WAKE COUNTY PUBLIC SCHOOL SYSTEM

Middle School Programs
Building Healthy Core Learning
Common Core Math I, Unit 5

Math I UNIT 5 OVERVIEW: Exponential Functions

Unit Outcomes At the end of this unit, your student should be able to:	**Key Vocabulary** Terms to deepen the student's understanding
✓ Classify exponential functions as growth or decay ✓ Compare/contrast properties and the graphs of linear and exponential functions ✓ Construct a graph of an exponential function from a table, sequence or a situation ✓ Model an exponential relationship between two quantities with tables, graphs, and equation ✓ Recognize that the solutions to an exponential equation are represented by the points on the graph ✓ Understand that a geometric sequence is a sequence of numbers where the ratio between consecutive numbers is constant ✓ Understand that an exponential function has a *r* value greater than 1 if the function is growing ✓ Identify the common ratio of the sequence ✓ Write the first and subsequent terms of the sequence ✓ Evaluate functions for given domains ✓ Recognize a pattern will allow them to determine an arithmetic or geometric model ✓ Translate between the recursive (NOW/NEXT) and explicit forms in modeling situations ✓ Construct a table and graph of a linear function with slope m and exponential rate of change equal to the slope to identify the point where the exponential function exceeds the linear function ✓ Determine the difference between the rate of change of a linear model (add each time) versus an exponential model (multiply each time)	✓ Base ✓ Common Ratio ✓ Constant ✓ Explicit Form ✓ Exponent ✓ Exponential Decay ✓ Exponential Equation ✓ Exponential Form ✓ Exponential Function ✓ Exponential Growth ✓ Function Notation ✓ Geometric Sequence ✓ Horizontal and Vertical Translation ✓ Initial Term ✓ Intercepts ✓ Intervals Where Increasing, Decreasing, Positive or Negative ✓ NOW-NEXT ✓ Rate of Change ✓ Relative Maximum ✓ Relative Minimum
Key Standards Addressed Connections to Common Core/NC Essential Standards	**Where This Unit Fits** Connections to prior and future learning
A-CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **8.F.3** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line. **A-REI.10** Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve. **A-SSE.1** Interpret complicated expressions by viewing one or more of their parts as a single entity. **A-SSE.2** Use the structure of an expression to identify ways to rewrite it. **F-BF.3** 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. **F-LE.3** Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or as a polynomial function. **F-LE.5** Interpret the parameters in a linear or exponential function in terms of a context. **N-Q.1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	**Coming into this unit, students should have a strong foundation in:** ✓ Solving one variable equations ✓ Graphing linear functions ✓ Identifying the initial value for a linear function ✓ Writing recursive and explicit forms of an equation ✓ Identifying key features of a function from a graph **This unit builds to the following future skills and concepts:** ✓ Solving quadratic equations ✓ Solving systems of equations and inequalities through graphing, substitution and elimination ✓ Graphing and analyzing more complex functions (including inverse, step, exponential, absolute value, trigonometric and logarithmic functions) ✓ Using regression models to predict linear, quadratic and exponential models

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F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. ***Note:*** *At this level, the focus is linear and exponential functions.* **F-IF.4** 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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Note: At this level, focus on linear, exponential and quadratic functions; no end behavior or periodicity.* **F-IF.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function. Note: At this level, focus on linear and exponential functions.* **F-IF.6** Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. *Note: At this level, focus on linear functions and exponential functions whose domain is a subset of the integers.* **F-IF.7e** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. *Note: At this level, for part e, focus on exponential functions only.* **F-IF.8b** 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. *For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.* **F-IF.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.* *Note: At this level, focus on linear, exponential, and quadratic functions.* **F-BF.1** 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. *For example, build a function that models the temperature of a cooling body by adding a constant function*	

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to a decaying *exponential, and relate these functions to the model. Note: At this level, limit to addition or subtraction of constant to linear, exponential or quadratic functions or addition of linear functions to linear or quadratic functions.* **F-BF.2** Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. *Note: At this level, formal recursive notation is not used. Instead, use of informal recursive notation* *(such as NEXT = NOW + 5 starting at 3) is intended.* **F-LE.1c** Distinguish between situations that can be modeled with linear functions and with exponential functions c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. **F-LE.2** 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).	
Additional Resources Materials to support understanding and enrichment	**"Learning Checks"** Questions Parents Can Use to Assess Understanding
✓ Exponential Growth and Decay ✓ Modeling exponential growth and decay (video) ✓ Graphing exponential functions (practice) ✓ Evaluating exponential functions (practice) ✓ Geometric sequences overview (video) ✓ Write explicit form of geometric sequences (practice)	✓ What considerations should be taken into account when determining the boundaries and scales of a graph? ✓ What are the key features of an exponential function? ✓ When given one of the four forms of information, what should be taken into consideration when determining the best function to model the situation? ✓ How do you determine the best model for a data pattern? ✓ Why is a multiplicative rate of change the key feature of an exponential function and how is it revealed in the different forms of this function (verbal, graph, table, equation)? ✓ When given a sequence, how do you identify whether it is arithmetic or geometric and how do you write a rule for the sequence?