GROWING, GROWING, GROWING   Exponential Functions

Instructional Time and Investigations	$22\frac{1}{2}$ days	• Inv. 1: Exponential Growth (3 Problems) • Inv. 2: Examining Growth Patterns (3 Problems) • Inv. 3: Growth Factors and Growth Rates (3 Problems) • Inv. 4: Exponential Decay (3 Problems) • Inv. 5: Patterns With Exponents (5 Problems)
Goals	**Exponential Functions:** Explore problem situations in which two or more variables have an exponential relationship to each other. • Situations that can be modeled by an exponential function show a multiplicative pattern in the table of data; the rate of change grows or decays by a constant factor. Tables and graphs can provide more information about an exponential function and help solve problems.	**Equivalence:** Develop understanding of equivalent exponential expressions. • There is often more than one way to write an equation. The ability to rewrite an equation as an equivalent expression can be helpful when solving problems involving exponential functions and relationships. • There are rules for working with exponential expressions. These properties of exponents are useful in writing equivalent expressions and particularly when working with values written in scientific notation.
Common Core Standards	**Common Core Standards for Mathematical Practice** **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.	**Common Core Content Standards** **8.EE.A.3:** Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. **8.EE.A.4:** Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. **8.F.A.2:** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). **8.F.B.5:** Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally. **Also 8.EE.A.1, 8.EE.A.2, 8.F.A.1, 8.F.A.3, 8.F.B.4**

GROWING, GROWING, GROWING Exponential Functions		
Content Connections to Other Units		
Goals of the Unit	**Prior Work**	**Future Work**
Exponential Functions: Explore problem situations in which two or more variables have an exponential relationship to each other.	• Looking for graphical or symbolic models to describe a pattern in data (*Variables and Patterns; Moving Straight Ahead; Thinking With Mathematical Models*) • Reasoning relationships such as connections among attributes of geometric figures (*Covering and Surrounding; Shapes and Designs*) • Representing relationships with words, tables, graphs, and equations (*Variables and Patterns; Moving Straight Ahead; Thinking With Mathematical Models*) • Exploring the significance of shapes of graphs and patterns in tables (*Variables and Patterns; Comparing and Scaling; Moving Straight Ahead; Thinking With Mathematical Models*) • Attaching meaning to the symbols in a linear equation of the form $y = mx + b$ (*Variables and Patterns; Comparing and Scaling; Moving Straight Ahead; Thinking With Mathematical Models*) • Recognizing the significance of constant additive growth (*Moving Straight Ahead*) • Reasoning about percent change (*Comparing and Scaling*) • Recognizing and describing situations that can be modeled by linear relationships (*Variables and Patterns; Comparing and Scaling; Moving Straight Ahead; Thinking With Mathematical Models*)	• Extending the analysis to include all positive real numbers for the domain (*Function Junction; High School*) • Using tabular, graphical, and symbolic methods to solve problems that involve exponential functions such as finding half-life or solving equations of the type $ax = b$ (*Function Junction; High School*) • Exploring the significance of shapes of graphs and patterns in tables (*Say It With Symbols; Frogs, Fleas, and Painted Cubes; Function Junction*); extending the experiences to include recognition of trigonometric relationships (*High School*) • Making sense of the symbols in quadratic relationships, expressed in expanded or factored form (*Frogs, Fleas, and Painted Cubes; Function Junction; High School*) • Reviewing and extending the analysis of exponential and quadratic functions (*Say It With Symbols; Frogs, Fleas, and Painted Cubes; Function Junction; High School*) • Analyzing symbolic expressions of trigonometric and logarithmic functions (*High School*) • Recognizing the significance of the pattern of change in quadratic relationships (*Say It With Symbols; High School*); analyzing patterns of change in exponential and trigonometric functions (*High School*) • Recognizing and describing situations that can be modeled by quadratic functions (*Say It With Symbols; Frogs, Fleas, and Painted Cubes; Function Junction; High School*); extending recognition to trigonometric functions (*High School*)
Equivalence: Develop understanding of equivalent exponential expressions.	• *Using exponents to express large and small quantities (Prime Time, Looking for Pythagoras)*	• Applying rules for exponents to interpret more complex algebraic expressions and exponential equations (*Function Junction; High School*)