Unit 2 Title	**Estimated Time Frame**
Polynomial Functions and **Conics**	**14 block days**

Big Idea (s)

Extend previous understanding of polynomials.
Identify the key features of polynomial functions and interpret graphs of polynomial functions.
Add, subtract, multiply, and divide polynomial expressions.
Use polynomial identities to multiply and factor polynomial expressions, use multiple theorems as tools to understand the roots of polynomial functions, and transform graphs from cubic or quartic parent functions.
Students will identify and use appropriate strategies for understanding and solving problems involving conic sections.

Essential Question(s)

What can the rule of a polynomial function reveal about its graph, and what can the graphs of polynomial functions reveal about the solutions of polynomial equations?
How can you use polynomial identities to rewrite expressions efficiently?
How can you divide polynomials?
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?
What are the geometric properties of a circle, and how do they relate to algebraic representations of a circle?

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

Common Preconceptions/Misconceptions		
• For what input values are the output values positive, negative, or 0? • Identify where f(x) is increasing, f(x), decreasing, and f(x) changes • Remind students, that in Geometry, we studied lines and circles, and in Algebra 1, we learned about lines and introduced parabolas. Now, in Algebra 2, we bring in many more types of curves. • Domain & Range (Interval Notation) / Positive & Negative Areas (Interval Notation) / then Increasing Decreasing (Interval Notation)		
KAS Standards	**Considerations**	**Samples of Learning Intentions and Success Criteria**
Cluster: Understand the concept of a function and use function notation.		
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. ☐ Conceptual ❑ Procedural ❑ Application b. Using appropriate function notation, evaluate functions for inputs in their domains and interpret statements that use function notation in terms of a context. ☐ Conceptual ☐ Procedural ❑ Application 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 graphs showing key features given a verbal description of the relationship. **MP.2, MP.4, MP.7, KILP.1, KILP.2, KILP.7**	c. Graphs become 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.	We are learning how to identify key features of a polynomial function to help sketch its graph. • I can identify the domain and range of a function. • I can determine if a relation is a function. • I can evaluate functions for given values of x. • I can determine the intervals where a function is increasing, decreasing or constant. • I can determine the interval(s) where a function is positive, negative, or zero. • I can describe the end behavior of a function.

Supporting Standard(s): KY.HS.A.5 ☐ Conceptual ❑ Procedural ❑ Application		
Cluster: Interpret functions that arise in applications in terms of the context.		
KY.HS.F.3 Understand the 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, KILP.1, KILP.9** ☐ Conceptual ☐ Procedural ☐ Application	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.	We are learning to use equations, tables, and graphs to analyze the rate of change in applied and mathematical contexts. ● I can interpret the average rate of change of a function, understanding that it represents the slope of the secant line between two points on the function's graph over the interval. ● I can calculate the average rate of change of a function from a table of values by determining the difference in function values and dividing by the difference in input values. ● I can estimate the average rate of change from a graph by visually determining the slope of the secant line between two points on the graph over the specified interval.
Cluster: Analyze functions using different representations.		
KY.HS.F.4 Graph functions expressed symbolically and show key features of the graph, with and without using technology (computer, graphing calculator). ★ b. Graph square root, cube root and absolute value functions. ☐ Conceptual ❑ Procedural ❑ Application c. Graph polynomial functions, identifying zeros when suitable factorizations are available and showing end behavior.	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.	I am learning to graph functions using the key features. ● I can identify key features of the graph of a linear function, including slope, y-intercept, and x-intercept. ● I can interpret the rate of change and y-intercept given data. ● I can graph functions, representing them on a coordinate plane. ● I can graph functions using technology to enhance accuracy and efficiency.

☐ Conceptual ☐ Procedural ☐ Application d. Graph exponential and logarithmic functions, showing intercepts and end behavior. **MP.4, MP.5, KILP.2, KILP.5,KILP.8** ☐ Conceptual ☐ Procedural ☐ Application	Students demonstrate fluency with linear, quadratic and exponential functions, including the ability to graph without using technology. In other function families, students graph simple cases without technology and more complex ones with technology.	I am learning to graph exponential and logarithmic functions demonstrating an understanding of intercepts and end behavior. ● I can identify the end behavior and key features of polynomial functions. ● I can apply their understanding of exponential and logarithmic functions to solve problems in various contexts, such as population growth, compound interest, and radioactive decay.
Cluster: Interpret the structure of expressions.		
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. **MP.7, MP.8, KILP.2, KILP.9** *Supporting Standard(s): KY.HS.A.1, KY.HS.A.5* ☐ Conceptual ☐ Procedural ❑ Application	Students see x4 – y4 as (x2) 2 – (y2) 2, thus recognizing it as a difference of squares factored as (x2 – y2)(x2 + y2). Additionally, students see there are three commonly used forms for a quadratic expression: • Standard • Factored • Vertex and can identify when one form might be more useful than another.	We are learning to rewrite expressions in equivalent forms. ● I can identify ways to factor expressions based on the structure of the expression. ● I can apply algebraic properties and rules to rewrite expressions, demonstrating proficiency in simplifying and manipulating expressions to achieve equivalent forms.
Cluster: Write expressions in equivalent forms to solve problems.		
KY.HS.A.3 Choose and produce an equivalent form of an expression to reveal and explain the properties of the quantity represented by the expression. ★ a. Write the standard form of a given polynomial and identify the terms, coefficients, degree, leading coefficient, and constant term. b. Factor a quadratic expression to reveal the zeros of the function it defines. d. (+) Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. **MP.5, MP.7, KILP.2, KILP.8, KILP.9**	b. Students recognize the connection between the zero product property and solving a quadratic in one variable by setting factored expressions equal to zero.	I am learning to manipulate polynomial expressions to reveal and explain their properties. ● I can write a polynomial in standard form. ● I can identify a polynomial's terms, coefficients, degrees, leading coefficients, and constant terms.

☐ Conceptual ☐ Procedural ❑ Application		
Cluster: Understand the relationship between zeros and factors of polynomials.		
KY.HS.A.7 Identify roots of polynomials when suitable factorizations are available. Know these roots become the zeros (x-intercepts) for the corresponding polynomial function. **MP.2, MP.5, MP.7, KILP.7, KILP.8, KILP.9** *Supporting Standard(s): KY. HS.A.5* ☐ Conceptual ☐ Procedural ❑ Application	Methods of finding roots could include, but are not limited to: • factoring • synthetic division • long division • an analysis of the graph (created by hand or through use of technology).	We are learning to identify roots of polynomials and relate them to the graph. ● I can understand that roots of polynomials as the values of the variable that make the polynomial function equal to zero ● I can identify ways to factor expressions based on the structure of the expression to find roots of a polynomial. ● I can determine the roots of polynomials by factoring or using other appropriate methods, such as synthetic division or the quadratic formula.

Supporting Standards

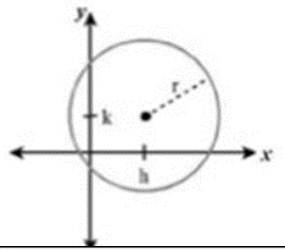
KY.HS.A.1 Interpret expressions that represent a quantity in terms of its context. ★
b. Interpret complicated expressions, given a context, by viewing one or more of their parts as a single entity. **MP.2, MP.6**

KY.HS.A.5 Add, subtract, and multiply polynomials. **MP.7, MP.8**

KY.HS.F.6 Write a function that describes a relationship between two quantities. ★ **MP.4, MP.7**
b. Combine standard function types using arithmetic operations.

KY.HS.G.19 Understand the relationship between the algebraic form and the geometric representation of a circle. **MP.6, MP.8**
a. Write the equation of a circle of a given center and radius using the Pythagorean Theorem. **(Lesson 9-2)**
b. (+) Derive and write the equation of a circle of a 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

KY.HS.G.20 (+) Derive the equations of conic sections. **MP.2, MP.7**
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 sum or difference of distances from the foci is constant.



Parabolas: $y-k=a(x-h)^2$
$x-h=a(y-k)^2$

Circles: $(x-h)^2+(y-k)^2=r^2$

Ellipse: $\frac{(x-h)^2}{a^2}+\frac{(y-k)^2}{b^2}=1$

Hyperbola: $\frac{(x-h)^2}{a^2}-\frac{(y-k)^2}{b^2}=1$

Essential Vocabulary

Polynomial Functions	**Conic section:**
Degree of a polynomial **Leading coefficient** **Polynomial function** **Relative maximum** **Relative minimum** **Standard form of a polynomial** **Turning point** Commutative property Associate property Distributive property Binomial Binomial Theorem **Identity** **Pascal's Triangle** **Factor Theorem** **Remainder Theorem** **Synthetic Division** Zero of a function Zero product property	Directrix Standard form of the equation of a circle Focus of a parabola Center Ellipse Foci of an ellipse Major axis Minor axis Center/Foci/Vertices of hyperbola Hyperbola

Standards Benchmark Assessment #1

November 2024

Anchor Resources

enVision Topic 3 - Polynomial Functions	**enVision Topic 9 -** Conic Sections
MILC - MILC Topic 3 resources **Polynomial Functions** **FAL** (one per semester): Representing polynomials graphically ***1st Semester FAL for Algebra 2**** **3 Act Math Task** - What are the Rules?	**MILC -** MILC Topic 5 resources **Conic Sections** **FAL (one per semester):** Sorting Equations of Circles 2 is one option lots of teachers recommend **3 Act Math Task -** Watering the Lawn (after circles)

***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 throughout each unit, depending on the tasks.

*** 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.