KY Math Standards

Unit 2 Title	**Estimated Time Frame**
Functions and **Systems**	**20 block days** (15 block days including Common Assessment to include Linear Functions and Systems and 5 block days in December to include Absolute Value)

Big Idea (s)

Interpret functions given graphically, numerically, symbolically, and verbally.
Translate between representations and understand the limitations of various functions.
Work with functions given by graphs and tables.
Solve Systems of Equations by: Graphing (including use of technology), Substitution or Elimination, Equations by Multiplication & by any method
Interpret solutions to Systems of Equations
Apply knowledge to solve real-world Systems of Equations

Essential Question(s)

Looking at a graph, can you explain in real-world context what is happening?
What makes a relation a function?
How do arithmetic sequences relate to linear functions?
How do you use systems of linear equations and inequalities to model situations and solve problems?
In what ways can the problem be solved, and why should one method be chosen over another?
How does using a model (such as a graph or table) assist us in finding the slope of a line or help us to solve systems of linear equations?
How does determining one solution, infinitely many solutions, or no solutions to an equation assist in knowing the reasonableness of a final answer?
How does a point of intersection relate to the solution of systems of equations?
What are the key features of the graph of the absolute value functions?

Standards for Mathematical Practice (MP.) - The practice standards in bold describe expertise to be intentionally developed in this Unit.	**Kentucky Interdisciplinary Literacy Practices (KILP.) -** The practice standards in bold describe expertise to be intentionally developed in Mathematics.
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**	KILP.1 Recognize that text is anything that communicates a message. KLIP.2 Employ, develop, and refine schema to understand and create text. KILP.3 View literacy experiences as transactional, interdisciplinary and transformational. KILP.4 Utilize receptive & expressive language arts to better understand self, others, and the world. KILP.5 Apply strategic practices, with scaffolding and then independently, to approach new literacy tasks. **KILP.6 Collaborate with others to create new meaning.** **KILP.7 Utilize digital resources to learn and share with others.** **KILP.8 Engage in specialized, discipline specific literacy practices.** **KILP.9 Apply high level cognitive processes to think deeply and critically about text.**

repeated reasoning.	KILP.10 Develop a literacy identity that promotes lifelong learning.

Common Preconceptions/Misconceptions

- Students frequently confuse the concept of each domain value being paired with one range value as also meaning each range value can only have one domain value. One way to illustrate this is to have at least 13 students match their names with their birth months. Every student will have exactly one birth month, but at least one month will be chosen twice. Students should consider if this is a function. This can also be seen in a table or in a diagram with arrows connecting the input and output.
- Students may think that a correlation coefficient of (-1) indicates that there is no correlation. Instead, it indicates that there is a strong negative correlation.
- Students who are having trouble with fluency in solving equations may need a hands-on approach (AlgeblocksTM, Hands-On EquationsTM, and Algebra TilesTM can be useful). All are available from the District Math Lab at the Teacher Resource Center.
- Skills Previously Taught:
  - Sketch Functions from Verbal Descriptions
  - Understanding Relations and Functions
  - Comparing Linear and Non-Linear Models
  - Analyze Linear Associations

KAS Standards	Considerations	Samples of Learning Intentions and Success Criteria
KY.HS.F.1 Understand properties and key features of functions and the different ways functions can be represented. a. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. b. Using appropriate function notation, evaluate functions for inputs in their domains and interpret statements that use function notation in terms of a context. c. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities and sketch	a. When describing relationships between quantities, the defining characteristic of a function is the input value determines the output value or, equivalently, the output value depends upon the input value. In some situations where two quantities are related, each can be viewed as a function of the other. b. n/a c. A function is often described and understood in terms of the output behavior, or over what input values it is increasing, decreasing, or constant. Important questions include, “For what input values is the output value positive, negative, or 0? What happens to the output when the input value gets very large in magnitude?” Graphs become	I am learning to determine the properties and key features of functions. **(Lessons 3-1, 3-2)** ● I can identify functions using diagrams. ● I can identify functions using tables. I am learning to determine if a relation is a function and how to represent it. **(Lesson 3-1, and Lesson 3-2 includes F.1.b)** ● I can recognize a relation as a function if each input only has one output. ● I can represent a linear function with an equation and a graph. ● I can use a table and graph to represent a nonlinear function. ● I can use appropriate function notation ● I can evaluate functions for inputs in their domains. ● I can interpret statements that use function notation.

graphs showing key features given a verbal description of the relationship. d. Relate the domain of a function to its graph, where applicable, to the quantitative relationship it describes. (algebraically, graphically, numerically in tables, or by verbal descriptions). **MP.2, MP.4, MP**	useful representations for understanding and comparing functions because these behaviors are often easy to see in the graphs of functions. Key features include, but are not limited to: intercepts; intervals where the function is increasing, decreasing, or remaining constant; relative maxima and minima; symmetries; end behavior; periodicity. d. n/a e. Students compare characteristics from various representations for one type of family of function at a time. For quadratics, students might determine which function has the larger maximum when given two different representations of quadratic functions.	I am learning to compare the properties of two functions. **(Lesson 3-1)** ● I can compare the constant rate of change and the initial value of a function using a table. ● I can determine the rate of change and initial value of a function using a graph. ● I can represent functions algebraically and determine the rate of change.
KY.HS.F.4 Graph functions expressed symbolically and show key features of the graph, with and without using technology (computer, graphing calculator). ★ a. Graph linear functions. . **MP.4, MP.5**	Within a family, the functions often have commonalities in the shapes of their graphs and in the kinds of features important for identifying and describing functions. This standard indicates the function families in students' repertoires, detailing which features are required for several key families. Students demonstrate fluency with linear functions, including the ability to graph without using technology.	I am learning to graph lines using the key features. **(Lessons 2-1, 2-2, and 2-3)** ● I can define key features of a linear function. ● I can graph quadratic equations.
KY.HS.F.3 Understand average rate of change of a function over an interval. a. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. b. Estimate the rate of change from a graph. ★ **MP.2, MP.4**	The rate of change over an interval is equivalent to the slope between the endpoints of the interval. For linear functions, the rate of change is constant, over all intervals. However, for nonlinear functions, the average rate of change may vary depending on the interval.	I am learning to calculate and interpret slopes given various forms. **(Lessons 2-0 and 3-1)** ● I can define the rate of change in relation to slope. ● I can find a slope from different representations: tables, graphs, and a set of points.
KY.HS.A.13 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes	Students solve systems of equations with two or more variables to solve problems in the real world setting.	I am learning to create equations with rate of change and starting point **(Lesson 3-5)**

with labels and scales. **MP.2, MP.5**		● I can interpret the slope and y-intercept given data. ● I can write equations from key features of graphed data.
KY.HS.SP.6 Represent data on two quantitative variables on a scatter plot and describe how the explanatory and response variables are related. a. Calculate an appropriate mathematical model, or use a given mathematical model, for data to solve problems in context. b. Informally assess the fit of a model (through calculating the correlation for linear data, plotting, calculating, and analyzing residuals). **MP.3, MP.4, MP.5**	Emphasize linear, quadratic and exponential models as illustrated below.	I am learning to construct and interpret scatterplots. **(Lessons 3-5, 3-6)** ● I can determine ordered pairs for a set of data. I am learning to use a scatter plot to describe the relationship between two data sets. **(Lesson 3-5)** ● I can plot ordered pairs on a coordinate grid ● I can describe the association of a scatter plot as positive, negative, or no association. ● I can calculate correlation for linear data. ● I can find the line of best fit for a data set and evaluate its goodness of fit.
KY.HS.SP.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. **MP.1, MP.2**	Students demonstrate interpreting slope in the context of a given situation when examining two variable statistics as being “for each additional known unit increase in an explanatory variable, we expect or predict a known unit increase (or decrease) in the response variable.” Students demonstrate interpreting intercept in the context of a given situation when examining two variable statistics as being “the predicted known unit of a response variable when the explanatory variable is zero known units.”	I am learning that linear regression is a method used to calculate the line of best fit. **(Lessons 2.0 , 3-5, 3-6)** ● I can use technology to compute the correlation coefficient of a linear fit. I am learning the correlation coefficient indicates the direction and strength of the linear relationship between two variables. ● I can interpret the meaning of the correlation within the context of the data. I am learning a residual that reveals how well a linear model fits the data set. ● I can describe the limitations of correlation when establishing causation.
KY.HS.A.13 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	Students solve systems of equations with two or more variables to solve problems in the real world setting.	I am learning the solution to a system of inequalities lies in the region where the graphs overlap. **(Lessons 4-1, 4-2, 4-3, 4-4, 4-5)** ● I can find a solution for a system.

MP.2, MP.5		• I can identify the conditions under which an optimal solution would occur for a given real-world situation. • I can justify solutions for equations that Include cases where f(x) and/or g(x) are linear or absolute value functions. ★
KY.HS.A.20 Solve systems of linear equations in two variables. a. Understand a system of two equations in two variables has the same solution as a new system formed by replacing one of the original equations with an equivalent equation. b. Solve systems of linear equations with graphs, substitution, **and** elimination, focusing on pairs of linear equations in two variables. **MP.3, MP.6**	a. This part of the standard is not focused on the actual process of solving a system of equations, but rather the proof of the method (specifically the elimination method). b. Students utilize a variety of methods to solve systems of equations including graphing the system, solving using the substitution method, solving the system with elimination both with and without involving multiplication. Students recognize the conclusion of these processes may result in obtaining one solution (expressed as an ordered pair), no solution or infinitely many solutions.	I am learning to identify, evaluate, graph, and write linear equations. **(Lessons 4-1, 4-2, 4-3)** • I can solve a system using the elimination method. • I can solve a system using the substitution method. • I can utilize a variety of methods to solve a system of equations, including graphing the system, solving using the substitution method, solving the system with elimination both with and without involving multiplication. • I can recognize one solution (expressed as an ordered pair), no solution, or infinitely many solutions.
KY.HS.A.25 Graph linear inequalities in two variables. a. Graph the solutions to a linear inequality as a half-plane (excluding the boundary in the case of a strict inequality). b. Graph the solution set to a system of linear inequalities as the intersection of the corresponding half-planes. **MP.5**	Students recall skills regarding graphing the solutions of a linear inequality in the coordinate plane in order to graph the solution set for a system of linear inequalities. Students utilize these skills in other standards via linear programming.	I am learning points above and below dashed lines will satisfy specific inequalities. **(Lessons 4-4, 4-5)** • I can recall skills regarding graphing the solutions of a linear inequality in the coordinate plane in order to graph the solution set for a system of linear inequalities. • I can use skills in other standards via linear programming. • I can graph linear functions, without using technology. • I can graph simple systems cases without technology and more complex ones with technology.
Supporting Standards		

KY.HS.A.14 Create a system of equations or inequalities to represent constraints within a modeling context. Interpret the solution(s) to the corresponding system as viable or nonviable options within the context. **(Lessons 4-1, 4-2, 4-3, 4-4, 4-5)**
MP.4, MP.5

KY.HS.A.16 Understand each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. **MP.1, MP.3 (Lesson 1-7)**

KY.HS.A.24 Justify that the solutions of the equations f(x) = g(x) are the x-coordinates of the points where the graphs of y = f(x) and y = g(x) intersect. Find the approximate solutions graphically, using technology or tables. ★
MP.3, MP.5

KY.HS.F.2 Recognize that arithmetic sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.**MP.7, MP.8**

KY.HS.F.4 a. Graph linear functions.
KY.HS.F.4.b. Graph absolute value functions. **(Lesson 5-1 / 5-4)**
KY.HS.F.4.f. (+) Graph piecewise functions, including step functions. (8th-grade Algebra only)

KY.HS.F.6 Write a function that describes a relationship between two quantities. ★ (this is a modeling standard)
a. Determine an explicit expression, a recursive process, or steps for calculation from a context. **(Lesson 3-4)**
b. Combine standard function types using arithmetic operations.
(3 Act Math Task, and Lesson 3-2)

KY.HS.F.7 Use arithmetic sequences to model situations and scenarios. **(Lesson 3-4)**
a. Use formulas (explicit and recursive) to generate terms for arithmetic sequences.
b. Write formulas to model arithmetic sequences and apply those formulas in realistic situations. ★
MP.4, MP.8

KY.HS.F.8 Understand the effects of transformations on the graph of a function. **(Lesson 5-1 / 5-4)**
a. Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx) and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs.
b. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
MP.3, MP.5

KY.HS.F.12 Construct linear functions, including arithmetic sequences, given a graph, a description of a relationship, or two input-output pairs (including reading these from a table). **MP.7, MP.8**

KY.HS.SP.8 Understand the role and purpose of correlation in linear regression.**MP.5, MP.6 (Lessons 3-5, 3-6)**
Considerations:
a. Students use technology.
b. Students understand correlation measures linear associations between two quantitative variables addressing the direction (positive or negative) and the relative strength of the given association.

c. Students understand one of the most common misinterpretations of correlation is to think of it as a synonym for causation. A high correlation between two variables (suggesting a statistical association between the two) does not imply one causes the other.

Essential Vocabulary

function - A correspondence between two sets, the domain, and range, that assigns to each member of the domain exactly one member of the range.
input - The number substituted for the variable in a function or rule machine.
linear function - A function defined by f(x) = mx + b.
non-linear - Not on a line.
output - The number that is the result of a function or rule machine.
rate of change - The speed at which a variable changes over a specific period of time. Also the same as the slope of a function.
function notation - A notation used in defining a function. EX: f(x) = 2x + 20
arithmetic sequence - Sequence which has a constant difference between terms.
average rate of change - Avg. rate = [f(x2) - f(x1)]/(x2 - x1)
intercepts - The x-intercept of a line or curve is the point where it crosses the x-axis, and the y-intercept of a line or curve is the point where it crosses the y-axis.
linear - of or pertaining to a line; having a degree of one nonlinear - not having a resemblance to a line
system of equations - Two or more linear equations in the same variables.
solution - The value of a variable that makes an equation true.
substitution - Replacement of a variable with an equal expression or constant.
intersection - The meeting of two lines/or segments or the two faces of a solid or any two geometric objects EX: 2 roads that cross each other have an intersecting point called an intersection.
solution - The value of a variable that makes an equation true.
substitution property - Replacement of a variable with an equal expression or constant.
system of equations - Two or more equations in the same variable.

Common Assessment

Common Assessment Unit 2 Algebra One

Anchor Resources

enVision Topic 3 - Linear Functions	**enVision Topic 4 - Systems of Linear Equations and Inequalities**	**enVision Topic 5 taught AFTER the common assessment - Absolute Value Functions**
MILC - MILC Topic 3 resources **MILC Linear Functions Resources** **FAL** (one per semester): ● **Interpreting Distance–Time Graphs**	**MILC -** MILC Topic 4 resources **MILC Systems Resources** **4.4 and 4.5** could be combined in one	**MILC -** MILC Topic 5 resources **MILC Absolute Value Functions and Equations Resources**

Recommended for Semester One FAL **** Omit Lesson 3-3	instructional day.	

*Disclaimer: Success Criteria is the evidence students must produce to demonstrate learning. This example is not comprehensive.

** Mathematical Practices (A.MP.1- 8) should be evidenced at some point throughout each unit, depending on the explored tasks. It is important to note that MP. 2 should support learning in every lesson.

*** **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.