

Unit 3 Title	Estimated Time Frame
<b>Exponents and Exponential Functions, Polynomials and Quadratic Functions</b>	<b>40 days or 20 block days</b>
<b>Big Idea (s)</b>	
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.	
<b>Essential Question(s)</b>	
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?	
<b>Standards for Mathematical Practice (MP.) -</b> The practice standards in bold describe expertise to be intentionally developed in this Unit.	<b>Kentucky Interdisciplinary Literacy Practices (KILP.) -</b> The practice standards in bold describe expertise to be intentionally developed in Mathematics.
MP.1 Make sense of problems and persevere in solving them. <b>MP.2 Reason abstractly and quantitatively.</b> <b>MP.3 Construct viable arguments and critique the reasoning of others.</b> <b>MP.4 Model with mathematics.</b> <b>MP.5 Use appropriate tools strategically.</b> MP.6 Attend to precision. <b>MP.7 Look for and make use of structure.</b> <b>MP.8 Look for and express regularity in repeated reasoning.</b>	KILP.1 Recognize that text is anything that communicates a message. KILP.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. <b>KILP.6 Collaborate with others to create new meaning.</b> <b>KILP.7 Utilize digital resources to learn and share with others.</b> <b>KILP.8 Engage in specialized, discipline specific literacy practices.</b> <b>KILP.9 Apply high level cognitive processes to think deeply and critically about text.</b> 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
<b>KY.HS.N.1</b> Extend the properties of integer exponents to rational exponents, allowing for the expression of radicals in terms of rational exponents. <b>MP.2, MP.7, KILP.5, KILP.6</b>	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 $4(1/3)^3 = (4/3)^3$ so $4(1/3)^3$ must equal 4.	I am learning to extend the properties of integer exponents to rational exponents. <b>(Lesson 6-0) and (Lesson 6-1)</b> <ul style="list-style-type: none"> <li>• I can write radicals as rational exponents.</li> </ul>
<b>KY.HS.N.2</b> Rewrite expressions involving radicals and rational exponents using the properties of exponents. <b>MP.7, KILP.1, KILP.2, KILP.8</b>	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. <b>(Lesson 6-1) and (Lesson 9-3)</b> <ul style="list-style-type: none"> <li>• I can apply the properties of exponents to rewrite a radical expression as an expression with a rational exponent.</li> <li>• I can apply the properties of exponents to rewrite an expression with rational exponents as a radical expression.</li> </ul>

<p><b>KY.HS.F.5</b> Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</p> <p><b>b.</b> Use the properties of exponents to interpret expressions for exponential functions <b>MP.3, MP.6, KILP.1, KILP.2, KILP.6</b></p>	<p><b>b.</b> Students examine real-world situations with constant multiplicative change, represented as expressions, such as growth or decay.</p> <p>Use the properties of exponents to classify the exponential function as representing growth or decay.</p>	<p>I am learning to interpret expressions for exponential functions. <b>(Lesson 6-2)</b></p> <ul style="list-style-type: none"> <li>I can use the properties of exponents to solve equations with rational exponents.</li> </ul> <p>I am learning to classify exponential functions. <b>(Lesson 6-3)</b></p> <ul style="list-style-type: none"> <li>I can examine the base of an exponential function to classify it as exponential growth or decay.</li> </ul>
<p><b>KY.HS.F.11.c.</b> Recognize situations where a quantity grows or decays by a constant percent rate per unit interval relative to another. <b>MP.3, MP.8, KILP.1, KILP.7, KILP.8</b></p>	<p>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.</p>	<p>I am learning how to determine exponential growth and decay in real-world situations. <b>(Lesson 6-3)</b></p> <ul style="list-style-type: none"> <li>I can construct exponential growth and decay functions given a description of a relationship.</li> <li>I can use exponential functions to make predictions about real-world situations.</li> </ul>
<p><b>KY.HS.A.15</b> Rearrange formulas to solve a literal equation, highlighting a quantity of interest, using the same reasoning as in solving equations. <b>MP.2, MP.7, KILP.1, KILP.2</b></p>	<p>Students encounter scenarios where they rewrite formulas/equations for variables different from the commonly used formulas.</p>	<p>I am learning to rewrite formulas/equations for variables different from the commonly used formulas <b>(Lesson 6.3, 6-4)</b></p> <ul style="list-style-type: none"> <li>I can relate <math>f(x) = a(1 + r)^x</math> to the Compound Interest Formula.</li> </ul>
<p><b>KY.HS.A.3</b> Choose and produce an equivalent form of an expression to reveal and explain the properties of the quantity represented by the expression. ★</p> <p><b>a.</b> Write the standard form of a given polynomial and identify the terms, coefficients, degree, leading coefficient, and constant term.</p> <p><b>b.</b> Factor a quadratic expression to reveal the zeros of the function it defines.</p> <p><b>c.</b> Use the properties of exponents to rewrite exponential expressions. <b>MP.5, MP.7, KILP.2, KILP.3</b></p>	<p>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.</p>	<p>I am learning to write equivalent forms of polynomials and identify their parts. <b>(Lesson 7-1)</b></p> <ul style="list-style-type: none"> <li>I can write a polynomial in standard form.</li> <li>I can identify a polynomial's terms, coefficients, degrees, leading coefficients, and constant terms.</li> <li>I can use properties of exponents to rewrite exponential expressions.</li> </ul> <p>I am learning how to factor quadratic equations. <b>(Lesson 7-4, 7-5, 7-6, 7-7 )</b></p> <ul style="list-style-type: none"> <li>I can identify the greatest common factor.</li> <li>I can rewrite a quadratic as a product using the GCF.</li> <li>I can factor quadratic trinomials multiple</li> </ul>

		ways.
<b>KY.HS.A.5</b> Add, subtract, and multiply polynomials. <b>MP.7, MP.8, KILP.6</b>	Students combine like terms and use the distributive property when adding, subtracting, and multiplying polynomials.	<p>I am learning to add and subtract polynomials. <b>(Lesson 7-1)</b></p> <ul style="list-style-type: none"> <li>I can use the properties of exponents to combine like terms.</li> </ul> <p>I am learning to multiply polynomials. <b>(Lesson 7-2)</b></p> <ul style="list-style-type: none"> <li>I can use the Distributive Property to multiply polynomials, recognizing that polynomials are closed under multiplication.</li> <li>I can combine like terms when simplifying the polynomial.</li> </ul> <p>I am learning to multiply special cases of binomials. <b>(Lesson 7-3)</b></p> <ul style="list-style-type: none"> <li>I can use the pattern <math>(a + b)^2 = a^2 + 2ab + b^2</math> to determine the square of a binomial.</li> <li>I can find the product of a sum and the difference of two squares.</li> </ul>

### Supporting Standards

**KY.8.EE.1** Know and apply the properties of integer exponents to generate equivalent numerical expressions. **MP.3, MP.7, MP.8, (Lesson 6-0)**

**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.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. ★**(Lesson 6-4)**

**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, (Lesson 8-1, 8-2, 8-3)**

**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 where one quantity changes at a constant rate per unit interval relative to another. **MP.3, MP.5, (Lesson 8-5)**

**KY.HS.F.12** Construct linear and exponential functions, including geometric sequences, given a graph, a description of a relationship, or two input-output pairs (including reading these from a table). **MP.7, MP.8, (Lesson 6-4)**

**KY.HS.A.10** Rewrite simple rational expressions in different forms. **MP.7, MP.8, (Lesson 7-4, 7-5, 7-6, 7-7)**

**KY.HS.A.11** Add, subtract, multiply and divide rational algebraic expressions. **MP.2, MP.3, (Lesson 7-4, 7-5, 7-6, 7-7)**

### 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.

### Common Assessment

Common Assessment Unit 3 Algebra One

### Anchor Resources

enVision Topic 6 Exponents and Exponential Functions	enVision Topic 7 Polynomials and Factoring	enVision Topic 8 Quadratic Functions
<p><b>MILC</b> - <a href="#">MILC Topic MILC Exponents and Exponential Functions Resources</a></p> <p><b>3 ACT Math Task - Fry's Bank</b> - ** Highly Recommend during or after Lesson 6.3 **</p> <p><b>3 ACT Math Task Dan Meyer</b></p>	<p><b>MILC</b> - <a href="#">MILC Topic MILC Polynomial Resources</a></p> <p><b>3 ACT Math Task</b> after Factoring (Complete as part of the review.)</p>	<p><b>MILC</b> - <a href="#">MILC Topic MILC Quadratic FUNCTION Resources</a></p> <p><b>3 ACT Math Task</b> after 8-3.</p> <p><b>FAL</b> (one per semester): <b>Quadratics FAL</b> Can be done at any time in the unit or in Topic 9 Unit as Quadratics continue.....</p> <ul style="list-style-type: none"> <li><a href="#">Quadratics FAL - HIGHLY recommend!!</a> *** Quadratics FAL is suggested as the 2nd</li> </ul>

**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)

\*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.