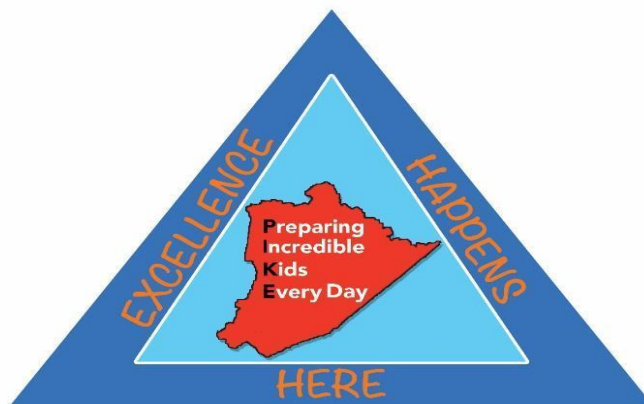


***Pike County School District
Standards Mastery Document***

High School Mathematics/Geometry
Revised 2019



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High School Geometry

The Standards Mastery Document is designed for educators by educators as a resource and tool to help educators increase their depth of understanding of the Common Core Standards. This document will enable teachers to plan College & Career Ready curriculum and classroom instruction that promotes inquiry and higher levels of cognitive demand.

The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important “processes and proficiencies” with longstanding importance in mathematics education.

8 Mathematical Practices (MP):

- 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.

Modeling Standards: Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. Making mathematical models is a Standard for Mathematical Practice and specific modeling standards appear throughout the high school standards indicated by a star symbol (★). The star symbol sometimes appears on the heading for a group of standards; in that case, it should be understood to apply to all standards in that group.

Plus (+) Standards: Additional mathematics concepts students should learn in order to take advanced courses such as calculus, advanced statistics or discrete mathematics are indicated by (+) symbol.

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Overview

Number and Quantity Overview

The Real Number System	Quantities	The Complex Number System	Vector and Matrix Quantities
<ul style="list-style-type: none"> Extend the properties of exponents to rational exponents. Use properties of rational and irrational numbers. 	<ul style="list-style-type: none"> Reason quantitatively and use units to solve problems. 	<ul style="list-style-type: none"> Perform arithmetic operations with complex numbers. Represent complex numbers and their operations on the complex plane. Use complex numbers in polynomial identities and equations. 	<ul style="list-style-type: none"> Represent and model with vector quantities. Perform operations on vectors. Perform operations on matrices and use matrices in applications.

Algebra Overview

Seeing Structure in Expressions	Arithmetic with Polynomials and Rational Expressions	Creating Equations ★	Reasoning with Equations and Inequalities
<ul style="list-style-type: none"> Interpret the structure of expressions. Write expressions in equivalent forms to solve problems. 	<ul style="list-style-type: none"> Perform arithmetic operations on polynomials. Understand the relationship between zeros and factors of polynomials. Use polynomial identities to solve problems. Rewrite rational expressions. 	<ul style="list-style-type: none"> Create equations that describe numbers or relationships. 	<ul style="list-style-type: none"> Understand solving equations as a process of reasoning and explain the reasoning. Solve equations and inequalities in one variable. Solve systems of equations. Represent and solve equations and inequalities graphically.

Functions Overview

Interpreting Functions	Building Functions	Linear, Quadratic and Exponential Models	Trigonometric Functions
<ul style="list-style-type: none"> Understand the concept of a function and use function notation. Interpret functions that arise in applications in terms of the context. Analyze functions using different representations. 	<ul style="list-style-type: none"> Build a function that models a relationship between two quantities. Build new functions from existing functions. 	<ul style="list-style-type: none"> Construct and compare linear, quadratic and exponential models and solve problems. Interpret expressions for functions in terms of the situation they model. 	<ul style="list-style-type: none"> Extend the domain of trigonometric functions using the unit circle. Model periodic phenomena with trigonometric functions. Prove and apply trigonometric identities.

Statistics and Probability Overview

Interpreting Categorical and Quantitative Data	Making Inferences and Justifying Conclusions	Conditional Probability and the Rules of Probability	Using Probability to Make Decisions
<ul style="list-style-type: none"> Summarize, represent and interpret data on a single count or measurement variable. Summarize, represent and interpret data on two categorical and quantitative variables. Interpret linear models. 	<ul style="list-style-type: none"> Understand and evaluate random processes underlying statistical experiments. Make inferences and justify conclusions from sample surveys, experiments and observational studies. 	<ul style="list-style-type: none"> Understand independence and conditional probability and use them to interpret data. Use the rules of probability to compute probabilities of compound events in a uniform probability model. 	<ul style="list-style-type: none"> Calculate expected values and use them to solve problems. Use probability to evaluate outcomes of decisions.

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Table 1
Common Addition and Subtraction Situations¹

	Result Unknown	Change Unknown	Start Unknown
Add To	Two bunnies sat on the grass. Three more bunnies hopped there. How many bunnies are on the grass now? $2+3=?$	Two bunnies were sitting on the grass. Some more bunnies hopped there. Then there were five bunnies. How many bunnies hopped over to the first two? $2+?=5$	Some bunnies were sitting on the grass. Three more bunnies hopped there. Then there were five bunnies. How many bunnies were on the grass before? $?+3=5$
Take From	Five apples were on the table. I ate two apples. How many apples are on the table now? $5-2=?$	Five apples were on the table. I ate some apples. Then there were three apples. How many apples did I eat? $5-?=3$	Some apples were on the table. I ate two apples. Then there were three apples. How many apples were on the table before? $?-2=3$
	Total Unknown	Addend Unknown	Both Addends Unknown ³
Put Together/ Take Apart²	Three red apples and two green apples are on the table. How many apples are on the table? $3+2=?$	Five apples are on the table. Three are red and the rest are green. How many apples are green? $3 + ? = 5, 5 - 3 = ?$	Grandma has five flowers. How many can she put in her red vase and how many in her blue vase? $5 = 0 + 5, 5 = 5 + 0, 5 = 1 + 4, 5 = 4 + 1, 5 = 2 + 3, 5 = 3 + 2$
	Difference Unknown	Bigger Unknown	Smaller Unknown
Compare	(“How many more?” version): Lucy has two apples. Julie has five apples. How many more apples does Lucy have than Julie? (“How many fewer?” version): Lucy has two apples. Julie has five apples. How many fewer apples does Lucy have than Julie? $2 + ? = 5, 5 - 2 = ?$	(Version with “more”): Julie has three more apples than Lucy. Lucy has two apples. How many apples does Julie have? (Version with “fewer”): Lucy has three fewer apples than Julie. Lucy has two apples. How many apples does Julie have? $2 + 3 = ?, 3 + 2 = ?$	(Version with “more”): Julie has three more apples than Lucy. Julie has five apples. How many apples does Lucy have? (Version with “fewer”): Lucy has three fewer apples than Julie. Julie has five apples. How many apples does Lucy have? $5 - 3 = ?, ? + 3 = 5$

Blue shading indicates the four Kindergarten problem subtypes. Students in grades 1 and 2 work with all subtypes and variants (blue and green). Yellow indicates problems that are the difficult four problem subtypes students in grade 1 work with but do not need to master until grade 2.

¹ Adapted from Box 2-4 of National Research Council (2009, op. cit., pp. 32, 33).

² These *take apart* situations can be used to show all the decompositions of a given number. The associated equations, which have the total on the left of the equal sign, help children understand that the = sign does not always mean *makes or results in* but always does mean *is the same number as*.

³ Either addend can be unknown, so there are three variations of these problem situations. Both Addends Unknown is a productive extension of this basic situation especially for small numbers less than or equal to 10. ⁴ For the Bigger Unknown or Smaller Unknown situations, one version directs the correct operation (the version using *more* for the bigger unknown and using *less* for the smaller unknown). The other versions are more difficult.

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Table 2
Common Multiplication and Division Situations¹

	Unknown Product	Group Size Unknown	Number of Groups Unknown
	$3 \times 6 = ?$	$3 \times ? = 18$ and $18 \div 3 = ?$	$? \times 6 = 18$ and $18 \div 6 = ?$
Equal Groups	<p>There are 3 bags with 6 plums in each bag. How many plums are there in all?</p> <p>Measurement example: you need 3 lengths of string, each 6 inches long. How much string will you need all together?</p>	<p>If 18 plums are shared equally into 3 bags, then how many plums will be in each bag?</p> <p>Measurement example: you have 18 inches of string which you will cut into 3 equal pieces. How long will each piece of string be?</p>	<p>If 18 plums are to be packed 6 to a bag, then how many bags are needed?</p> <p>Measurement example: you have 18 inches of string which you will cut into pieces that are 6 inches long. How many pieces of string will you have?</p>
Arrays,² Area³	<p>There are three rows of apples with 6 apples in each row. How many apples are there?</p> <p>Area example: what is the area of a 3 cm by 6 cm triangle?</p>	<p>If 18 apples are arranged into 3 equal rows, how many apples will be in each row?</p> <p>Area example: a rectangle has area of 18 square centimeters. If one side is 3 cm long, how long is a side next to it?</p>	<p>If 18 apples are arranged into equal rows of 6 apples, how many rows will there be?</p> <p>Area example: a rectangle has area of 18 square centimeters. If one side is 6 cm long, how long is the side next to it?</p>
Compare	<p>A blue hat costs \$6. A red hat costs 3 times as much as the blue hat. How much does the red hat cost?</p> <p>Measurement example: a rubber band is 6 cm long. How long will the rubber band be when it is stretched to be 3 times as long?</p>	<p>A red hat costs \$18 and that is 3 times as much as a blue hat costs. How much does a blue hat cost?</p> <p>Measurement example: a rubber band is stretched to be 18 cm long and is 3 times as long as it was at first. How long was the rubber band at first?</p>	<p>A red hat costs \$18 and a blue hat costs \$6. How many times as much does the red hat cost as the blue?</p> <p>Measurement example: a rubber band was 6 cm long at first. Now it is stretched to be 18 cm long. How many times as long is the rubber band now as it was at first?</p>
General	$a \times b = ?$	$a \times ? = p$ and $p \div a = ?$	$? \times b = p$ and $p \div b = ?$

¹ The first examples in each cell are examples of discrete things. These are easier for students and should be given before the measurement examples.

² The language in the array examples shows the easiest form of array problems. A harder form is to use the terms rows and columns: the apples in the grocery window are in 3 rows and 6 columns. How many apples are in there? Both forms are valuable.

³ Area involves arrays of squares that have been pushed together so that there are no gaps or overlaps, so array problems include these especially important measurement situations.

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Table 3 Properties of Operations

The variables a , b and c stand for arbitrary numbers in a given number system.
The properties of operations apply to the rational number system, the real number system and the complex number system.

Associative property of addition	$(a + b) + c = a + (b + c)$
Commutative property of addition	$a + b = b + a$
Additive identity property of 0	$a + 0 = 0 + a = a$
Existence of additive inverses	For every a there exists $-a$ so that $a + (-a) = (-a) + a = 0$
Associative property of multiplication	$(a \times b) \times c = a \times (b \times c)$
Commutative property of multiplication	$a \times b = b \times a$
Multiplicative identity property of 1	$a \times 1 = 1 \times a = a$
Existence of multiplicative inverses	For every $a \neq 0$ there exists $1/a$ so that $a \times 1/a = 1/a \times a = 1$
Distributive property of multiplication over addition	$a \times (b + c) = a \times b + a \times c$

Table 4 Properties of Equality

The variables a , b and c stand for arbitrary numbers in the rational, real or complex number systems.

Reflexive property of equality	$a = a$
Symmetric property of equality	If $a = b$, then $b = a$
Transitive property of equality	If $a = b$ and $b = c$, then $a = c$
Addition property of equality	If $a = b$, then $a + c = b + c$
Subtraction property of equality	If $a = b$, then $a - c = b - c$
Multiplication property of equality	If $a = b$, then $a \times c = b \times c$
Division property of equality	If $a = b$ and $c \neq 0$, then $a \div c = b \div c$
Substitution property of equality	If $a = b$, then b may be substituted for a in any expression containing a .

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Table 5 Properties of Inequality

The variables a , b and c stand for arbitrary numbers in the rational or real number systems.

Exactly one of the following is true: $a < b$, $a = b$, $a > b$
If $a > b$ and $b > c$ then $a > c$
If $a > b$, then $b < a$
If $a > b$, then $-a < -b$
If $a > b$, then $a \pm c > b \pm c$
If $a > b$ and $c > 0$, then $a \times c > b \times c$
If $a > b$ and $c < 0$, then $a \times c < b \times c$
If $a > b$ and $c > 0$, then $a \div c > b \div c$
If $a > b$ and $c < 0$, then $a \div c < b \div c$

**Table 6
Fluency Standards across All Grade Levels**

Grade	Coding	Fluency Standards
K	KY.K.OA.5	Fluently add and subtract within 5.
1	KY.1.OA.6	Fluently add and subtract within 10.
2	KY.2.OA.2 KY.2.NBT.5	Fluently add and subtract within 20. Fluently add and subtract within 100.
3	KY.3.OA.7 KY.3.NBT.2	Fluently multiply and divide within 100. Fluently add and subtract within 1000.
4	KY.4.NBT.	Fluently add and subtract multi-digit whole numbers using an algorithm.
5	KY.5.NBT.5	Fluently multiply multi-digit whole numbers (not to exceed four-digit by two-digit multiplication) using an algorithm.
6	KY.6.NS.2 KY.6.NS.3 KY.6.EE.2	Fluently divide multi-digit numbers using an algorithm. Fluently add, subtract, multiply and divide multi-digit decimals using an algorithm for each operation. Write, read and evaluate expressions in which letters stand for numbers.

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Geometry (KY.HS.G)

Standard: KY.HS.G.1 Know and apply precise definitions of the language of Geometry:

- a. Understand properties of line segments, angles and circle.
- b. Understand properties of and differences between perpendicular and parallel lines.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.6 Attend to precision.

- a. Understand properties of line segments, angles and circle.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand definitions of point, line, and arc.	Describe the terms, point, line, and distance along a line in a plane. Define circle and the distance around a circular arc.	Identify points and lines in a plane. Identify and name circular arcs.

- b. Understand properties of and differences between perpendicular and parallel lines.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand definitions of angle, circles, perpendicular lines, parallel lines, and line segments.	Define perpendicular lines, parallel lines, line segments, and angles.	Identify and name perpendicular lines, parallel lines, line segments, and angles. Identify and name circular arcs.

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Geometry (KY.HS.G)

Standard: KY.HS.G.2 Representing transformations in the plane.

- a. Describe transformations as functions that take points in the plane as inputs and give other points as outputs
- b. Compare transformations that preserve distance and angle measures to those that do not.
- c. Given a rectangle, parallelogram, trapezoid, or regular polygon, formally describe the rotations and reflections that carry it onto itself, using properties of these figures.

Enduring Skills:

- MP.3. Construct viable arguments and critique the reasoning of others.
- MP.5 Use appropriate tools strategically.
- MP.7. Look for and make use of structure.

- a. Describe transformations as functions that take points in the plane as inputs and give other points as outputs

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand the different types of transformations including translations, reflections, rotations, and dilations. How are transformations and functions related?	Represent transformations in the plane. Write functions to represent transformations.	Describe and compare function transformations on a set of points as inputs to produce a set of points as outputs, to include translations and horizontal and vertical stretching.

- b. Compare transformations that preserve distance and angle measures to those that do not.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand which transformations are a rigid motion (isometry) and which are not	Compare transformations that preserve distance and angle to those that do not.	Compare transformations that preserve distance and angles to those that do not.

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c. Given a rectangle, parallelogram, trapezoid, or regular polygon, formally describe the rotations and reflections that carry it onto itself, using properties of these figures.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand that rotations and reflections carry it onto itself, recognizing the important properties of these figures.	Use technology to represent and compare rigid and size transformations and size of figures in a coordinate plane.	Use technologies such as transparencies, geometry software, interactive whiteboards, and digital visual presenters to represent and compare rigid and size transformations of figures in a coordinate plane.

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Geometry (KY.HS.G)

Standard: KY.HS.G.3 (+) Develop definitions of rotations, reflections and translations in terms of angles, circles, perpendicular lines, parallel lines and line segments.

Enduring Skills:

MP.6. Attend to precision.

MP.7. Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Define angles, circles, perpendicular and parallel lines, and line segments. Define rotations, reflections, and translations.	Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments.	Create accurate definitions of rotations, reflections, and translations.

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Geometry (KY.HS.G)

Standard: KY.HS.G.4 Understand the effects of transformations of geometric figures.

- a. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure.
- b. Specify a sequence of transformations that will carry a given figure onto another.
- c. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure. Given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

Enduring Skills:

- MP.2. Reason abstractly and quantitatively.
- MP.4. Model with mathematics.
- MP.8 Look for and express regularity in repeated reasoning.

- a. Given a geometric figure and a rotation, reflection, or translation, draw the transformed figure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to transform a geometric figure.	Draw a transformed figure. Specify the sequence of transformations that were used to carry the given figure onto the other.	Identify the sequence of transformations that carries a figure onto another.

- b. Specify a sequence of transformations that will carry a given figure onto another.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to transform a geometric figure.	Specify the sequence of transformations that were used to carry the given figure onto the other.	Identify the sequence of transformations that carries a figure onto another.

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c. Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure. Given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to identify corresponding angles and sides after transformations.	Justify congruency of two triangles using transformations. Use the definition of congruence in terms of rigid motion to show that two triangles are congruent if corresponding pairs of angles are congruent.	Identify corresponding angles and sides of triangles use corresponding sides and angles to justify triangle congruency.

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Geometry (KY.HS.G)

Standard: KY.HS.G.5 Know and apply the concepts of triangle congruence:

- a. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.
- b. Explain how the criteria for triangle congruence (ASA, SAS and SSS) follow from the definition of congruence in terms of rigid motions.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.6 Attend to precision.

- a. Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Define congruence. Understand triangle congruence criteria (ASA, SSS, and SAS).	Informally use rigid motions to take angles to angles and segments to segments. Use dynamic geometric software, straightedge, and compass to take angles to angles and segments to segments.	Explain how the criteria for triangle congruence (ASA, SAS, SSS) follows from the definition of congruence in terms of rigid motions.

- b. Explain how the criteria for triangle congruence (ASA, SAS and SSS) follow from the definition of congruence in terms of rigid motions.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Define congruence. Understand triangle congruence criteria (ASA, SSS, and SAS).	Informally use rigid motions to take angles to angles and segments to segments. Use dynamic geometric software, straightedge, and compass to take angles to angles and segments to segments.	Explain how the criteria for triangle congruence (ASA, SAS, SSS) follows from the definition of congruence in terms of rigid motions.

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Geometry (KY.HS.G)

Standard: KY.HS.G.6 Apply theorems for lines, angles, triangles, parallelograms.

Enduring Skills:

MP.2 Reason abstractly and quantitatively

MP.3 Construct viable arguments and critique the reasoning of others.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>What strategy can be used to prove geometric theorems?</p> <p>Understand the properties of vertical angles, parallel lines with transversals, all angle relationships, corresponding angles, perpendicular lines, and equidistant from endpoint.</p>	<p>Prove vertical angles are congruent.</p> <p>Prove corresponding angles are congruent when two parallel lines are cut by a transversal and converse.</p> <p>Prove alternate interior angles are congruent when two parallel lines are cut by a transversal and converse.</p> <p>Prove points are on a perpendicular bisector of a line segment are exactly equidistant from the segment's endpoint.</p>	<p>Prove theorems pertaining to lines and angles.</p> <p>Prove vertical angles congruent.</p> <p>Prove when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent.</p> <p>Prove points on a perpendicular bisector of a line segment are exactly equidistant from the segment's endpoints.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.7 Prove theorems about geometric figures.

- a. Construct formal proofs to justify theorems for lines, angles and triangles.
- b. (+) Construct formal proofs to justify theorems for parallelograms.

Enduring Skills:

- MP.6 Attend to precision.
- MP.7 Look for and make use of structure.

- a. Construct formal proofs to justify theorems for lines, angles and triangles.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Understand hypothesis and conclusion of a theorem.</p> <p>Understand properties of triangles that can be used to prove theorems.</p>	<p>Prove theorems pertaining to triangles.</p> <p>Prove the measures of interior angles of a triangle have a sum of 180°.</p> <p>Prove base angles of isosceles triangles are congruent.</p> <p>Prove the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length.</p> <p>Prove the medians of a triangle meet at a point.</p> <p>Analyze components of a theorem.</p>	<p>Design an argument to prove theorems about triangles.</p> <p>Analyze components of a theorem.</p> <p>Prove theorems about triangles.</p>

- b. (+) Construct formal proofs to justify theorems for parallelograms.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Determine whether a quadrilateral is a parallelogram.</p>	<p>Apply theorems to prove if a quadrilateral is a parallelogram or not.</p>	<p>Write a paragraph proof, a flow proof, or a two column proof to show that a quadrilateral is a parallelogram.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.8 Create and apply geometric constructions.

- a. Make formal geometric constructions with a variety of tools and methods.
- b. Apply basic construction procedures to construct more complex figures.

Enduring Skills:

- MP.5 Use appropriate tools strategically.
- MP.6 Attend to precision.

- a. Make formal geometric constructions with a variety of tools and methods.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>What tools can we use to construct geometric figures?</p> <p>To make basic constructions using the tools of geometry.</p>	<p>Copy a segment.</p> <p>Copy an angle.</p> <p>Bisect a segment.</p> <p>Bisect an angle.</p> <p>Construct perpendicular lines, including the perpendicular bisector of a line segment.</p> <p>Construct a line parallel to a given line through a point not on the line.</p>	<p>Perform geometric constructions using a variety of tools and methods.</p>

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b. Apply basic construction procedures to construct more complex figures.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>What tools can we use to construct geometric figures?</p> <p>To make basic constructions using the tools of geometry.</p>	<p>Copy a segment.</p> <p>Copy an angle.</p> <p>Bisect a segment.</p> <p>Bisect an angle.</p> <p>Construct perpendicular lines, including the perpendicular bisector of a line segment.</p> <p>Construct a line parallel to a given line through a point not on the line.</p>	<p>Perform geometric constructions using a variety of tools and methods.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.9 Understand properties of dilations.

- a. Verify the properties that result from that dilations given by a center and a scale factor.
- b. Verify that a dilation produces an image that is similar to the pre-image.

Enduring Skills:

- MP.5. Use appropriate tools strategically.
- MP.7 Look for and make use of structure.

a. Verify the properties that result from that dilations given by a center and a scale factor.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How can transformations help me to understand similarity?</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Verify experimentally that a dilated image is similar to its pre-image by showing congruent corresponding angles and proportional sides.</p> <p>Verify experimentally that a dilation takes a line not passing through the center of the dilation to a parallel line by showing the lines are parallel.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Given a center and a scale factor, verify experimentally, that when dilating a figure in a coordinate plane, a segment of the pre-image that does not pass through the center of the dilation, is parallel to it's image when the dilation is performed.</p>
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b. Verify that a dilation produces an image that is similar to the pre-image.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Define image, pre-image, scale factor, center, and similar figures as they relate to transformations.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Verify experimentally that dilation leaves a line passing through the center of the dilation unchanged, by showing that it is the same line.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Given a center and a scale factor, verify experimentally, that when performing dilations of a line segment, the pre-image, the segment which becomes the image is no longer or shorter based on the ratio given by the scale factor.</p>
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Geometry (KY.HS.G)

Standard: KY.HS.G.10 Apply the properties of similarity transformations to establish the AA criterion for two triangles to be similar.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP. Attend to precision.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand the properties of similarity transformations.	Extend the properties of similarity transformations to the general case of any two similar triangles to establish the AA criterion for similarity of triangles.	Recall the properties of similarity and transformations. Establish the AA criterion for similarity of triangles by extending the properties of similarity transformations to the general case of any two similar triangles.

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Geometry (KY.HS.G)

Standard: KY.HS.G.11 Understand theorems about triangles.

- a. Apply theorems about triangles.
- b. (+) Prove theorems about triangles.
- c. Use similarity criteria for triangles to solve problems and to prove relationships in geometric figures.

Enduring Skills:

- MP.1. Make sense of problems and persevere in solving them.
- MP.3 Construct viable arguments and critique the reasoning of others.

a. Apply theorems about triangles.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand postulates and theorems about triangles.	Use AA, SAS, SSS similarity theorems to prove triangles are similar.	Prove a parallel line to one side of a triangle divides the other two proportionally, and it's converse.

b. (+) Prove theorems about triangles.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand postulates and theorems about triangles.	Prove theorems involving similarity about triangles.	Prove theorems involving similarity about triangles. Use triangle similarity to prove other theorems about triangles. Prove the Pythagorean Theorem using triangle similarity.

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

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand the properties of similarity transformations	Extend the properties of similarity transformations to the general case of any two similar triangles to establish the AA criterion for similarity of triangles	Explain that triangles are similar if all pairs of corresponding angles are congruent and are corresponding pairs of sides are proportional.

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Geometry (KY.HS.G)

Standards: KY.HS.G.12 Understand properties of right triangles.

- a. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles (sine, cosine and tangent).
- b. Explain and use the relationship between the sine and cosine of complementary angles.
- c. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.4. Model with mathematics
- MP.8 Look for and express regularity in repeated reasoning.

- a. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles (sine, cosine and tangent).

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to name the sides of right triangles. Recognize that triangles are similar.	Name the sides of right triangles as related to an acute angle. Recognize that if two right triangles have a pair of acute, congruent angles, and the triangles are similar.	Using a corresponding angle of similar right triangles, show that the relationships of the side ratios are the same, which leads to the definition of trigonometric ratios for acute angles.

- b. Explain and use the relationship between the sine and cosine of complementary angles.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
The Law of Sines and Cosines How to apply the Law of Sines and Cosines to find missing sides and angles	Prove the Law of Sines Prove the Law of Cosines Find missing angles and sides of triangles	Use the Law of Sines to solve problems. Use the Law of Cosines to solve problems.

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c. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Which methods could be used to solve right triangles in applied problems	Solve for an unknown angle or side of a right triangle using sine, cosine, and tangent. Apply both trigonometric ratios and the Pythagorean Theorem to solve application problems involving right triangles	Apply both trigonometric ratios and Pythagorean Theorem to solve application problems involving right triangles.

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Geometry (KY.HS.G)

Standard: KY.HS.G.13 (+) Derive the formula $A = \frac{1}{2} ab \sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side.

Enduring Skills:

MP.6. Attend to precision.

MP.7 Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How does trigonometry help in solving problems involving general triangles?	Draw an auxiliary line from a vertex, perpendicular to the opposite side. Derive the formula $A = \frac{1}{2} ab \sin C$ for the area of a triangle.	Draw an auxiliary line from a vertex, perpendicular to the opposite side. Derive the formula $A = \frac{1}{2} ab \sin C$ for the area of a triangle.

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Geometry (KY.HS.G)

Standard: KY.HS.G.14 (+) Understand and apply the Law of Sines and the Law of Cosines.

- a. Use the Law of Sines and Cosines to find unknown measurements in right and non-right triangles.
- b. Prove the Laws of Sines and Cosines and use them to solve problems.

Enduring Skills:

- MP.1 Make sense of problems and persevere in solving them.
- MP.3 Construct viable arguments and critique the reasoning of others.

a. Use the Law of Sines and Cosines to find unknown measurements in right and non-right triangles.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
The Law of Sines and Cosines. How to apply the Law of Sines and Cosines to find missing angles and sides.	Find missing angles and sides of triangles.	Use the Law of Sines to solve problems. Use the Law of Cosines to solve problems.

b. Prove the Laws of Sines and Cosines and use them to solve problems.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
The Law of Sines and Cosines.	Prove the Law of Sines. Prove the Law of Cosines.	Prove the Law of Sines. Prove the Law of Cosines.

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Geometry (KY.HS.G)

Standard: KY.HS.G.15 Verify using dilations that all circles are similar.

Enduring Skills:

MP.5 Use appropriate tools strategically.

MP.8 Look for and express regularity in repeated reasoning.

Know: What content does the student need to know to demonstrate this standard?	Do: What skill must the student demonstrate?	Mastery: How does the student demonstrate the earning of the standard?
<p>Recognize when figures are similar.</p>	<p>Compare the ratio of the circumference of a circle to the diameter of the circle.</p> <p>Discuss, develop, and justify the ratio of the circumference of a circle to the diameter of the circle for several circles.</p>	<p>Use the fact that the ratio of diameter to circumference is the same for circles, prove that all circles are similar.</p> <p>Determine that the ratio of diameter to circumference is constant for all circles.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.16 Identify and describe relationships among angles and segments within the context of circles involving:

- a. Recognize differences between and properties of inscribed, central and circumscribed angles.
- b. Understand relationships between inscribed angles and the diameter of a circle.
- c. Understand the relationship between the radius of a circle and the line drawn through the point of tangency on that radius.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.7 Look for and make use of structure.

- a. Recognize differences between and properties of inscribed, central and circumscribed angles.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Identify inscribed angles, radii, central angles, circumscribed angles, diameter, and tangent.	Examine the relationship between central, inscribed, and circumscribed angles by applying theorems and their measures.	Using definitions, properties, and theorems, identify and describe relationships among inscribed angles, radii, and chords. Include central, inscribed, and circumscribed angles.

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b. Understand relationships between inscribed angles and the diameter of a circle.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Recognize that inscribed angles on a diameter are right angles.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Examine the relationship between central, inscribed, and circumscribed angles by applying theorems and their measures.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Understand that inscribed angles on a diameter are right angles.</p>
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c. Understand the relationship between the radius of a circle and the line drawn through the point of tangency on that radius.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Recognize that radius of a circle is perpendicular to the radius at the point of tangency.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Examine the relationship between central, inscribed, and circumscribed angles by applying theorems and their measures.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Understand that the radius of a circle is perpendicular to the tangent where the radius intersects the circle.</p>
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Geometry (KY.HS.G)

Standard: KY.HS.G.17 Apply basic construction procedures within the context of a circle.

- a. Construct the inscribed and circumscribed circles of a triangle.
- b. (+) Construct a tangent line from a point outside a given circle to the circle.

Enduring Skills:

MP.5 Use appropriate tools strategically.

MP.6 Attend to precision.

- a. Construct the inscribed and circumscribed circles of a triangle.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Define inscribed and circumscribed circles of a triangle. Recall midpoint and bisector definitions. Define a point of concurrency.	Prove properties of angles for a quadrilateral inscribed in a circle. Use geometric simulation software to make geometric constructions.	Construct inscribed circles of a triangle. Construct circumscribed circles of a triangle. Using definitions, properties, and theorems, prove properties of angles for a quadrilateral inscribed in a circle.

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b. (+) Construct a tangent line from a point outside a given circle to the circle.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Define tangent, radius, perpendicular bisector and midpoint.</p> <p>Identify the center of the circle.</p>	<p>Construct the perpendicular bisector of the line segment between the center C, to the outside point P</p> <p>Construct arcs on a circle C from the midpoint Q, having length CQ.</p> <p>Construct a tangent line</p>	<p>Synthesize the theory that applies to circles that tangents drawn from common external points are congruent.</p> <p>Synthesize the theory that applies to circles that a radius is perpendicular to a tangent at the point of tangency</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.18 (+) Understand the relationship between an intercepted arc length within a circle and the radius of the circle.

- a. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius. Derive the formula for the area of a sector.
- b. Define the radian measure of the angle as the measure of a central angle that intercepts an arc equal in length to the radius of the circle.

Enduring Skills:

- MP.2 Reason abstractly and quantitatively.
- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.5 Use appropriate tools strategically.

a. Derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius. Derive the formula for the area of a sector.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Recall how to find area and circumference of a circle.</p> <p>Recall that circles are similar.</p>	<p>Justify the radii of any two circles (r_1 and r_2) and the arc lengths (s_1 and s_2) determined by congruent central angles are proportional.</p>	<p>Find the arc length of a circle.</p> <p>Using similarity, derive the formula for the area of a sector.</p>

b. Define the radian measure of the angle as the measure of a central angle that intercepts an arc equal in length to the radius of the circle.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Explain that $1^\circ = \pi/18$-radians</p>	<p>Verify that the constant of a proportion is the same as the radian measure of the given angle.</p>	<p>Find the area of a sector in a circle.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.19 Understand the relationship between the algebraic form and the geometric representation of a circle.

- a. Write the equation of a circle of given center and radius using the Pythagorean Theorem.
- b. (+) Derive and write the equation of a circle of given center and radius using the Pythagorean Theorem.
- c. (+) Complete the square to find the center and radius of a circle given by an equation.

Enduring Skills:

- MP.1. Make sense of problems and persevere in solving them.
- MP.2. Reason abstractly and quantitatively.

- a. Write the equation of a circle of given center and radius using the Pythagorean Theorem.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the learning of the standard?</i>
<p>Definition of a circle</p> <p>Know the Pythagorean Theorem</p>	<p>Use the Pythagorean Theorem to derive the equation of a circle, given the center and the radius</p>	<p>Derive the equation of a circle using the Pythagorean Theorem, given coordinates of the center and length of the radius</p>

- b. (+) Derive and write the equation of a circle of given center and radius using the Pythagorean Theorem.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the learning of the standard?</i>
<p>Definition of a circle</p> <p>Know the Pythagorean Theorem</p>	<p>Use the Pythagorean Theorem to derive the equation of a circle, given the center and the radius</p>	<p>Derive the equation of a circle using the Pythagorean Theorem, given coordinates of the center and length of the radius</p>

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c. (+) Complete the square to find the center and radius of a circle given by an equation.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How to complete the square of a quadratic equation</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Given an equation of a circle, complete the square to find the center and the radius</p>	<p>Mastery: <i>How does the student demonstrate the learning of the standard?</i></p> <p>Determine the center and radius of a circle by completing the square.</p>
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Geometry (KY.HS.G)

Standard: KY.HS.G.20 (+) Derive the equations of conic sections.

- a. Derive the equation of a parabola given a focus and directrix.
- b. Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Enduring Skills:

- MP.6 Attend to precision.
- MP.7 Look for and make use of structure.

- a. Derive the equation of a parabola given a focus and directrix.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Know the equation of a parabola $y-k=a(x-h)^2$ $x-h=a(y-k)^2$</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Given a focus and a directrix, derive the equation of a parabola</p>	<p>Mastery: <i>How does the student demonstrate the learning of the standard?</i></p> <p>Derive the equation of a parabola given a focus and directrix</p>
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- b. Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Know the equations for ellipses and hyperbolas</p> <p>Ellipse: $\frac{(x-h)^2}{a^2} + \frac{(y-k)^2}{b^2} = 1$</p> <p>Hyperbola: $\frac{(x-h)^2}{a^2} - \frac{(y-k)^2}{b^2} = 1$</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Given a foci, derive the equations of ellipses and hyperbolas</p>	<p>Mastery: <i>How does the student demonstrate the learning of the standard?</i></p> <p>Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.</p>
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Geometry (KY.HS.G)

Standard: KY.HS.G.21 Use coordinates to justify and prove simple geometric theorems algebraically.

Enduring Skills:

- MP.2 Reason abstractly and quantitatively.
- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.6. Attend to precision

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Recall previous understanding of coordinate geometry including distance, midpoint, and slope formulas, equation of a line, definitions of parallel and perpendicular lines	Derive the equation of a line through 2 points using similar right triangles Derive simple proofs involving circles	Use coordinates to prove simple geometric theorems algebraically Derive the equation of a line through 2 points using similar right triangles Derive simple proofs involving circles

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Geometry (KY.HS.G)

Standard: KY.HS.G.22 Justify and apply the slope criteria for parallel and perpendicular lines and use them to solve geometric problems.

Enduring Skills

- MP.3 Construct viable arguments and critique the reasoning of others
- MP.7. Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Recognize that slopes of parallel lines are equal.	Find the equation of a line parallel to a given line that passes through a given point.	Using slope, prove lines are parallel or perpendicular.
Recognize that slopes of perpendicular lines are opposite reciprocals.	Find the equation of a line perpendicular to a given line that passes through a given point.	Find equations of lines based on certain slope criteria such as; finding the equation of a line parallel or perpendicular to a given line that passes through a given point.
	Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems.	

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Geometry (KY.HS.G)

Standard: KY.HS.G.23 Find measurements among points within the coordinate plane.

- a. Use points from the coordinate plane to find the coordinates of a midpoint of a line segment and the distance between the endpoints of a line segment.
- b. Find the point on a directed line segment between two given points that partitions the segment in a given ratio.

Enduring Skills:

- MP.2 Reason abstractly and quantitatively.
- MP.8. Look for and express regularity in repeated reasoning.

- a. Use points from the coordinate plane to find the coordinates of a midpoint of a line segment and the distance between the endpoints of a line segment.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Formula for midpoint</p> <p>Distance formula</p>	<p>Given a segment (or 2 ordered pairs) apply the formula for midpoint and the distance formula for the length of the segment</p>	<p>Choose and apply the correct formulas for a given segment.</p>

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

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Recall the definition of ratio.</p> <p>Recall previous understandings of coordinate geometry.</p>	<p>Given a line segment (including those with positive and negative slopes) and a ratio, find the point on the segment that partitions the segment into the given ratio.</p>	<p>Given two points (line segment), find the point on the line segment between the two points that divides the segment into a given ratio.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.24 Use coordinates within the coordinate plane to calculate measurements of two dimensional figures.

- a. Compute the perimeters of various polygons.
- b. Compute the areas of triangles, rectangles and other quadrilaterals. ★

Enduring Skills:

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics
- MP.7 Look for and make use of structure.

a. Compute the perimeters of various polygons.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand how the coordinates of the vertices of a polygon, triangle, and rectangle relate to find perimeter.	Formulate a model of figures in contextual problems to compute perimeter.	Use the coordinates of the vertices of a polygon to find the necessary dimensions for finding the perimeter.

b. Compute the areas of triangles, rectangles and other quadrilaterals. ★

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand how the coordinates of the vertices of a polygon, triangle, and rectangle relate to find area.	Formulate a model of figures in contextual problems to compute area.	Use the coordinates of the vertices of a triangle to find the necessary dimensions for finding the area. Use the coordinates of the vertices of a rectangle to find the necessary dimensions for finding the area.

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Geometry (KY.HS.G)

Standard: KY.HS.G.25 Analyze and determine the validity of arguments for the formulas for the various figures and shapes.

- a. Finding the circumference and area of a circle.
- b. Finding the volume of a sphere, prism, cylinder, pyramid and cone.

Enduring Skills:

- MP.4 Model with mathematics
- MP.7. Look for and make use of structure.

a. Finding the circumference and area of a circle.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Know the formula for circumference and area of a circle	Apply the formulas to find the circumference and area of a circle given a circle with a diameter or radius	Apply formulas to determine circumference and area of a given circle

b. Finding the volume of a sphere, prism, cylinder, pyramid and cone.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How do the properties of circles provide a basis for explaining volume formulas and solving problems	<p>Explain the formulas for the circumference of a circle by determining the meaning of each term or factor.</p> <p>Explain the formulas for the volume of a cylinder, pyramid, and cone by determining the meaning of each term or factor.</p>	<p>Give an informal argument for the formula for circumference and area of a circle</p> <p>Give an informal argument for the formulas for the volume of a cylinder, pyramid, and cone.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.26 (+) Give an informal argument using Cavalieri’s principle for the formulas for the volume of a sphere and other solid figures.

Enduring Skills:

- MP.2. Reason abstractly and quantitatively.
- MP.5 Use appropriate tools strategically.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How do the properties of circles provide a basis for explaining volume formulas and solving problems?	Using Cavalieri’s Principle, provide informal arguments to develop the formulas for the volume of spheres and other solid figures.	Give an informal argument using Cavalieri’s principle for the formula for the volume of a sphere and other solid figures.

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Geometry (KY.HS.G)

Standard: KY.HS.G.27 Use volume formulas to solve problems for cylinders, pyramids, cones, spheres, prisms ★

Enduring Skills:

- MP.4 Model with mathematics
- MP.6 Attend to precision.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Formulas for volume for various figures	Solve problems using volume formulas for cylinders, pyramids, cones, and spheres.	Use volume formulas for cylinders, pyramids, cones, and spheres to solve contextual problems.

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Geometry (KY.HS.G)

Standard: KY.HS.G.28 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects

Enduring Skills:

- MP.5 Use appropriate tools strategically.
- MP.7. Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Strategies to help visualize relationships between two-dimensional and three-dimensional objects.	<p>Given a three-dimensional object, identify the shape made when the object is cut into cross-sections.</p> <p>When rotating a two-dimensional figure, such as a square, know the three-dimensional figure that is generated, such as a cylinder.</p> <p>Understand that the cross-section of a solid is an intersection of a plane (two-dimensional) and a solid (three-dimensional).</p>	<p>Relate the shapes of two-dimensional cross-sections to their three-dimensional objects.</p> <p>Discover three-dimensional objects generated by rotations of two-dimensional objects.</p>

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Geometry (KY.HS.G)

Standard: KY.HS.G.29 Use geometric shapes, their measures and their properties to describe objects in real world settings.

Enduring Skills:

- MP.1. Make sense of problems and persevere in solving them.
- MP.7 Look for and make use of structure

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to relate geometric shapes to real-world objects.	Classify a real-world object as a known geometric shape. Solve real-world problems involving geometric shapes.	Given a real-world object, classify the object as a known geometric shape – use this to solve problems in context. Use geometric shapes, their measures, and their properties to describe objects.

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Geometry (KY.HS.G)

Standard: KY.HS.G.30 Apply concepts of density based on area and volume in modeling situations, using appropriate units of measurement.

Enduring Skills:

MP.4 Model with mathematics.

MP.6 Attend to precision.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
*Definition of density.	Apply concepts of density based on area and volume to model real-world situations.	Use the concept of density when referring to situations involving area and volume models, such as persons per square mile.

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Geometry (KY.HS.G)

Standard: KY.HS.G.31 Apply geometric methods to solve design problems. ★

Enduring Skills:

- MP.1 Make sense of problems and persevere in solving them.
- MP.4 Model with mathematics.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Describe a topographical design system.</p> <p>How can geometric concepts be used to describe objects found in nature?</p>	<p>Apply geometric methods to solve design problems.</p>	<p>Solve design problems by designing an object or structure that satisfies certain constraints, such as minimizing cost or working with a grid system based on ratios.</p>

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.14 Describe events as subsets of a sample space. Use characteristics (or categories) of the outcomes, such as,

- as unions, “A or B,” that are mutually exclusive events and
- as unions, “A or B,” that are non-mutually exclusive events and
- as intersections, “A and B,” and
- as complements of other events, “not A.” to calculate basic probabilities.

Enduring Skills:

MP.2 Reason abstractly and quantitatively.

MP.3. Construct viable arguments and critique the reasoning of others.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Define unions, intersections, and complements of events.	Describe events as subsets of sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events.	Define a sample space and events within the sample space. Identify subsets from sample space given defined events, including unions, intersections, and complements of events.

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.15 Understand the concept of independence.

- a. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their individual probabilities, $P(A) \times P(B)$
- b. (+) Determine whether two events are independent and provide a justification to support the decision.
- c. Recognize and explain the concept of independence in everyday language and everyday situations.

Enduring Skills:

- MP.1. Make sense of problems and persevere in solving them.
- MP.6 Attend to precision.

a. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their individual probabilities, $P(A) \times P(B)$

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Definition of independent events Understand the properties of independence and conditional probabilities	Categorize events as independent or dependent Explain properties of independence and conditional probabilities in context and simple English	Label events as independent or not

b. (+) Determine whether two events are independent and provide a justification to support the decision.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Definition of independent events.	Categorize events as independent or dependent.	Label events as independent or not.

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c. Recognize and explain the concept of independence in everyday language and everyday situations.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Understand the properties of Independence and Conditional Probabilities.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Explain properties of Independence and Conditional Probabilities in context and simple English.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Relate independence and conditional probability in everyday language and everyday situations</p>
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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.16 Understand the concept of conditional probability.

- a. Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$.
- b. (+) Interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A and the conditional probability of B given A is the same as the probability of B.
- c. Recognize and explain the concept of conditional probability in everyday language and everyday situations.
- d. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A and interpret the answer in terms of the model.

Enduring Skills:

- MP.1. Make sense of problems and persevere in solving them.
- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.6 Attend to precision.

a. Understand the conditional probability of A given B as $P(A \text{ and } B)/P(B)$.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Know the conditional probability of A given B as $P(A \text{ and } B)/P(B)$.	Define and calculate conditional probabilities.	Calculate conditional probabilities using the Multiplication Principle

b. (+) Interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A and the conditional probability of B given A is the same as the probability of B.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Definition of independent events	Categorize events as independent or dependent. Explain properties of independence and conditional probabilities in context and simple English	Label events as independent or not.

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c. Recognize and explain the concept of conditional probability in everyday language and everyday situations.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How are independence and conditional probability related and used to interpret data</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Recognize and explain the concepts of independence and conditional probability in everyday situations</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Relate independence and conditional probability in everyday language and everyday situations</p>
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d. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A and interpret the answer in terms of the model.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How to define and calculate conditional probabilities.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Define and calculate conditional probabilities.</p> <p>Use the Multiplication Principle to decide if two events are independent.</p> <p>Calculate conditional probabilities.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Determine if two events are independent or dependent.</p> <p>Calculate conditional probabilities using the Multiplication Principle</p>
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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.17 (+) Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide whether events are independent and to approximate conditional probabilities.

Enduring Skills:

- MP.4 Model with mathematics.
- MP.7 Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>How to use a two way sample space to decide if events are independent and approximate conditional probabilities.</p> <p>Develop understanding of independence and conditional probability.</p>	<p>Interpret two-way frequency tables of data when two categories are associated with each object being classified.</p>	<p>Use two-way frequency tables of data to determine if events are independent and approximate conditional probabilities</p>

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.18 (+) Apply the General Multiplication Rule, $P(A \text{ and } B) = P(A)P(B|A) = P(B)P(A|B)$, in a uniform probability model and interpret the answer in terms of the model.

Enduring Skills:

- MP.4 Model with mathematics.
- MP.5 Use appropriate tools strategically.
- MP.7 Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to use the multiplication rule with correct notation.	Calculate probabilities using the General Multiplication Rule. Apply the General Multiplication Rule in a uniform probability model. Interpret answers in terms of the model.	Apply the General Multiplication Rules to calculate probabilities.

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.19 Use permutations and combinations to compute probabilities.

- a. Distinguish between situations that can be modeled using counting techniques, including Fundamental Counting Principle, permutations and combinations.
- b. Perform calculations using the appropriate counting technique, including simple probabilities.
- c. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Enduring Skills:

- MP.4 Model with mathematics.
- MP.5 Use appropriate tools strategically.
- MP.7 Look for and make use of structure.

a. Distinguish between situations that can be modeled using counting techniques, including Fundamental Counting Principle, permutations and combinations.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How to correctly identify situations that are permutations and those that are combinations.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Use permutations and combinations to compute probabilities of compound events and solve problems.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Identify permutations and combinations for given situations.</p> <p>Solve problems and find compound probabilities using permutations and combinations</p>
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b. Perform calculations using the appropriate counting technique, including simple probabilities.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How to correctly identify situations that are permutations and those that are combinations.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Use permutations and combinations to compute probabilities of compound events and solve problems.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Identify permutations and combinations for given situations.</p> <p>Solve problems and find compound probabilities using permutations and combinations</p>
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c. (+) Use permutations and combinations to compute probabilities of compound events and solve problems.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
How to correctly identify situations that are permutations and those that are combinations	Use permutations and combinations to compute probabilities of compound events and solve problems	Identify permutations and combinations for given situations Solve problems and find compound probabilities using permutations and combinations

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.20 (+) Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space; graph the corresponding probability distribution using the same appropriate graphical displays as for data distributions.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.4 Model with mathematics
- MP.5 Use appropriate tools strategically.
- MP.8 Look for and express regularity in repeated reasoning.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Find the probability of an event	Use a geometric probability model in which points represent outcomes	Use segment and area models to find probabilities of events

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.21 (+) Calculate the expected value of a random variable; interpret it as the mean of the probability distribution and use the value in analyzing decisions.

Enduring Skills:

- 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.5 Use appropriate tools strategically.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
<p>Recall previous understanding of probability.</p> <p>How can I evaluate outcomes of decisions using probability?</p>	<p>Analyze decisions and strategies using probability concepts.</p> <p>Explain in context decisions made based on expected values.</p>	<p>Analyze decisions and strategies using probability concepts.</p>

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.22 (+) Develop a probability distribution for a random variable.

- a. Find an expected value based on a sample space in which theoretical probabilities can be calculated.
- b. Find an expected value based on a sample space in which empirical probabilities can be calculated.

Enduring Skills:

- MP.2 Reason abstractly and quantitatively.
- MP.4 Model with mathematics.
- MP.8 Look for and express regularity in repeated reasoning.

- a. Find an expected value based on a sample space in which theoretical probabilities can be calculated.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Theoretical probability is given by the number of ways a particular event can occur divided by the total number of possible outcomes	Find an expected value based on a sample space	Determine a value in which theoretical probabilities can be calculated

- b. Find an expected value based on a sample space in which empirical probabilities can be calculated.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
The empirical probability of an event is given by the number of times an event occurs divided by the total number of incidents observed	Find an expected value base on a sample space	Solve for a value based on the sample space in which empirical probabilities can be calculated

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Probability and Statistics (KY.HS.SP)

Standard: KY.HS.SP.23 (+) Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.

- a. Find the expected payoff for a game of chance.
- b. Evaluate and compare strategies on the basis of expected values.
- c. Use calculated expected values to make fair decisions and formulate strategies.

Enduring Skills:

- MP.2 Reason abstractly and quantitatively.
- MP.3 Construct viable arguments and critique the reasoning of others.

- a. Find the expected payoff for a game of chance.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>How to compute theoretical and experimental probabilities</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Use probabilities to make decisions</p>	<p>Mastery: <i>How does the student demonstrate the learning of the standard?</i></p> <p>Find the expected payoff for a game of chance.</p>
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- b. Evaluate and compare strategies on the basis of expected values.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Recall previous understandings of probability</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Use probabilities to make decisions</p>	<p>Mastery: <i>How does the student demonstrate the learning of the standard?</i></p> <p>Evaluate and compare strategies on the basis of expected values</p>
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- c. Use calculated expected values to make fair decisions and formulate strategies.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Recall previous understandings of probability and how decisions are made from it</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Use probabilities to make fair decisions</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Use calculated expected values when making decisions and formulating strategies</p>
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Number and Quantity (The Real Number System) (KY.HS.N)

Standard: KY.HS.N.12 (+) Understand and apply properties of vectors.

- a. Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes.
- b. Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.
- c. Solve problems involving velocity and other quantities that can be represented by vectors.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP. 7 Look for and make use of structure

a. Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Understand that vectors are directed by an angle and continue in that direction for a set length.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Recognize vector quantities as having both magnitude and direction, and use appropriate symbols for vectors.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Represent vector quantities by directed line segments.</p>
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b. Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Find vertical and horizontal components and magnitude of a vector.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Find the components of a vector by computing the coordinates from the initial point.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Connect components and magnitude of a vector and use the Pythagorean Theorem in the coordinate plane.</p>
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c. Solve problems involving velocity and other quantities that can be represented by vectors.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Know that velocity and other quantities are represented by vectors.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Determine the terminal point of a vector.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Solve problems by applying properties of vectors involving velocity and other quantities, limited to two dimensional vectors.</p>
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Number and Quantity (The Real Number System) (KY.HS.N)

Standard: KY.HS.N.13 (+) Perform operations with vectors (addition, subtraction and multiplication by a scalar).

- a. Add vectors end-to-end, component-wise and by the parallelogram rule. Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.
- b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.
- c. Understand vector subtraction $v-w$ as $v+(-w)$, where $-w$ is the additive inverse of w , with the same magnitude as w and pointing in the opposite direction. Represent vector subtraction graphically by connecting the tips in the appropriate order and perform vector subtraction component-wise.
- d. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise.
- e. Compute the magnitude of a scalar multiple cv using $||cv|| = |c|v$. Compute the direction of cv knowing that when $|c|v \neq 0$, the direction of cv is either along v (for $c>0$) or against v (for $c<0$).

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.7 Look for and make use of structure.

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

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Know the magnitude of a sum of two vectors is not the sum of the magnitudes.	Add vectors end-to-end, component-wise, and by the parallelogram rule.	Solve problems by vector addition.

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

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand the form of vector magnitude and direction.	Determine magnitude and direction of the sum of two vectors.	Solve problems involving the sum of two vectors.

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

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
For vector subtraction, use $v-w$ as $v+(-w)$	Apply additive inverse to vectors in vector subtraction.	Solve problems that require vector subtraction.

d. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction; perform scalar multiplication component-wise.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand how to reverse direction of a vector.	Represent scalar multiplication graphically by scaling vectors.	Perform scalar multiplication component-wise.

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

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Compute magnitude using the absolute value of cv	Compute the magnitude of a scalar multiple	Solve problems involving both magnitude and direction using a scalar multiple.

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Number and Quantity (The Real Number System) (KY.HS.N)

Standard: KY.HS.N.14 Use matrices to represent and manipulate data.

Enduring Skills:

MP.4 Model with mathematics

MP.5 Use appropriate tools strategically

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Know that matrices represent a set of data.</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Write a matrix from a problem or a given set of data.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Write and solve problems using matrices.</p>
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Number and Quantity (The Real Number System) (KY.HS.N)

Standard: KY.HS.N.15 Perform operations with matrices.

- a. Add, subtract and multiply matrices of appropriate dimensions.
- b. Multiply matrices by scalars to produce new matrices.

Enduring Skills:

- MP.7 Look for and make use of structure.
- MP.8 Look for and express regularity in repeated reasoning.

a. Add, subtract and multiply matrices of appropriate dimensions.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Understand when addition, subtraction and multiplication of matrices of different dimensions is possible</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Add, subtract, and multiply matrices of different dimensions.</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Correctly identify when matrix operations are possible and perform those operations to solve problems.</p>
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b. Multiply matrices by scalars to produce new matrices.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Understand what a matrix scalar is, and how the new matrix size is related</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Perform scalar multiplication</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Solve problems using scalar matrix multiplication</p>
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Number and Quantity (The Real Number System) (KY.HS.N)

Standard: KY.HS.N.16 (+) Understand properties of square and identity matrices.

- a. Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.
- b. Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.
- c. Work with 2x2 matrices as transformations of the plane and interpret the absolute value of the determinant in terms of area.

Enduring Skills:

- MP.3 Construct viable arguments and critique the reasoning of others.
- MP.7 Look for and make use of structure.

a. Understand that, unlike multiplication of numbers, matrix multiplication for square matrices is not a commutative operation, but still satisfies the associative and distributive properties.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Understand matrix multiplication of square matrices is not commutative.	Multiply square matrices using associative and distributive properties.	Fill in matrix values from a problem and solve using matrix multiplication.

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b. Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Understand that zero and identity matrices play a role in addition and multiplication of matrices</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Apply the roles of 0 and 1 in matrices of real numbers</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Apply rules that the determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse.</p>
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c. Work with 2x2 matrices as transformations of the plane and interpret the absolute value of the determinant in terms of area.

<p>Know: <i>What content does the student need to know to demonstrate this standard?</i></p> <p>Understand how to solve a 2x2 matrix problem</p>	<p>Do: <i>What skill must the student demonstrate?</i></p> <p>Perform transformations using and applying matrices</p>	<p>Mastery: <i>How does the student demonstrate the earning of the standard?</i></p> <p>Work with 2x2 matrices as transformations in the plane</p>
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Number and Quantity (The Real Number System) (KY.HS.N)

Standard: KY.HS.N.17 (+) Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector. Work with matrices as transformations of vectors.

Enduring Skills:

MP.2 Reason abstractly and quantitatively.

MP.3 Construct viable arguments and critique the reasoning of others.

MP.7 Look for and make use of structure.

Know: <i>What content does the student need to know to demonstrate this standard?</i>	Do: <i>What skill must the student demonstrate?</i>	Mastery: <i>How does the student demonstrate the earning of the standard?</i>
Know that a vector is a 1-column matrix.	Multiply a vector by a matrix.	Work with matrices as transformations of vectors.

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Table 1
Common Addition and Subtraction Situations¹

	Result Unknown	Change Unknown	Start Unknown
Add To	Two bunnies sat on the grass. Three more bunnies hopped there. How many bunnies are on the grass now? $2 + 3 = ?$	Two bunnies were sitting on the grass. Some more bunnies hopped there. Then there were five bunnies. How many bunnies hopped over to the first two? $2 + ? = 5$	Some bunnies were sitting on the grass. Three more bunnies hopped there. Then there were five bunnies. How many bunnies were on the grass before? $? + 3 = 5$
Take From	Five apples were on the table. I ate two apples. How many apples are on the table now? $5 - 2 = ?$	Five apples were on the table. I ate some apples. Then there were three apples. How many apples did I eat? $5 - ? = 3$	Some apples were on the table. I ate two apples. Then there were three apples. How many apples were on the table before? $? - 2 = 3$
Put Together/ Take Apart²	Total Unknown Three red apples and two green apples are on the table. How many apples are on the table? $3 + 2 = ?$	Addend Unknown Five apples are on the table. Three are red and the rest are green. How many apples are green? $3 + ? = 5, 5 - 3 = ?$	Both Addends Unknown³ Grandma has five flowers. How many can she put in her red vase and how many in her blue vase? $5 = 0 + 5, 5 = 5 + 0$ $5 = 1 + 4, 5 = 4 + 1$ $5 = 2 + 3, 5 = 3 + 2$
Compare⁴	Difference Unknown ("How many more?" version): Lucy has two apples. Julie has five apples. How many more apples does Lucy have than Julie? ("How many fewer?" version): Lucy has two apples. Julie has five apples. How many fewer apples does Lucy have than Julie? $2 + ? = 5, 5 - 2 = ?$	Bigger Unknown ("Version with "more"): Julie has three more apples than Lucy. Lucy has two apples. How many apples does Julie have? ("Version with "fewer"): Lucy has three fewer apples than Julie. Lucy has two apples. How many apples does Julie have? $2 + 3 = ?, 3 + 2 = ?$	Smaller Unknown ("Version with "more"): Julie has three more apples than Lucy. Julie has five apples. How many apples does Lucy have? ("Version with "fewer"): Lucy has three fewer apples than Julie. Julie has five apples. How many apples does Lucy have? $5 - 3 = ?, ? + 3 = 5$

Blue shading indicates the four Kindergarten problem subtypes. Students in grades 1 and 2 work with all subtypes and variants (blue and green). Yellow indicates problems that are the difficult four problem subtypes students in grade 1 work with but do not need to master until grade 2.

¹ Adapted from Box 2-4 of National Research Council (2009, op. cit., pp. 32, 33).

² These take apart situations can be used to show all the decompositions of a given number. The associated equations, which have the total on the left of the equal sign, help children understand that the = sign does not always mean makes or results in but always does mean is the same number as.

³ Either addend can be unknown, so there are three variations of these problem situations. Both Addends Unknown is a productive extension of this basic situation especially for small numbers less than or equal to 10.

⁴ For the Bigger Unknown or Smaller Unknown situations, one version directs the correct operation (the version using more for the bigger unknown and using less for the smaller unknown). The other versions are more difficult.

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Table 6
Fluency Standards across All Grade Levels

Coding	Fluency Standards
KY.K.OA.5	Fluently add and subtract within 5.
KY.1.OA.6	Fluently add and subtract within 10.
KY.2.OA.2	Fluently add and subtract within 20.
KY.2.NBT.5	Fluently add and subtract within 100.
KY.3.OA.7	Fluently multiply and divide within 100.
KY.3.NBT.2	Fluently add and subtract within 1000.
KY.4.NBT.	Fluently add and subtract multi-digit whole numbers using an algorithm.
KY.5.NBT.5	Fluently multiply multi-digit whole numbers (not to exceed four-digit by two-digit multiplication) using an algorithm.
KY.6.NS.2	Fluently divide multi-digit numbers using an algorithm.
KY.6.NS.3	Fluently add, subtract, multiply and divide multi-digit decimals using an algorithm for each operation.
KY.6.EE.2	Write, read and evaluate expressions in which letters stand for numbers.
KY.7.NS.1d	Apply properties of operations as strategies to add and subtract rational numbers.
KY.7.NS.2c	Apply properties of operations as strategies to multiply and divide rational numbers.
KY.8.EE.7	Solve linear equations in one variable.
KY.HS.A.2	Use the structure of an expression to identify ways to rewrite it and consistently look for opportunities to rewrite expressions in equivalent forms.
KY.HS.A.19	Solve quadratic equations in one variable.
KY.HS.F.4	Graph functions expressed symbolically and show key features of the graph both with and without technology (i.e., computer, graphing calculator). ★
KY.HS.F.8	Understand the effects of transformations on the graph of a function.
KY.HS.G.21	Use coordinates to justify and prove simple geometric theorems algebraically.
KY.HS.G.11c	Use similarity criteria for triangles to solve problems in geometric figures.
KY.HS.G.12c	Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★