Unit 3 Title	**Estimated Time Frame**
Exponents and Exponential Functions, Polynomials and **Quadratic Functions**	**40 days** or **20 block days**

Big Idea (s)

Build upon and extend understanding of integer exponents to exponential functions.
Extend the laws of exponents to rational exponents.
Perform operations on polynomials.
Identify different forms of quadratic functions and their key features.

Essential Question(s)

How do you use exponential functions to model situations and solve problems?
How can you identify and apply the appropriate property to simplify exponent expressions?
How can you write an exponential equation to represent a real-world situation?
Why will an exponential decay situation never equal zero?
How do you apply the geometric sequence to find a term in the sequence?
How do you work with polynomials to rewrite expressions and solve problems?
How can the properties of the real number system be beneficial when working with polynomials and rational expressions?
How do you use quadratic functions to model situations and solve problems?

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 and 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.** KILP.10 Develop a literacy identity that promotes lifelong learning.

Common Preconceptions/Misconceptions

- Students may confuse the concepts of additive inverses and multiplicative inverses when working with rational exponents. Provide students with problems that allow them to differentiate between the two.
- Negative exponents can be a problem when using fractional exponents. Using a calculator as well as looking at a graph helps.
- Ensure that students know what closure means by working with integers and subsets of integers with addition, subtraction, multiplication, and division.
- **Skills Previously Taught:**
  - Properties of Exponents but will need to review as a part of Lesson 6-0.
  - Explain *how to name* a polynomial.
- A common misconception for students occurs when adding and multiplying like terms if students have not used manipulatives or models before learning the rules. One method to address this is to use Algeblocks or Algebra Tiles to introduce polynomials. Both are available for checkout from the DIstrict Math Lab in the Teacher Resource Center at Central Office or from Math Chairs.

KAS Standards	Considerations	Samples of Learning Intentions and Success Criteria
Cluster: Extend the properties of exponents to rational exponents.		
KY.HS.N.1 Extend the properties of integer exponents to rational exponents, allowing for the expression of radicals in terms of rational exponents. **MP.2, MP.7, KILP.5, KILP.6** *Supporting Standard: KY.HS.N.4, KY.HS.N.6* ☐ *Conceptual* ❑ *Procedural* ❑ *Application*	Students understand that a single root can be expressed as a rational exponent with a numerator of one and a base that is equal to the root index. Students understand that powers and roots can be concisely expressed as a single rational exponent where the numerator is the power and the denominator is the root index. For example, students understand that defining 4^1/3 is the same as the cube root of 4 because 4(1⁄3)^3 = (41⁄3)^3 so 4(1⁄3)^3 must equal 4.	I am learning to use my understanding of integer exponents to rational exponents, to express radicals using rational exponents. ● I can identify the key features of exponential functions, such as the base, exponent, and constant multiplier. ● I can use the properties of integer exponents and apply them to rational exponents. ● I can express radicals in terms of rational exponents. ● I can simplify expressions involving rational exponents.
KY.HS.N.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. **MP.7, KILP.1, KILP.2, KILP.8** *Supporting Standard: KY.HS.N.4, KY.HS.N.6* ☐ *Conceptual* ☐ *Procedural* ❑ *Application*	Standard KY.HS.N.2 builds on standard KY.HS.N.1 by extending student understanding to situations where the numerator is not one.	I am learning to rewrite expressions with radicals and rational exponents. ● I can apply the properties of exponents to rewrite a radical expression as an expression with a rational exponent. ● I can apply the properties of exponents to rewrite an expression with rational exponents as a radical expression.

Cluster: Analyze functions using different representations.		
KY.HS.F.5 Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. b. Use the properties of exponents to interpret expressions for exponential functions and classify the exponential function as representing growth or decay **MP.3, MP.6, KILP.1, KILP.2, KILP.6** *Supporting Standard:* KY.HS.F.1, KY.HS.F.2, KY.HS.F.3, KY.HS.F.6 ☐ *Conceptual* ☐ *Procedural* ❑ *Application*	b. Students examine real-world situations with constant multiplicative change, represented as expressions, such as growth or decay.	I am learning to use the properties of exponents to classify exponential functions. ● I can examine the base of an exponential function to classify it as exponential growth or decay. ● I can apply the properties of exponents to simplify and interpret expressions involving exponential functions. ● I can classify exponential functions based on their behavior, including growth or decay, and the value of their base.
Cluster: Construct and compare linear, quadratic and exponential models and solve problems.		
KY.HS.F.11 Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Recognize and justify that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another **MP.3, MP.8, KILP.1, KILP.7, KILP.8** *Supporting Standard:* KY.HS.F.6 , KY.HS.F.7, KY.HS.F.8, KY.HS.F.4	Linear functions have the same average rate of change over same-sized intervals; the same value is added to the output over each interval. In contrast, the outputs of exponential functions grow or decay by the same percent over same-sized intervals; the same value is multiplied by the output over each interval. They will recognize the characteristics of each function type and justify their choices based on the given context.	I am learning to distinguish between linear and exponential functions. ● Identify that linear functions grow by equal differences over equal intervals. ● Identify that exponential functions grow by equal factors over equal intervals. I am learning to recognize situations that can be modeled with linear and exponential functions. ● Recognize scenarios where the relationship between two quantities exhibits a constant rate of change. ● Recognize the growth patterns of exponential functions based on their ● Determine if the constant rate of change indicates a linear or exponential relationship. ● Justify the choice of linear or exponential modeling based on the observed constant rate of change or constant percent rate of change.

☐ *Conceptual* ☐ *Procedural* ☐ *Application*		
KY.HS.F.12 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). **MP.7, MP.8** *Supporting Standard: KY.HS.F.4, KY.HS.F.6 KY.HS.F.7, KY.HS.F.8, KY.HS.F.14, KY.HS.A.15* ☐ *Conceptual* ☐ *Procedural* ☐ *Application*	Students construct functions with and without technology. **Note:** Use *KY.HS.F.7* to Ensure you are teaching interest and compound interest.	I am learning to create exponential functions from various forms of input, such as graphs, descriptions, or input-output pairs from tables. ● I can construct exponential functions from graphs, descriptions, or input-output pairs. ● I can accurately represent geometric sequences using exponential functions. ● I can justify my choices and constructions using mathematical reasoning. ● I can relate $f(x) = a(1 + r)^x$ to the Compound Interest Formula.
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. **c.** Use the properties of exponents to rewrite exponential expressions. **MP.5, MP.7, KILP.2, KILP.3** *Supporting Standards: KY.HS.A.1, KY.HS.A.10, KY.HS.A.11(+), KY.HS.N.1* ☐ *Conceptual* ☐ *Procedural* ❑ *Application*	Students recognize that completing the square allows them to identify the coordinates of the maximum or minimum value more easily than when the quadratic is in standard form, and there are pros and cons to each equivalent form.	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. I am learning how to factor quadratic expressions to reveal and explain the zeros of the function they define. ● I can factor quadratic expressions into binomial factors. ○ I can apply different factoring techniques, such as factoring by grouping, difference of squares, or trinomial factoring, depending on the structure of the quadratic expression. ● I can identify the zeros of the quadratic function by setting the factored expression equal to zero and solving for the variable. ● I can explain how factoring reveals the roots or solutions of the quadratic equation. ● I can interpret the significance of the zeros in the context of the problem being modeled by

		the quadratic function. I am learning to produce equivalent forms of exponential expressions. ● I can use properties of exponents to rewrite exponential expressions. ● I can explain how using the properties of exponents changes the form and reveals the properties of the quantities represented by the expressions. ● I can apply these concepts to simplify and manipulate exponential expressions effectively.
Cluster: Perform arithmetic operations on polynomials.		
KY.HS.A.5 Add, subtract, and multiply polynomials. **MP.7, MP.8, KILP.6** *Supporting Standards: KY.HS.N.1* ☐ *Conceptual* ☐ *Procedural* ❑ *Application*	Students combine like terms and use the distributive property when adding, subtracting, and multiplying polynomials.	I am learning to add and subtract polynomials. ● I can use the properties of exponents to combine like terms. ● I can add polynomials by combining like terms and simplifying the resulting expression. ● I can subtract polynomials by distributing the subtraction operation and simplifying the resulting expression. I am learning to multiply polynomials including special cases. ● I can use the Distributive Property to multiply polynomials, recognizing that polynomials are closed under multiplication. ● I can combine like terms when simplifying the polynomial. ● I can use the pattern $(a + b)^2 = a^2 + 2ab + b^2$ determine the square of a binomial. ● I can find the product of a sum and the difference of two squares.
Supporting Standards		
KY.HS.N.4 Use units in context as a way to understand problems and to guide the solution of multi-step problems; ★ **MP.5, MP.6**		

a. Choose and interpret units consistently in formulas;
b. Choose and interpret the scale and the origin in graphs and data displays.

KY.HS.N.6 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities**.** ★ **MP.2, MP.6**

KY.HS.F.1 Understand properties and key features of functions and the different ways functions can be represented.**MP.2, MP.4**
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.
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).
e. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

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

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

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 and quadratic functions and show intercepts, maxima and minima. **MP.4, MP.5**

KY.HS.F.6 Write a function that describes a relationship between two quantities. ★ a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. Combine standard function types using arithmetic operations. c. (+) Compose functions. **MP.4, MP.7**

KY.HS.F.7 Use **geometric** sequences to model situations and scenarios. a. Use formulas (explicit and recursive) to generate terms for geometric sequences. b. Write formulas to model geometric sequences and apply those formulas in realistic situations. ★

KY.HS.F.8 Understand the effects of transformations on the graph of a function.
Mastery of this standard includes recognizing even and odd functions from their graphs and algebraic expressions.
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 explain the effects on the graph using technology. **MP.3, MP.5**

KY.HS.F.14 Interpret the parameters in a linear or exponential function in terms of a context. **MP.1, MP.2**

KY.HS.A.1 Interpret expressions that represent a quantity in terms of its context. ★ a. Interpret parts of an expression, such as terms, factors, and coefficients. 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.10(+) Rewrite simple rational expressions in different forms. **MP.7, MP.8**

KY.HS.A.11(+) Add, subtract, multiply and divide rational algebraic expressions. **MP.2, MP.3**

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. **MP.2, MP.5**

KY.HS.A.15 Rearrange formulas to solve a literal equation, highlighting a quantity of interest, using the same reasoning as in solving equations. **MP.2, MP.7**

Essential Vocabulary

exponential function - the function e^x where e is the number (approximately 2.71.8281828) such that the function e^x equals its own derivative. It is used to model phenomena when a constant change in the independent variable gives the same proportional change (increase or decrease) in the dependent variable
Supporting Vocabulary: exponents, growth, decay, geometric sequence, common ratio, exponential functions, constant ratio, growth or decay factor, asymptote, rational exponent, radical, arithmetic sequence, equal differences, equal factors, geometric sequence, linear function, parameter, rate of change, properties of exponents, Fibonacci numbers
polynomial - a function consisting of monomial or a sum or difference of monomials
Supporting Vocabulary - monomial, binomial, trinomial, factor, product
Quadratics Vocabulary: axis of symmetry, quadratic function, vertex, vertex form, parabola, standard form of a quadratic function, Zero of a function, Zero product property, Perfect square trinomial, Completing the square, Radicand, Discriminant, Quadratic Formula.

Standards Benchmark Assessment #2

March 2025

Anchor Resources

enVision Topic 6 Exponents and Exponential Functions	enVision Topic 7 Polynomials and Factoring	enVision Topic 8 Quadratic Functions
MILC - MILC Topic **MILC Exponents and Exponential Functions Resources** **3 ACT Math Task - Fry's Bank -** ** HIghly Recommend during or after Lesson 6.3 ** **3 ACT Math Task Dan Meyer** (link)	**MILC -** MILC Topic **MILC Polynomial Resources** **3 ACT Math Task** after Factoring (Complete as part of the review.)	**MILC -** MILC Topic **MILC Quadratic FUNCTION Resources** **3 ACT Math Task** after 8-3. **FAL** (one per semester): **Quadratics FAL** *Can be done at any time in the unit or in Topic 9 Unit as Quadratics continue…..* • **Quadratics FAL - HIGHLY recommend!!** *** Quadratics FAL is suggested as the 2nd

Supplement - and add - **AVERAGE RATE OF CHANGE** with **Lesson 6-2**		semester Algebra 1 FAL *** In addition to the card sort, see the following options for Quadratics FAL, including a Google slide deck using the FAL digitally. • **Quadratics FAL - Digital Option** Screencastify for Quadratics FAL (that explains how to teach and use this rich task) NOTES - ****8-5** Can be taught at the beginning of Topic 8 to build connections between different families of functions. ****5-1** Graphing Absolute Values can be used for the families of functions.

*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 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.