely many or no solutions.	
8.PAR.3.3	Create and solve linear equations and inequalities in one variable within a relevant application.	***Strategies and Methods*** ● Students should use algebraic reasoning in their descriptions of the solutions to linear equations. ● Include linear equations and inequalities with rational number coefficients and whose solutions require expanding expressions using the distributive property and collecting like terms.	
8.PAR.3.4	Using algebraic properties and the properties of real numbers, justify the steps of a one-solution equation or inequality.	***Strategies and Methods*** ● Students should justify their own steps, or if given two or more steps of an equation, explain the progression from one step to the next using properties.	
8.PAR.3.5	Solve linear equations and inequalities in one variable with coefficients represented by letters and explain the solution based on the contextual, mathematical situation.	***Strategies and Methods*** ● Students should use algebraic reasoning to solve linear equations and inequalities in one variable.	***Example*** ● Given ax + 3 = 7, solve for x.
8.PAR.3.6	Use algebraic reasoning to fluently manipulate linear and literal equations expressed in various forms to solve relevant, mathematical problems.	***Strategies and Methods*** ● To achieve fluency, students should be able to choose flexibly among methods and strategies to solve mathematical problems accurately and efficiently. ● Students should rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations. Interpret and explain the results.	***Example*** ● Find the radius given the formula $V=\pi r^2h$ by rearranging the equation to solve for the radius, r.

<table>
<tr><td colspan="5">8.PAR.4: Show and explain the connections between proportional and non-proportional relationships, lines, and linear equations; create and interpret graphical mathematical models and use the graphical, mathematical model to explain real phenomena represented in the graph.</td></tr>
<tr><td colspan="2">Expectations</td><td colspan="3">Evidence of Student Learning
(not all inclusive; see Grade Level Overview for more details)</td></tr>
<tr><td>8.PAR.4.1</td><td>Use the equation y = mx (proportional) for a line through the origin to derive the equation y = mx + b (non-proportional) for a line intersecting the vertical axis at b.</td><td>Fundamentals
● Students should be given opportunities to explore how an equation in the form y = mx + b is a translation of the equation y = mx.
● In Grade 7, students had multiple opportunities to build a conceptual understanding of slope as they made connections to unit rate and analyzed the constant of proportionality for proportional relationships.
● Students should be given opportunities to explore and generalize that two lines with the same slope but different intercepts, are also translations of each other.
● Students should be encouraged to attend to precision when discussing and defining b (i.e., b is not the intercept; rather, b is the y-coordinate of the y-intercept). Students must understand that the x-coordinate of the y-intercept is always 0.</td><td>Strategies and Methods
● Students should be given the opportunity to explore and discover the effects on a graph as the value of the slope and y-intercept changes using technology.</td><td>Example
● The business model for a company selling a service with no flat cost charges $3 per hour. What would the equation be as a proportional equation? If the company later decides to charge a flat rate of $10 for each transaction with the same per hour cost, what would be the new equation? How do these two equations compare when analyzed graphically? What is the same? What is different? Why?</td></tr>
<tr><td>8.PAR.4.2</td><td>Show and explain that the graph of an equation representing an applicable situation in two variables is the set of all its solutions plotted in the coordinate plane.</td><td colspan="3">Strategies and Methods
● Students should use algebraic reasoning to show and explain that the graph of an equation represents the set of all its solutions.
● Students continue to build upon their understanding of proportional relationships, using the idea that one variable is conditioned on another.
● Students should relate graphical representations to contextual, mathematical situations.
● Students should use tables to relate solution sets to graphical representations on the coordinate plane.</td></tr>
</table>

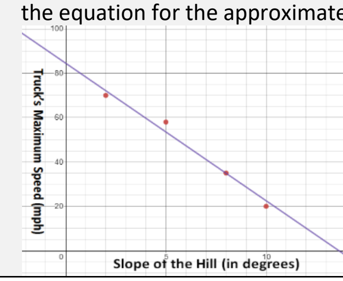
FUNCTIONAL & GRAPHICAL REASONING *–relate domain to linear functions, rate of change, linear vs. nonlinear relationships, graphing linear functions, systems of linear equations, parallel and perpendicular lines*

8.FGR.5: Describe the properties of functions to define, evaluate, and compare relationships, and use functions and graphs of functions to model and explain real phenomena.

Expectations		Evidence of Student Learning **(not all inclusive; see Grade Level Overview for more details)**
8.FGR.5.1	Show and explain that a function is a rule that assigns to each input exactly one output.	***Strategies and Methods*** ● Students should be able to use algebraic reasoning when formulating an explanation or justification regarding whether or not a relationship is a function or not a function. ● Describe the graph of a function as the set of ordered pairs consisting of an input and the corresponding output.
8.FGR.5.2	Within realistic situations, identify and describe examples of functions that are linear or nonlinear. Sketch a graph that exhibits the qualitative features of a function that has been described verbally.	***Strategies and Methods*** ● Students should be able to model practical situations using graphs and interpret graphs based on the situations. ● Students should model functions that are nonlinear and explain, using precise mathematical language, how to tell the difference between linear (functions that graph into a straight line) and nonlinear functions (functions that do not graph into a straight line). ● Students should analyze a graph by determining whether the function is increasing or decreasing, linear or non-linear. ● Students should have the opportunity to explore a variety of graphs including time/distance graphs and time/velocity graphs. **Examples** ● 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. ● Examples such as this can be used to help students learn that graphs can tell stories. 
8.FGR.5.3	Relate the domain of a linear function to its graph and where applicable to the quantitative relationship it describes.	***Example*** ● If the function h(n) gives the number of hours it takes a person to assemble n engines in a factory, then the set of positive integers would be an appropriate domain for the function.
8.FGR.5.4	Compare properties (rate of change and initial value) of two functions used to model an authentic situation each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).	***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.
8.FGR.5.5	Write and explain the equations $y = mx + b$ (slope-intercept form), $Ax + By = C$ (standard form), and $(y - y_1) = m(x-x_1)$ (point-slope form) as defining a linear function whose graph is a straight line to reveal and explain different properties of the function.	***Strategies and Methods*** ● Students should be able to rewrite linear equations written in different forms depending on the given situation. ***Terminology*** ● Forms of linear equations: standard, slope-intercept, and point-slope forms.

8.FGR.5.6	Write a linear function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.	***Strategies and Methods*** ● Problems should be practical and applicable to represent real situations, providing a purpose for analyzing equivalent forms of an expression. ● Rewrite a function expressed in standard form to slope-intercept form to make sense of a meaningful situation.	
8.FGR.5.7	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.	***Strategies and Methods*** ● This learning objective also includes verbal descriptions and scenarios of equations, tables, and graphs.	
8.FGR.5.8	Explain the meaning of 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.	***Strategies and Methods*** ● This learning objective also includes verbal descriptions and scenarios of equations, tables, and graphs.	
8.FGR.5.9	Graph and analyze linear functions expressed in various algebraic forms and show key characteristics of the graph to describe applicable situations.	***Strategies and Methods*** ● Use verbal descriptions, tables and graphs created by hand and/or using technology.	***Terminology*** ● Various forms of linear functions include standard, slope-intercept, and point-slope forms. ● Key features include rate of change (slope), intercepts, strictly increasing or strictly decreasing, positive, negative, and end behavior.

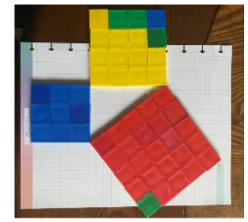
8.FGR.6: Solve practical, linear problems involving situations using bivariate quantitative data.

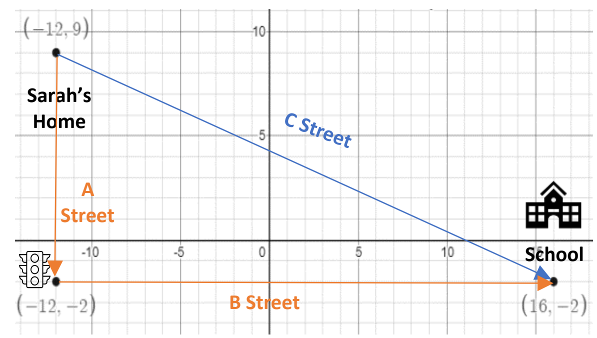
Expectations		Evidence of Student Learning (not all inclusive; see Grade Level Overview for more details)		
8.FGR.6.1	Show that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, visually fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line of best fit.	***Strategies and Methods*** ● Students should discover the line of best fit as the one that comes closest to most of the data points.	***Terminology*** ● The line of best fit shows the linear relationship between two variables in a data set.	***Example*** ● Given a set of data points, a student creates a scatter plot (see below), approximates a line of best fit, and writes the equation for the approximated line. 

8.FGR.6.2	Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercepts.	***Strategies and Methods*** ● Students should solve practical, linear problems involving situations using bivariate quantitative data.	***Terminology*** ● A linear model shows the relationship between two variables in a data set, such as lines of best fit.
8.FGR.6.3	Explain the meaning of the predicted slope (rate of change) and the predicted intercept (constant term) of a linear model in the context of the data.	***Terminology*** ● It is important to indicate 'predicted' to indicate this is a *probabilistic* interpretation in context, and not *deterministic*.	***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.FGR.6.4	Use appropriate graphical displays from data distributions involving lines of best fit to draw informal inferences and answer the statistical investigative question posed in an unbiased statistical study.	***Fundamentals*** ● Students should be given opportunities to analyze the data distribution displayed graphically to answer the statistical investigative question generated from a realistic situation.	

8.FGR.7: Justify and use various strategies to solve systems of linear equations to model and explain realistic phenomena.			
Expectations		**Evidence of Student Learning** **(not all inclusive; see Grade Level Overview for more details)**	
8.FGR.7.1	Interpret and solve relevant mathematical problems leading to two linear equations in two variables.	***Strategies and Methods*** ● Students should have a variety of opportunities to explore problems using technology and tools in order to strengthen their conceptual understanding of systems of linear equations as they visually analyze what happens when the variables are manipulated in the problem.	***Examples*** ● A trampoline park that you frequently go to is \$9 per visit. You have the option to purchase a monthly membership for \$30 and then pay \$4 for each visit. Explain whether you will buy the membership, and why. Option A: y=\$9x Option B: y= \$30 + \$4x ● Anya is traveling from out of town. This is the only time she will visit this trampoline park. Which option should she choose? ● Jin plans on going to the trampoline park seven times this month. Which option should he choose? What does the point of intersection of the graphs represent?
8.FGR.7.2	Show and explain that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because the points of	***Strategies and Methods*** ● Students should be provided with opportunities to explore systems of equations represented on interactive graphs to analyze and interpret the solutions to the systems. ● Students should be able to analyze and explain solutions to systems of equations presented numerically, algebraically, and graphically.	

	intersection satisfy both equations simultaneously.		
8.FGR.7.3	Approximate solutions of two linear equations in two variables by graphing the equations and solving simple cases by inspection.	***Strategies and Methods*** ● Students should be provided with opportunities to explore systems of equations represented on interactive graphs to analyze and interpret the solutions to the systems. ● Students should have opportunities to analyze and explore problems using technology and tools to strengthen their conceptual understanding of systems of linear equations.	***Example*** ● A student can graph two linear equations that represent a culturally relevant problem using digital graphing tools (i.e., Desmos) and visually make sense of the graphed lines based on a given context. A student can provide a verbal or written explanation of their reasoning.
8.FGR.7.4	Analyze and solve systems of two linear equations in two variables algebraically to find exact solutions.	***Strategies and Methods*** ● Students should be able to analyze and solve pairs of simultaneous linear equations (systems of linear equations) within realistic situations and an expressed phenomenon. ● Students should validate their graphical approximations using algebraic strategies. ● Students should use substitution and elimination to solve systems of linear equations.	***Example*** ● Given coordinates for two pairs of points, a student can determine whether the line through the first pair of points intersects the line through the second pair.
8.FGR.7.5	Create and compare the equations of two lines that are either parallel to each other, perpendicular to each other, or neither parallel nor perpendicular.	***Strategies and Methods*** ● Students should have the opportunity to explore visual graphs of equations that are parallel, perpendicular or neither parallel nor perpendicular to develop a deep, conceptual understanding. ● As students are comparing parallelism and perpendicularity of lines, they should see the connection as a system of equations. ● Students should be able to explain if systems are consistent or inconsistent.	***Example*** ● A student can recognize that there is no solution to the system of equations formed by $3x + 2y = 5$ and $3x + 2y = 6$ because the lines are parallel and $3x + 2y$ cannot simultaneously be 5 and 6.

GEOMETRIC & SPATIAL REASONING – Pythagorean theorem and volume of triangles, rectangles, cones, cylinders, and spheres				
8.GSR.8: Solve geometric problems involving the Pythagorean Theorem and the volume of geometric figures to explain real phenomena.				
Expectations		**Evidence of Student Learning** (not all inclusive; see Grade Level Overview for more details)		
8.GSR.8.1	Explain a proof of the Pythagorean Theorem and its converse using visual models.	***Age/Developmentally Appropriate*** ● Students are not limited to a particular proof for the Pythagorean Theorem or its converse.	***Strategies and Methods*** ● Geometric and spatial reasoning should be used when explaining the Pythagorean Theorem.	***Example*** 
8.GSR.8.2	Apply the Pythagorean Theorem to determine unknown side lengths in right triangles within authentic, mathematical problems in two and three dimensions.	***Age/Developmentally Appropriate*** ● Triangle dimensions may be rational or irrational numbers.	***Strategies and Methods*** ● Geometric and spatial reasoning should be used to solve problems involving the Pythagorean theorem. ● Models and drawings may be useful as students solve contextual problems in two- and three-dimensions.	***Example***  How tall is the Great Pyramid of Giza?
8.GSR.8.3	Apply the Pythagorean Theorem to find the distance between two points in a coordinate system in practical, mathematical problems.	***Age/Developmentally Appropriate*** ● Students should apply their understanding of the Pythagorean Theorem to find the distance. Use of the distance formula is not an expectation for this grade level.	***Strategies and Methods*** ● Students should be provided opportunities to solve problems using a variety of strategies.	***Example*** ● There are two paths that Sarah can take when walking to school. One path is to take is to take A Street from home to the traffic light and then walk on B street from the traffic light to the school, and the other way is for her to take C street directly to the school. How much shorter is the direct path along C Street?

				 To answer this question, students may use what they learned in 6th grade to find the distance between (-12,9) and (-12, -2) representing A street and the distance between (-12, -2) and (16, -9) representing B street. Then, students could use those two distances to find the sum of the distances for the first path. Then, students can apply the Pythagorean theorem to determine the distance between the final two points, (-12,9) and (16,-2) to determine the answer to the question.
8.GSR.8.4	Apply the formulas for the volume of cones, cylinders, and spheres and use them to solve in relevant problems.	***Age/Developmentally Appropriate*** ● This learning objective is limited to right circular cones, right cylinders, and spheres.	***Strategies and Methods*** ● Given the volume, solve for an unknown dimension of the figure. Students will need to be able to express the answer in terms of pi and as a decimal approximation. ● Students should be able to use their knowledge of cube roots to solve for unknown dimensions of geometric figures.	***Relevance and Application*** ● Students should be given opportunities to find missing dimensions of a right circular cone (e.g., slant height, radius, etc.). ● Students should be able to make connections between the Pythagorean Theorem and solving relevant problems related to volume of cones.