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| **Common Core Standards** | **Common Core Standards** | **Mathematic Practices** |
| N = Number and Quantity Overview  N-RN = The Real Number System  N-Q = Quantities  N-CN = The Complex Number System  N-VM = Vector and Matrix Quantities  A= Algebra Overview  A-SSE = Seeing Structure in Expressions  A-APR= Arithmetic with Polynomials  and Rational Expressions  A-CED= Creating Equations  A-REI = Reasoning with Equations  and inequalities  F= Functions Overview  F-IF = Interpreting Functions  F-BF = Building Functions  F-LE = Linear and Exponential Models  F-TF = Trigonometric Functions | G = Geometry Overview  G-CO = Congruence  G-SRT = Similarity, Right Triangles and Trigonometry  G-C = Circles  G-GPE = Expressing Geometric Properties with Equations  G-GMD = Geometric Measurement and Dimension  G-MG = Modeling with Geometry  S=Statistics and Probability  S-ID = Categorical and Quantitative Data  S-IC = Inferences and Justifying Conclusions  S-CP = Conditional Probability and Rules of Probability  S-MD = Using Probability to Make Decisions | 1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning. |
| CC.9-12.F.IF.1 Understand the concept of a function and use function notation. 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). | F.IF.1 Use the definition of a function to determine whether a relationship is a function given a table, graph or words.  F.IF.1 Given the function f(x), identify x as an element of the domain, the input, and f(x) is an element in the range, the output.  F.IF.1 Know that the graph of the function, f, is the graph of the equation y=f(x). |  |
| CC.9-12.F.IF.2 Understand the concept of a function and use function notation. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context. | F.IF.2 Evaluate functions for inputs in their domain. F.IF.2 Interpret statements that use function notation in terms of the context in which they are used. |  |
| CC.9-12.F.IF.3 Understand the concept of a function and use function notation. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1 (n is greater than or equal to 1 | F.IF.3 Recognize that sequences, sometimes defined recursively, are functions whose domain is a subset of the set of integers. |  |
| CC.9-12.F.IF.4 Interpret functions that arise in applications in terms of the context. 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.\* | F.IF.4 Given a function, identify key features in graphs and tables including: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.  F.IF.4 Given the key features of a function, sketch the graph. |  |
| CC.9-12.F.IF.5 Interpret functions that arise in applications in terms of the context. 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.\* | F.IF.5 Given the graph of a function, determine the practical domain of the function as it relates to the numerical relationship it describes. |  |
| CC.9-12.F.IF.6 Interpret functions that arise in applications in terms of the context. 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.\* | F.IF.6 Calculate the average rate of change over a specified interval of a function presented symbolically or in a table.  F.IF.6 Estimate the average rate of change over a specified interval of a function from the function’s graph.  F.IF.6 Interpret, in context, the average rate of change of a function over a specified interval. |  |
| CC.9-12.F.IF.7 Analyze functions using different representations. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.\* | F.IF.7 Graph functions expressed symbolically and show key features of the graph. Graph simple cases by hand, and use technology to show more complicated cases including: |  |
| CC.9-12.F.IF.7a Graph linear and quadratic functions and show intercepts, maxima, and minima.\* | F.IF.7a Linear functions showing intercepts, quadratic functions showing intercepts, maxima, or minima. |  |
| CC.9-12.F.IF.7b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.\* | F.IF.7b Square root, cube root, and piecewise-defined functions, including step functions and absolute value  functions. |  |
| CC.9-12.F.IF.7c Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.\* | F.IF.7c Polynomial functions, identifying zeros when factorable, and showing end behavior. |  |
| CC.9-12.F.IF.7d (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.\* | F.IF.7d (+) Rational functions, identifying zeros and asymptotes when factorable, and showing end behavior. |  |
| CC.9-12.F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.\* | F.IF.7e Exponential and logarithmic functions, showing intercepts and end behavior.  F.IF.7e Trigonometric functions, showing period, midline, and amplitude. |  |
| CC.9-12.F.IF.8 Analyze functions using different representations. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. | F.IF.8 Write a function in equivalent forms to show different properties of the function. F.IF.8 Explain the different properties of a function that are revealed by writing a function in equivalent forms. |  |
| CC.9-12.F.IF.8a Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. | F.IF.8a Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. |  |
| CC.9-12.F.IF.8b 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 and decay. | F.IF.8b Use the properties of exponents to interpret expressions for percent rate of change, and classify them as growth or decay. |  |
| CC.9-12.F.IF.9 Analyze functions using different representations. 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. | F.IF.9 Compare the key features of two functions represented in different ways. For example, compare the end behavior of two functions, one of which is represented graphically and the other is represented symbolically. |  |
| CC.9-12.F.BF.1 Build a function that models a relationship between two quantities. Write a function that describes a relationship between two quantities.\* |  |  |
| CC.9-12.F.BF.1a Determine an explicit expression, a recursive process, or steps for calculation from a context. | F.BF.1a From context, either write an explicit expression, define a recursive process, or describe the calculations needed to model a function between two quantities. |  |
| CC.9-12.F.BF.1b 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 to a decaying exponential, and relate these functions to the model. | F.BF.1b. Combine standard function types, such as linear and exponential, using arithmetic operations. |  |
| CC.9-12.F.BF.1c (+) Compose functions. For example, if T(y) is the temperature in the atmosphere as a function of height, and h(t) is the height of a weather balloon as a function of time, then T(h(t)) is the temperature at the location of the weather balloon as a function of time. | F.BF.1c Compose functions. |  |
| CC.9-12.F.BF.2 Build a function that models a relationship between two quantities. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.\* | F.BF.2 Write arithmetic sequences recursively and explicitly, use the two forms to model a situation, and translate between the two forms.  F.BF.2 Write geometric sequences recursively and explicitly, use the two forms to model a situation, and translate between the two forms.  F.BF.2 Understand that linear functions are the explicit form of recursively-defined arithmetic sequences and that exponential functions are the explicit form of recursively-defined geometric sequences. |  |
| CC.9-12.F.BF.3 Build new functions from existing functions. 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. | F.BF.3 Identify, through experimenting with technology, the effect on the graph of a function by replacing f(x)  with f(x) + k, k  f(x), f(kx), and f(x + k) for specific values of k (both positive and negative).  F.BF.3 Given the graphs of the original function and a transformation, determine the value of (k). F.BF.3 Recognize even and odd functions from their graphs and equations. |  |
| CC.9-12.F.BF.4 Build new functions from existing functions. Find inverse functions. |  |  |
| CC.9-12.F.BF.4a Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, f(x) =2(x^3) or f(x) = (x+1)/(x-1) for x ≠ 1 (x not equal to 1). | F.BF.4a Solve a function for the dependent variable and write the inverse of a function by interchanging the values of the dependent and independent variables. |  |
| CC.9-12.F.BF.4b (+) Verify by composition that one function is the inverse of another. | F.BF.4b Verify that one function is the inverse of another by illustrating that f-1(f(x)) = f(f-1(x)) = x. |  |
| CC.9-12.F.BF.4c (+) Read values of an inverse function from a graph or a table, given that the function has an inverse. | F.BF.4c Read values of an inverse function from a graph or table. |  |
| CC.9-12.F.BF.4d (+) Produce an invertible function from a non-invertible function by restricting the domain. | F.BF.4d Find the inverse of a function that is not one-to-one by restricting the domain. |  |
| CC.9-12.F.BF.5 (+) Build new functions from existing functions. Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. | F.BF.5 Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents. |  |
| CC.9-12.F.LE.1 Construct and compare linear, quadratic, and exponential models and solve problems. Distinguish between situations that can be modeled with linear functions and with exponential functions.\* | F.LE.1 Given a contextual situation, describe whether the situation in question has a linear pattern of change or an exponential pattern of change. |  |
| CC.9-12.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.\* | F.LE.1a Show that linear functions change at the same rate over time and that exponential functions change by equal factors over time. |  |
| CC.9-12.F.LE.1b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.\* | F.LE.1b Describe situations where one quantity changes at a constant rate per unit interval as compared to another. |  |
| CC.9-12.F.LE.1c Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.\* | F.LE.1c Describe situations where a quantity grows or decays at a constant percent rate per unit interval as compared to another. |  |
| CC.9-12.F.LE.2 Construct and compare linear, quadratic, and exponential models and solve problems. 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).\* | F.LE.2 Create linear and exponential functions given the following situations:  •arithmetic and geometric sequences •a graph  •a description of a relationship  •two points, which can be read from a table |  |
| CC.9-12.F.LE.3 Construct and compare linear, quadratic, and exponential models and solve problems. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.\* | F.LE.3 Make the connection, using graphs and tables, that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or any other polynomial function. |  |
| CC.9-12.F.LE.4 Construct and compare linear, quadratic, and exponential models and solve problems. For exponential models, express as a logarithm the solution to ab^(ct) = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.\* | F.LE.4 Express logarithms as solutions to exponential functions using bases 2, 10, and e. F.LE.4 Use technology to evaluate a logarithm. |  |
| CC.9-12.F.LE.5 Interpret expressions for functions in terms of the situation they model. Interpret the parameters in a linear or exponential function in terms of a context.\* | F.LE.5 Based on the context of a situation, explain the meaning of the coefficients, factors, exponents, and/or intercepts in a linear or exponential function. |  |
| CC.9-12.F.TF.1 Extend the domain of trigonometric functions using the unit circle. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle. | F.TF.1 Know that if the length of an arc subtended by an angle is the same length as the radius of the circle, then the measure of the angle is 1 radian.  F.TF.1 Know that the graph of the function, f, is the graph of the equation y=f(x). |  |
| CC.9-12.F.TF.2 Extend the domain of trigonometric functions using the unit circle. Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. | F.TF.2 Explain how radian measures of angles rotated counterclockwise in a unit circle are in a one-to-one correspondence with the nonnegative real numbers, and that angles rotated clockwise in a unit circle are in a ont-to- one correspondence with the non-positive real numbers. |  |
| CC.9-12.F.TF.3 (+) Extend the domain of trigonometric functions using the unit circle. Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6, and use the unit circle to express the values of sine, cosine, and tangent for π - x, π + x, and 2π - x in terms of their values for x, where x is any real number. | F.TF.3 Use 30o-60o-90o and 45o-45o-90o triangles to determine the values of sine, cosine, and tangent for values of , ,and . |  |
| CC.9-12.F.TF.4 (+) Extend the domain of trigonometric functions using the unit circle. Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. | F.TF.4 Use the unit circle and periodicity to find values of sine, cosine, and tangent for any value of  , such as + , 2  + , where is a real number.  F.TF. 4 Use the values of the trigonometric functions derived from the unit circle to explain how trigonometric functions repeat themselves.  F.TF.4 Use the unit circle to explain that f(x) is an even function if f(-x) = f(x), for all x, and an odd function if f(-x) = -f(x). Also know that an even function is symmetric about the y-axis. |  |
| CC.9-12.F.TF.5 Model periodic phenomena with trigonometric functions. Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.\* | F.TF.5 Use sine and cosine to model periodic phenomena such as the ocean’s tide or the rotation of a Ferris wheel.  F.TF.5 Given the amplitude; frequency; and midline in situations or graphs, determine a trigonometric function used to model the situation. |  |
| CC.9-12.F.TF.6 (+) Model periodic phenomena with trigonometric functions. Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. | F.TF.6 Know that the inverse for a trigonometric function can be found by restricting the domain of the function so it is always increasing or decreasing. |  |
| CC.9-12.F.TF.7 (+) Model periodic phenomena with trigonometric functions. Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context.\* | F.TF.7 Use the inverse of trigonometric functions to solve equations that arise in real-world contexts.  F.TF.7 Use technology to evaluate the solutions to the inverse trigonometric functions, and interpret their meaning in terms of the context. |  |
| CC.9-12.F.TF.8 Prove and apply trigonometric identities. Prove the Pythagorean identity (sin A)^2 + (cos A)^2 = 1 and use it to find sin A, cos A, or tan A, given sin A, cos A, or tan A, and the quadrant of the angle. | F.TF.8 Use the unit circle to prove the Pythagorean identity sin2(θ) + cos2(θ) = 1.  F.TF.8 Given the value of the sin(θ) or cos(θ), use the Pythagorean identity sin2(θ) + cos2(θ) = 1 to calculate other trigonometric ratios. |  |
| CC.9-12.F.TF.9 (+) Prove and apply trigonometric identities. Prove the addition and subtraction formulas for sine, cosine, and tangent and use them to solve problems. | F.TF.9 Prove the addition and subtraction formulas sin(ά±β), cos(ά±β), and tan(ά±β).  F.TF.9 Use the addition and subtraction formulas to determine exact trigonometric values such as sin(75o) or cos( ). |  |