Kentucky Academic Standards for Mathematics: Grade 8 Overview

The Number System (NS)	Expressions and Equations (EE)	Functions (F)	Geometry (G)	Statistics and Probability (SP)
• Know that there are numbers that are not rational and approximate them by rational numbers.	• Work with radicals and integer exponents. • Understand the connections between proportional relationships, lines and linear equations. • Analyze and solve linear equations and pairs of simultaneous linear equations.	• Define, evaluate and compare functions. • Use functions to model relationships between quantities.	• Understand congruence and similarity using physical models, transparencies, or geometry software. • Understand and apply the Pythagorean Theorem. • Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.	• Investigate patterns of association in bivariate data.

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

1. **In the Number System, the Expressions, Equations and Inequalities, and the Probability and Statistics domains, students will:**
   - recognize equations for proportions (y/x = m or y=mx) as special linear equations (y = mx + b), understanding that the constant of proportionality (m) is the slope and the graphs are lines throughout the origin;
   - understand that the slope (m) of a line is a constant rate of change, as well as how the input and output changes as a result of the constant rate of change;
   - interpret a model in the context of the data by expressing a linear relationship between the two quantities in question and interpret components of the relationship (such as slope and y-intercept) in terms of the situation;
   - solve systems of two linear equations in two variables and relate the systems to pairs of lines in the plane; these intersect, are parallel, or are the same line;
   - use linear equations, systems of linear equations, linear functions and their understanding of slope of a line to represent, analyze and solve a variety of problems.
2. **In the Functions and the Expressions, Equations and Inequalities domains, students will:**
   - grasp the concept of a function as a rule that assigns to each input exactly one output;
   - understand that functions describe situations where one quantity determines another;
   - translate among representations and partial representations of functions (noting that tabular and graphical representations may be partial representations of the function) and describe how aspects of the function are reflected in the different representations.
3. **In the Geometry domain, students will:**
   - use ideas about distance and angles, how they behave under translations, rotations, reflections and dilations and ideas about congruence and similarity to describe and analyze two-dimensional figures and to solve problems;
   - show that the sum of the angles in a triangle is the angle formed by a straight line and that various configurations of lines give rise to similar triangles because of the angles created when a transversal cuts parallel lines;
   - understand the statement of the Pythagorean Theorem and its converse, and why the Pythagorean Theorem holds;
   - apply the Pythagorean Theorem to find distances between points on the coordinate plane, to find lengths and to analyze polygons.

The Number System	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.

Cluster: Know that there are numbers that are not rational and approximate them by rational numbers.

Standards	Clarifications
KY.8.NS.1 Understand informally that every number has a decimal expansion; the rational numbers are those with decimal expansions that terminate in 0s or eventually repeat. Know that other numbers are called irrational. **MP.2**, **MP.6**, **MP.7**	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. Coherence KY.7.NS.2→ KY.8.NS.1→ KY.HS.N.3
KY.8.NS.2 Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram and estimate the value of expressions. **MP.2**, **MP.7**, **MP.8**	For example, by shortening the decimal expansion of $\sqrt{2}$ by dropping all decimals past a certain point and showing $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5 and so on. Students recognize this process could be repeated an infinite number of times. Coherence KY.8.NS.2→ KY.HS.N.3

Attending to the Standards for Mathematical Practice

Students attend to precision (**MP.6**) by recognizing and identifying numbers as rational or irrational. Students know the definition of an irrational number and represent the number in different ways, as a root, non-repeating decimal block, or symbol. Students attend to precision when clarifying the difference between an exact value of an irrational number compared to the decimal approximation of the irrational number. Ultimately, students come to an informal understanding (**MP.2**) the set of real numbers consists of rational numbers and irrational numbers. They continue to work with irrational numbers and rational approximations when solving equations such as $x^2 = 18$. While using the long division algorithm to convert fractions to decimals, students recognize when a sequence of remainders repeats that the decimal form of the number will contain a repeat block (**MP.8**). Students recognize when the decimal expansion of a number does not repeat or terminate, the number is irrational and can be represented with a method of rational approximation using a sequence of rational numbers to get closer and closer to the given number (**MP.7**). Students look for structure in repeating decimals, recognize repeating blocks and know every fraction is equal to a repeating decimal.

The identified mathematical practices, coherence connections and clarifications are possible suggestions; however, they are not the only pathways.

Expressions and Equations

Standards for Mathematical Practice

MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.

Cluster: Work with radicals and integer exponents.

<table>
<tr><th>Standards</th><th>Clarifications</th></tr>
<tr><td>KY.8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions.
MP.3, MP.7, MP.8</td><td>
<table>
<tr><th>Name</th><th>Product of Powers</th><th>Quotient of Powers</th><th>Power of a Product</th><th>Power of a Quotient</th><th>Power of a Power</th><th>Negative Exponent</th></tr>
<tr><td>Property</td><td>$a^m \cdot a^n = a^{m+n}$</td><td>$\frac{a^m}{a^n} = a^{m-n}$</td><td>$(a \cdot b)^n = a^n \cdot b^n$</td><td>$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$</td><td>$(a^m)^n = a^{mn}$</td><td>$a^{-n} = \frac{1}{a^n}$</td></tr>
</table>
Coherence KY.8.EE.1→ KY.HS.N.1</td></tr>
<tr><td>KY.8.EE.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that perfect squares and perfect cubes are rational.
MP.5, MP.6</td><td>Students do not prove these are the only solutions, but rather use informal methods, such as guess and check. For 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 correct to say (as is common) $\sqrt{64} = \pm 8$. In describing the solutions to $x^2 = 64$, students write $x = \pm\sqrt{64} = \pm 8$.
Coherence KY.8.EE.2→ KY.HS.A.12</td></tr>
<tr><td>KY.8.EE.3 Use numbers expressed in the form of a single digit times an integer power of 10 (Scientific Notation) to estimate very large or very small quantities and express how many times larger or smaller one is than the other.
MP.3, MP.5, MP.6</td><td>Students conceptualize why a number could be written in scientific notation and the benefits of doing so and connect exponent rules learned earlier to the methods of writing a quantity in scientific notation.
Coherence KY.8.EE.3→ KY.HS.N.6</td></tr>
<tr><td>KY.8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities. Interpret scientific notation that has been generated by technology.
MP.2, MP.5, MP.6</td><td>Choose appropriate units for real-life situations. When solving problems and using technology, it is possible solutions are given that take the form of $1.2\ x\ 10^{00}$ or $3.4\ x\ 10^{-07}$. Some technologies also use a capital E when denoting numbers such a $1.45E07$ or $4.665E\text{-}11$.
Coherence KY.8.EE.4→ KY.HS.N.4</td></tr>
</table>

Attending to the Standards for Mathematical Practice
Students construct mathematical arguments and reasoning emphasized as students learn the properties of exponents (**MP.3**). Students reason $5^3 \cdot 5^2 = (5 \cdot 5 \cdot 5) \cdot (5 \cdot 5) = 5^5$ through numerous experiences of working with exponents, students generalize the properties of exponents (**MP.7**) before using them fluently. Students notice if calculations are repeated (**MP.8**) and look both for general methods and for shortcuts. Students expand their exponent work as they perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used (**MP.2**, **MP.7**, **MP.8**). Students compare and interpret scientific notation quantities in the context of the situation, recognizing the powers of 10 indicated in quantities expressed in scientific notation follow the rules of exponents shown previously (**MP.3**).

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Expressions and Equations	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.

Cluster: **Understand the connections between proportional relationships, lines and linear equations.**

Standards	Clarifications
KY.8.EE.5 Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. **MP.2**, **MP.3**, **MP.4**	Emphasis is on relating previous knowledge of unit rate to slope in tables, graphs, equations and sets of ordered pairs and comparing the slopes of two different proportional relationships. Different ways the proportional relationships can be represented include tables, graphs, equations, or sets of ordered pairs. KY.8.F.2 Coherence KY.7.RP.2→ KY.8.EE.5→ KY.HS.A.23
KY.8.EE.6 Use similar triangles to explain why the slope, *m*, is the same between any two distinct points on a non-vertical line in the coordinate plane; know the equation *y* = *mx* for a line through the origin and the equation *y* = *mx* + *b* for a line intercepting the vertical axis at *b*. **MP.3**, **MP.4**, **MP.7**	Using the properties of similar triangles, demonstrate the slope between any two pairs of points on a non-vertical line create the same rise-run ratio when simplified. Understand $y = mx$ and $y = mx + b$ differ in that $y = mx$ only has the possibility of 0 being the *y*-intercept and that $y = mx + b$ has infinite possibilities, including 0, for the *y*-intercept depending on the value of *b*. KY.HS.G.22 Coherence KY.7.RP.2→ KY.8.EE.6→ KY.HS.A.23

Attending to the Standards for Mathematical Practice

Students represent real-world situations symbolically (**MP.4**). Students identify important quantities from a context and represent the relationship in the form of an equation, a table and a graph. Students analyze the various representations and draw conclusions and/or make predictions (**MP.3**). Once a solution or prediction has been made, students reflect on whether the solution makes sense in the context presented (**MP.4**). One example of this is when students determine how many buses are needed for a field trip. As this is most probably not an exact solution, students must interpret their fractional solution and make sense of it as it applies to the real world. Mathematical modeling is a process that uses mathematics to represent, analyze, make predictions or otherwise provide insight into real-world phenomena. Students use the structure of an equation to make sense of the information in the equation (**MP.7**). For example, students write equations that represent the constant rate of motion for a person walking. In doing so, they interpret an equation such as $y = \frac{3}{5}x$ as the total distance a person walks, y, in x

amount of time, at a rate of $\frac{3}{5}$. Students look for patterns or structure in tables and show a rate is constant; students also understand a lack of a pattern represents a non-constant (non-linear) rate.

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Expressions and Equations	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.
Cluster: **Analyze and solve linear equations and pairs of simultaneous linear equations.**	
Standards	**Clarifications**
KY.8.EE.7 Solve linear equations in one variable. a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where *a* and *b* are different numbers). b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and combining like terms. **MP.2**, **MP.3**, **MP.7**	Building upon skills from grade 7, students combine like terms on the same side of the equality and use the distributive property to simplify the equation when solving. Emphasis in this standard is also on using rational number coefficients. Solutions of certain equations may elicit infinitely many or no solutions. Coherence KY.7.EE.1→ KY.8.EE.7→ KY.HS.A.18
KY.8.EE.8 Analyze and solve a system of two linear equations. a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously; understand that a system of two linear equations may have one solution, no solution, or infinitely many solutions. b. Solve systems of two linear equations in two variables algebraically by using substitution where at least one equation contains at least one variable whose coefficient is 1 and by inspection for simple cases c. Solve real-world and mathematical problems leading to two linear equations in two variables.	a. Examples are both mathematical and real-life contexts. Emphasis is on determining what types of contexts lead to having no solutions or infinitely many solutions. Students use tables, graphs and equations to explain why a graphed system has infinitely many or no solutions. b. Elimination and/or matrices are not required for grade 8. Emphasis is on *choosing* a method. Students solve simple cases by inspection, for example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6 and select from the other approaches, based on the numbers in the problem. Solving systems algebraically will be

Standards	Clarifications
MP.1, **MP.3**, **MP.4**	limited to at least one equation containing at least one variable with a coefficient of 1; for example, $y = 3x$, $y = -12x + 6, x = 2, x = 2y + 1$. Coherence KY.7.EE.2→ KY.8.EE.8→ KY.HS.A.20

Attending to the Standards for Mathematical Practice
Students solve linear equations in one variable, including cases with one solution, an infinite number of solutions and no solutions. Students show examples of each of these cases by successively transforming an equation into simpler forms. Some linear equations require students to expand expressions by using the distributive property and to collect like terms (**MP.2**, **MP.7**). Solving pairs of simultaneous linear equations builds on the skills and understandings students used to solve linear equations with one variable and systems of linear equations may also have one solution, an infinite number of solutions, or no solutions (**MP.2**, **MP.3**). Students discover these cases as they graph systems of linear equations and solve algebraically.

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Functions	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.

Cluster: **Define, evaluate and compare functions.**

Standards	Clarifications
KY.8.F.1 Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output. **MP.7**, **MP.8**	Students understand the reasoning that not all relations are functions. Note: Function notation is not required in grade 8. Coherence KY.8.F.1→ KY.HS.F.1
KY.8.F.2 Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). **MP.1**, **MP.2**, **MP.4**	Given a linear function represented using one method listed and another linear function represented by different method listed, determine which function has the greater or lesser rate of change or greater or lesser initial value. Coherence KY.7.RP.2→ KY.8.F.2→ KY.HS.F.1
KY.8.F.3 Understand properties of linear functions. a. Interpret the equation *y* = *mx* + *b* as defining a linear function, whose graph is a straight line. b. Identify and give examples of functions that are not linear. **MP.7**	a. For example, the equation $c = 3g + 5$ models the linear function for the total cost, *c*, of bowling, where *g* represents the number of games played and shoe rental is $5. b. For example, the function A = s^2 giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line. Coherence KY.7.EE.4→ KY.8.F.3→ KY.HS.F.11

Attending to the Standards for Mathematical Practice

Students examine, interpret and represent functions symbolically (**MP.2**, **MP.4**). They make sense of quantities and their relationships in problem situations (**MP.2**). For example, students make sense of values as they relate to the total cost of items purchased or a phone bill based on usage in a particular time interval. Students use what they know about rate of change to distinguish between linear and nonlinear functions (**MP.8**). Further, students contextualize information gained from the comparison of two functions (**MP.7**).

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Functions	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.
Cluster: Use functions to model relationships between quantities.	
Standards	**Clarifications**
KY.8.F.4 Construct a function to model a linear relationship between two quantities. a. 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. b. Interpret the rate of change and initial value of a linear function in terms of the situation it models and in terms of its graph or a table of values. **MP.4**, **MP.5**, **MP.8**	Examining a relationship between two quantities yields a function rule. This function rule can be described using its initial value and rate of change, from a variety of representations, including tables, graphs, equations and verbal descriptions. Understand the rate of change and initial value in terms of the situation it models. KY.HS.F.6 Coherence KY.7.RP.2→ KY.8.F.4→ KY.HS.F.3
KY.8.F.5 Use graphs to represent functions. a. Describe qualitatively the functional relationship between two quantities by analyzing a graph. b. Sketch a graph that exhibits the qualitative features of a function that has been described verbally. **MP.3**, **MP.7**	Students describe whether a function is increasing or decreasing and linear or nonlinear. Function examples are described in contexts as well as in symbols. Coherence KY.7.RP.2→ KY.8.F.5→ KY.HS.F.4
Attending to the Standards for Mathematical Practice	
Students model relationships between variables using linear and nonlinear functions. They interpret models in the context of the data and reflect on whether or not the models make sense based on slopes, initial values, or the fit to the data (**MP.4**). There are many real-world problems that can be modeled with linear functions, including instances of constant payment plans (phone plans), costs associated with running a business and relationships between associated bivariate data. When students are analyzing graphs, they focus on how the function is changing. Students take verbal descriptions and create graphs, while also being able to take a graph and create a verbal description (**MP.2**, **MP.5**). Students look for patterns within the graphs to provide justification of the verbal description being represented by the graph (**MP.7**).	

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Geometry	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.
Cluster: Understand congruence and similarity using physical models, transparencies, or geometry software.	
Standards	**Clarifications**
KY.8.G.1 Verify experimentally the properties of rotations, reflections and translations: ● Lines are congruent to lines. ● Line segments are congruent to line segments of the same length. ● Angles are congruent to angles of the same measure. ● Parallel lines are congruent to parallel lines. **MP.5**, **MP.6**	Emphasis is congruence transformations preserve corresponding congruent lines, segments and angles. KY.HS.G.2 Coherence KY.8.G.1→ KY.HS.G.3(+)
KY.8.G.2 Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections and translations. Given two congruent figures, describe a sequence that exhibits the congruence between them. **MP.2**, **MP.7**	Students understand a figure, called a pre-image, is congruent to another figure, called the image, if the second figure can be obtained by a sequence of congruence transformations performed on the first figure. Students describe the sequence of congruence transformations necessary to transform one figure to a congruent second figure. KY.HS.G.4 Coherence KY.8.G.2→ KY.HS.G.5
KY.8.G.3 Describe the effect of dilations, translations, rotations and reflections on two-dimensional figures using coordinates. **MP.3**, **MP.5**, **MP.6**	Emphasis is on noticing patterns across examples, noting how the *x* and *y* values change for different kinds of transformations. Coherence KY.8.G.3→ KY.HS.G.9
KY.8.G.4 Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations and dilations. Given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them. **MP.2**, **MP.5**, **MP.7**	If similar, non-congruent figures are given, students understand a dilation must have taken place in the sequence of transformations to obtain the image from the pre-image. KY.HS.G.2 Coherence KY.8.G.4→ KY.HS.G.10

Standards	Clarifications
KY.8.G.5 Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal and the angle-angle criterion for similarity of triangles. **MP.3**	Students use technology or physical tools to explore triangles. They arrange three copies of the same triangle so that the sum of the three angles appears to form a line and give an argument in terms of transversals of why this is so. KY.HS.G.7 Coherence KY.7.G.5→ KY.8.G.5→ KY.HS.G.10

Attending to the Standards for Mathematical Practice
Students construct arguments around the properties of rigid motions. Students make assumptions about parallel and perpendicular lines and use properties of rigid motions to directly or indirectly prove their assumptions. Students use definitions to describe a sequence of rigid motions to prove or disprove congruence. Students build a logical progression of statements to show relationships between angles of parallel lines cut by a transversal, the angle sum of triangles and properties of polygons like rectangles and parallelograms (**MP.3**). With the aid of physical models, transparencies and geometry software, students in grade eight gain an understanding of transformations and their relationship to congruence of shapes (**MP.5**, **MP.6**). Through experimentation, students verify the properties of rotations, reflections and translations, including discovering these transformations change the position of a geometric figure but not its shape or size (**MP.7**). Finally, students understand congruent shapes are precisely those that can be "mapped" one onto the other by using rotations, reflections, or translations (**MP.2**).

The identified mathematical practices, coherence connections and clarifications are possible suggestions; however, they are not the only pathways.

Geometry	
Standards for Mathematical Practice	
MP.1. Make sense of problems and persevere in solving them. MP.2. Reason abstractly and quantitatively. MP.3. Construct viable arguments and critique the reasoning of others. MP.4. Model with mathematics.	MP.5. Use appropriate tools strategically. MP.6. Attend to precision. MP.7. Look for and make use of structure. MP.8. Look for and express regularity in repeated reasoning.
Cluster: **Understand and apply the Pythagorean Theorem.**	
Standards	**Clarifications**
KY.8.G.6 Explain a proof of the Pythagorean Theorem and its converse. **MP.3**, **MP.7**	Students verify, using a model, the sum of the squares of the legs is equal to the square of the hypotenuse in a right triangle. Students understand if the sum of the squares of the two smaller legs is equal to the square of the third leg, then the triangle is a right triangle. Coherence KY.7.G.6→ KY.8.G.6→KY.HS.G.11
KY.8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. **MP.1**, **MP.2**, **MP.4**	Students apply the Pythagorean Theorem to mathematical real-world problems. For example, finding the width of a television given the length and diagonal distance (two-dimensional) and the distance from the top left rear corner of a prism to the bottom right front corner of the prism (three-dimensional). Coherence KY.8.G.7→KY.HS.G.12
KY.8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system. **MP.5**, **MP.6**	Students calculate distances on the coordinate plane between two non-vertical or non-horizontal points by applying the Pythagorean Theorem. Students calculate distances between two non-vertical or non-horizontal points not given on a coordinate plane by applying the Pythagorean Theorem to absolute horizontal and vertical distances the student calculates. KY.HS.G.19 Coherence KY.8.G.8→ KY.HS.G.21
Attending to the Standards for Mathematical Practice	
By explaining a proof of the Pythagorean Theorem and its converse, students are constructing and defending arguments as to why the relationship is true (**MP.3**). The structure inherent in the use of the Theorem is a set of guidelines students seek to apply when applying the Theorem to right triangle relationships (**MP.7**). Students make sense of the world around them by applying the Pythagorean Theorem in a variety of ways (**MP.1**). Investigation into Pythagorean Triples and the relationships among similar triangles with the same ratio of Pythagorean Triples	

allows students to reason about the relationships (**MP.2**). Extending knowledge of the Pythagorean Theorem to the coordinate plane gives students another tool to prove the relationship exists and to apply the relationship to quantitative tasks (**MP.5**). Attending to precision is inherent in the study of this cluster, as a discussion will inevitably occur involving leaving a solution in terms of a radical, or a rational approximation ($\sqrt{50}\ vs.\ 7.07106\ldots$)(**MP.6**).

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Geometry	
Standards for Mathematical Practice	
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Cluster: **Solve real-world and mathematical problems involving volume of cylinders, cones and spheres.**

Standards	Clarifications
KY.8.G.9 Apply the formulas for the volumes and surface areas of cones, cylinders and spheres and use them to solve real-world and mathematical problems. **MP.1**, **MP.7**, **MP.8**	Cones: $V = \frac{1}{3}\pi r^2 h \quad SA = \pi r\,(r + \sqrt{(r^2 + h^2)})$ Cylinders: $V = \pi r^2 h \quad SA = 2\pi rh + 2\pi r^2$ Spheres: $V = \frac{4}{3}\pi r^3 \quad SA = 4\pi r^2$ KY.HS.G.29 Coherence KY.7.G.4→ KY.8.G.9→ KY.HS.G.25

Attending to the Standards for Mathematical Practice

Students may confuse the three formulas given if they try to apply a formula to a specific shape. Student understanding of the volume formulas is enhanced by investigations into the derivations of the volume formulas (**MP.1**). Students examining structure in real-world problems in order to apply the correct volume formula (if needed) begin to see where these are useful in real life (**MP.7**). If students can successfully compare volumes of similar shapes, for example, which of two storage tank can hold the most fuel, they begin to use repeated reasoning in the real-world (**MP.8**).

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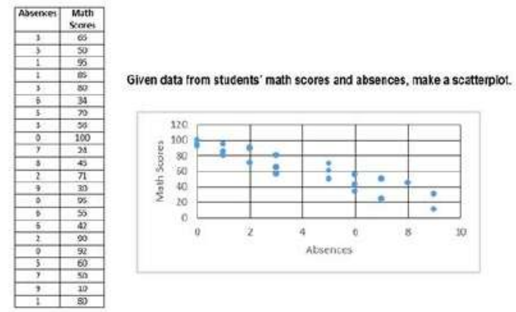
<tr><td colspan="2">Cluster: Investigate patterns of association in bivariate data.</td></tr>
<tr><th>Standards</th><th>Clarifications</th></tr>
<tr><td>KY.8.SP.1 Construct and interpret scatter plots for bivariate numerical data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association and nonlinear association.
MP.2, MP.7</td><td>


For example, given the data and scatter plot to the left, students explain the relationship between students' absences and math scores shows a negative, linear association and has no obvious outliers.
KY.HS.SP.6
Coherence KY.8.SP.1→ KY.HS.SP.8</td></tr>
<tr><td>KY.8.SP.2 Know that lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a line and informally assess the model fit by judging the closeness of the data points to the line.
MP.2</td><td>Students are informally fitting a line to data; they judge whether or not a given line is a good fit for the data and describe needed adjustments. Students recognize some scatter plots cannot be described by a line.
KY.HS.SP.6
Coherence KY.8.SP.2→ KY.HS.SP.8</td></tr>
<tr><td>KY.8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate numerical data, interpreting the slope and intercept.
MP.2, MP.4</td><td>For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height and an initial value of 4 cm means the plant was 4 cm tall when measuring began.
KY.HS.SP.6
Coherence KY.8.SP.3→ KY.HS.SP.7</td></tr>
</table>

Attending to the Standards for Mathematical Practice
Students reason quantitatively by symbolically representing the verbal description of a relationship between two bivariate variables. They attend to the meaning of data based on the context of problems and the possible linear or nonlinear functions that explain the relationships of the variables. When classifying characteristics of sets of data, students reason about the descriptions that apply based on definition (**MP.2**). Students model relationships between variables using linear and nonlinear functions. They interpret models in the context of the data and reflect on whether or not the models make sense based on slopes, initial values, or the fit to the data. This requires a deep understanding of the parts of the model used and their interpretations (**MP.4**). Mathematical modeling is a process that uses mathematics to represent, analyze, make predictions or otherwise provide insight into real-world phenomena. Students identify patterns or structures in scatter plots. They fit lines to data displayed in a scatter plot and determine the equations of lines based on points or the slope and initial value (**MP.7**).