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| **Title: Unit 3: Linear and *Exponential Functions*** | **Dates: 12**/2-6/2013 | **Teacher:** L. White/M Reid |
| **Standards:** **MCC9‐12.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 (which could be a line). **MCC9‐12.A.REI.11** Explain why the *x*‐coordinates of the points where the graphs of the equations *y* = *f*(*x*) and *y* = *g*(*x*) intersect are the solutions of the equation *f*(*x*) = *g*(*x*); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where *f*(*x*) and/or *g*(*x*) are linear, exponential, and functions.**MCC9‐12.F.IF.1** 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. The graph of *f* is the graph of the equation *y* = *f*(*x*). **MCC9‐12.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. **MCC9‐12.F.IF.3** Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. **MCC9‐12.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; **MCC9‐12.F.IF.5** Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.★ **MCC9‐12.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.★**MCC9‐12.F.IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. ★ **MCC9‐12.F.IF.7a** Graph linear functions and show intercepts, maxima, and minima.★**MCC9‐12.F.IF.7e** Graph exponential functions, showing intercepts and end behavior, ★**MCC9‐12.F.IF.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). **MCC9‐12.F.BF.1** Write a function that describes a relationship between two quantities.★ **MCC9‐12.F.BF.1a** Determine an explicit expression, a recursive process, or steps for calculation from a context. **MCC9‐12.F.BF.1b** Combine standard function types using arithmetic operations. **MCC9‐12.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.★**MCC9‐12.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 (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them. **MCC9‐12.F.LE.1** Distinguish between situations that can be modeled with linear functions and with exponential functions.★**MCC9‐12.F.LE.1a** Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.★**MCC9‐12.F.LE.1b** Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.★**MCC9‐12.F.LE.1c** Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.★**MCC9‐12.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).★**MCC9‐12.F.LE.3** Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly,★**MCC9‐12.F.LE.5** Interpret the parameters in a linear or exponential function in terms of a context.★  |
| **Learning Plan** |
| Day | Instructional Framework | Procedures |
| **Day 1** | **Pre- Opening/****Daily Routines** | **TITD:** 1. f(x) =4x + 2

Evaluate1. f(3) = (b) f(0) = (c)f(-1)
2. Create a table and graph the equation.

Identify the following characteristics: domain and range, if the function is increasing or decreasing, the x and y int4ercepts and the asymptote. |
|  | **OPENING** | **Activator:**  Teacher will facilitate a discussion on use function notation, interpret functions that arise in applications, analyze functions using different representations, build a function that models a relationship w/ 2 quantities. **Standard**  **MCC9‐12.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 (which could be a line). *(Focus on linear and exponential equations and be able to adapt* *and apply that learning to other types of equations in future courses.)***MCC9‐12.A.REI.11** Explain why the x‐coordinates of the points where the graphs of the equations *y* = *f*(*x*) and *y* = *g*(*x*) intersect are the solutions of the equation *f*(*x*) = *g*(*x*); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where *f*(*x*) and/or *g*(*x*) are linear, ~~polynomial, rational, absolute value~~, exponential, and ~~logarithmic~~ functions.**MCC9‐12.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. *(Draw examples from* *linear and exponential functions.)***MCC9‐12.F.IF.7** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★ *(Focus on linear* *and exponential functions. Include comparisons of two functions* *presented algebraically.)***MCC9‐12.F.IF.9** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *(Focus on linear* *and exponential functions. Include comparisons of two functions* *presented algebraically.)***MCC9‐12.F.BF.1** Write a function that describes a relationship between two quantities.★ *(Limit to linear and exponential* *functions.)***Standards of mathematical practice** -Make sense of problems and persevere in solving them; Reason abstractly and quantitatively; Construct viable arguments and critique the reasoning of others; Model with mathematics; Use appropriate tools strategically; Attend to precision, persevere, strategically selecting tools, construct viable arguments, and reasoning abstractly and quantitatively**Essential Questions**:* How do I use graphs to represent and solve real-world equations and inequalities?
* **Why is the concept of a function important and how do I use function notation to show a variety of situations modeled by functions?**
* **How do I interpret functions that arise in applications in terms of context?**
* How do I use different representations to analyze linear and exponential functions?
* How do I build a linear or exponential function that models a relationship between two quantities?
* **How do I build new functions from existing functions?**
* How can we use real-world situations to construct and compare linear and exponential models and solve problems?
* **How do I interpret expressions for functions in terms of the situation they model?**

**Vocabulary Development:** Students will understand and discuss the meaning of the following terms: * **Arithmetic Sequence.** A sequence of numbers in which the difference between any two consecutive terms is the same.
* **Average Rate of Change.** The change in the value of a quantity by the elapsed time. For a function, this is the change in the *y*-value divided by the change in the *x*-value for two distinct points on the graph.
* **Coefficient.** A number multiplied by a variable in an algebraic expression.
* **Constant Rate of Change.** Withrespect to the variable *x* of a linear function *y* = *f*(*x*), the constant rate of change is the slope of its graph.
* **Continuous.** Describes a connected set of numbers, such as an interval.
* **Discrete.** A set with elements that are disconnected.
* **Domain.** The set of *x*-coordinates of the set of points on a graph; the set of *x*-coordinates of a given set of ordered pairs. The value that is the input in a function or relation.
* **End Behaviors.** The appearance of a graph as it is followed farther and farther in either direction.
* **Explicit Expression.** A formula that allows direct computation of any term for a sequence a1, a2, a3, . . . , an, . . . .
* **Exponential Function.** A nonlinear function in which the independent value is an exponent in the function, as in *y* = *abx*.
* **Exponential Model.** An exponential function representing real-world phenomena. The model also represents patterns found in graphs and/or data.
* **Expression.** Any mathematical calculation or formula combining numbers and/or variables using sums, differences, products, quotients including fractions, exponents, roots, logarithms, functions, or other mathematical operations.
* **Even Function.** A function with a graph that is symmetric with respect to the *y*-axis. A function is only even if and only if *f*(–*x*) = *f*(*x*).
* **Factor.** For any number *x*, the numbers that can be evenly divided into *x* are called factors of *x*. For example, the number 20 has the factors 1, 2, 4, 5, 10, and 20.
* **Geometric Sequence.** A sequence of numbers in which the ratio between any two consecutive terms is the same. In other words, you multiply by the same number each time to get the next term in the sequence. This fixed number is called the common ratio for the sequence.
* **Interval Notation.** A notation representing an interval as a pair of numbers. The numbers are the endpoints of the interval. Parentheses and/or brackets are used to show whether the endpoints are excluded or included.
* **Linear Function.** Afunction with a constant rate of change and a straight line graph.
* **Linear Model.** A linear function representing real-world phenomena. The model also represents patterns found in graphs and/or data.
* **Odd Function.** A function with a graph that is symmetric with respect to the origin. A function is odd if and only if *f*(–*x*) = –*f*(*x*).
* **Parameter.** The independent variable or variables in a system of equations with more than one dependent variable.
* **Range.** Theset of all possible outputs of a function.
* **Recursive Formula.** A formula that requires the computation of all previous terms to find the value of *an*.
* **Slope.** The ratio of the vertical and horizontal changes between two points on a surface or a line.
* **Term.** A value in a sequence--the first value in a sequence is the 1st term, the second value is the 2nd term, and so on; a term is also any of the monomials that make up a polynomial.
* **Vertical Translation.** A shift in which a plane figure moves vertically.
* ***X*-intercept.** The point where a line meets or crosses the *x*-axis
* ***Y*-intercept.** The point where a line meets or crosses the *y*-axis

**Technology Skills: Students will be able to enter equations in a graphing calculator and model solving equations by graphing and using the table.****Direct / Group Instruction:** Teacher will facilitate a discussion to review the standards present the essential questions and review key vocabulary (ordered pairs, coordinate plane, solution, non-solutions, table, function, intersection, approximate, linear, domain, range, input, output, evaluate, intercept, rate of change).Teacher will review warm up activity/TITD and facilitate discussion of exponential functions and its parts as students analyze graphs, create equations, functions, and tables. Students will state standards in their own words and identify what they know and still need to learn. Students will participate in whole group and complete Part 1 of the graphic organizer.  |
| **WORK PERIOD** | **Individual, Pair, or Group Task:**  Teacher will observe and provide guidance/clarity as needed to ensure students are making progress.Students will complete a graphic organizer to practice using function notation, interpret functions that arise in applications, analyze functions using different representations, build a function that models a relationship comparing exponential and linear functions.* Students will work in groups of four and complete tasks Talk is cheap, Functioning Well, and You ar toast Dude Tasks.
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| **CLOSING** | * **Students will:** take five minutes to write in journal the answer to at least one of the essential questions. Some students will be allowed to share their answers.

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| **HOMEWORK** | **Students will:** Complete handouts from class and Carnegie Cognitive Tutor... |
| **Day2** | **Pre- Opening/****Daily Routines** | **TITD**: Exponential word problems. Students will work alone for 10 minutes to solve the four word problems.  |
| **OPENING** | **Activator:** Students will compare their answers to their partners and make corrections...Students will look at sequences and identify patterns and learn to write recursive equations to represent arithmetic sequences.**Standard:** **MCC9‐12.F.LE.1** Distinguish between situations that can be modeled with linear functions and with exponential functions.★**MCC9‐12.F.LE.1a** Prove that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.★**MCC9‐12.F.LE.1b** Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.★**MCC9‐12.F.LE.1c** Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.★**MCC9‐12.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).★**MCC9‐12.F.LE.3** Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly,★**MCC9‐12.F.LE.5** Interpret the parameters in a linear or exponential function in terms of a context.**Standards of mathematical practice** -Make sense of problems and persevere in solving them; Reason abstractly and quantitatively; Construct viable arguments and critique the reasoning of others; Model with mathematics; Use appropriate tools strategically; Attend to precision, persevere, strategically selecting tools, construct viable arguments, and reasoning abstractly and quantitatively**Essential Question**: * How do I use graphs to represent and solve real-world equations and inequalities?
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**Vocabulary Development:** Students share their thoughts and discuss key vocabulary terms.**Direct / Group Instruction:** Teacher facilitates a discussion on standard and EQ. Teacher models analyzing exponential functions and presents lesson. Students complete tasks on exponential growth.  |
| **WORK PERIOD** | **Individual, Pair, or Group Task:**  Students will complete problems to practice solving problems on exponential growth and decay and transformations of exponential functions.Ch 5. Students will practice writing recursive and explicit functions for arithmetic sequences.Ch4.2 1-10 and 21-30, 41,46,47,50; 4.3 #1-10, 22,24,25,27 |
| **CLOSING** | **Students will:** Students will identify any sticking points and teacher will provide clarity of any misconceptions. Teacher will facilitate a discussion on EQ and standard... |
|  | **HOMEWORK** | **Students will:** Students complete Carnegie Skills Practice Ch 4.1 even, classwork, and Carnegie Cognitive Tutor. |
| **Day3** | **Pre- Opening/****Daily Routines** | **TITD**: none**Independent Reading:** Students will read real life application problem on exponential problem and write how that problem helps them in real life. |
|  | **OPENING** | **Activator: Student will analyze geometric sequence and practice identifying the common ratio and writing the recursive function.****Essential Question**: * How do I use graphs to represent and solve real-world equations and inequalities?
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**Vocabulary Development:** Students share their thoughts and discuss key vocabulary terms.(common difference and common ration, geometic and arithmetic sequence.**Direct / Group Instruction:** Teacher facilitates a discussion on standard and EQ. . |
|  | **WORK PERIOD** | **Individual, Pair, or Group Task:**  Students will practice analyzing geometric sequences, identifying the common ration and writing the recursive and explicit function for each sequence.  |
|  | **CLOSING** | **Students will:** compare exponential functions to linear functions to sequences. |
|  | **HOMEWORK** | **Students will:** complete Carnegie Cognitive Tutor. Carnegie Skills Practice Ch 4Homework Tasks Community Service. |