DRAFT

Algebra 2 EOC Item Specifications

Florida
Standards Assessments

The draft Florida Standards Assessment (FSA) *Test Item Specifications* (*Specifications)* are based upon the Florida Standards and the Florida Course Descriptions as provided in CPALMs. The *Specifications* are a resource that defines the content and format of the test and test items for item writers and reviewers. Each grade-level and course *Specifications* document indicates the alignment of items with the Florida Standards. It also serves to provide all stakeholders with information about the scope and function of the FSA.

Item Specifications Definitions

Also assesses refers to standard(s) closely related to the primary standard statement.

Clarification statements explain what students are expected to do when responding to the question.

Assessment limits define the range of content knowledge and degree of difficulty that should be assessed in the assessment items for the standard.

Acceptable response mechanisms describe the characteristics from which a student must answer a question.

Context defines types of stimulus materials that can be used in the assessment items.

MAFS.912.A-APR.1.1 Also assesses MAFS.912.A-APR.3.4	Understand that polynomials form a system analogous to the integers; namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. Prove polynomial identities and use them to describe numerical relationships. *For example, the polynomial identity* $(x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2$ *can be used to generate Pythagorean triples.*
Item Types	Drag and drop response – May require using graphics in the construction of a proof. Equation response – May require creating a value or an expression. Hot spot response – May require identifying steps in the construction of a proof. Movable text response – May require ordering steps in a proof. Multiple-choice response – May require selecting a value, an expression, or a statement from a list. Natural Language response – May require explaining the steps used in generating a polynomial identity. Selectable text response – May require highlighting a step in an informal argument.
Clarifications	Students will apply their understanding of closure to adding, subtracting, and multiplying polynomials with rational coefficients. Students will use polynomial identities to describe numerical relationships. Students will use the structure of algebra to complete an algebraic proof of a polynomial identity.
Assessment Limits	Items set in a real-world context should not result in a nonreal answer if the polynomial is solved. In items that require addition and subtraction, polynomials are limited to polynomials with no more than 5 terms. The simplified polynomial should contain no more than 8 terms. In items that require multiplication of polynomials, the factors are limited to a product of: two binomials; a monomial and two binomials; a monomial, a binomial, and a trinomial; two trinomials; and a binomial and a polynomial with four terms. The simplified product should contain no more than 9 terms. Polynomial identities are restricted to trinomials, difference of squares, sum of cubes, and difference of cubes.
Stimulus Attributes	Items can be set in a mathematical or real-world context. Items can use function notation.
Response Attributes	Items may require students to recognize equivalent expressions. Items may require students to rewrite expressions with negative exponents, but items must not require the student to rewrite rational expression as seen in the standard MAFS.912.A-APR.4.6.
Calculator	No

MAFS.912.A-APR.4.6 Also assesses MAFS.912.A-APR.2.2	Rewrite simple rational expressions in different forms; write a(x)/b(x) in the form q(x) + r(x)/b(x), where a(x), b(x), q(x), and r(x) are polynomials with the degree of r(x) less than the degree of b(x), using inspection, long division, or, for the more complicated examples, a computer algebra system. Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x).
Item Types	Drag and drop response – May require using completing long division. Equation response – May require creating an expression or a value. Graphic response – May require graphing the location of key features. Multiple-choice response – May require identifying an expression or a value. Multi-select response – May require choosing factors from a list. Natural Language response – May require explaining what a value means.
Clarifications	Students will rewrite a rational expression as the quotient in the form of a polynomial added to the remainder divided by the divisor. Students will use polynomial long division to divide a polynomial by a polynomial. Students will use the Remainder Theorem to determine if (x – a) is a factor. Students will use the Remainder Theorem to determine the remainder of p(x)/(x – a).
Assessment Limits	The polynomial that is the dividend should have a degree no less than 3 and no greater than 6. The polynomial that is the divisor should have a degree of 1, 2, or 3. In items that require the Remainder Theorem, the value of a in (x – a), the divisor, can be a rational number.

Stimulus Attributes	Items should be set in a mathematical context. Items can use function notation.
Response Attribute	Items may require the student to provide sub-steps to complete polynomial long division.
Calculator	No

MAFS.912.A-CED.1.1 Also assesses MAFS.912.A-REI.1.2 Also assesses MAFS.912.A-CED.1.4	Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions and simple rational, absolute, and exponential functions.* Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations. *For example, rearrange Ohm's law, $V = IR$, to highlight resistance, R.*
Item Types	Drag and drop response – May require rearranging equations. Equation response – May require creating an equation, an inequality, or a value. Hot spot response – May require selecting key features of a function. Multiple-choice response – May require identifying an equation or a value from a list of four choices. Natural Language response – May require creating a written explanation.
Clarifications	Students will write and solve an equation that represents a real-world context in one variable. Students will solve a rational equation in one variable. Students will solve a radical equation in one variable. Students will justify algebraically why a solution is extraneous. Students will solve multi-variable formulas or literal equations for a specific variable.

Assessment Limits	In items that require students to write an equation, equations are limited to simple rational, absolute value, and exponential with rational exponents. Items may include equations that contain variables on both sides. Items that involve formulas should not include overused contexts such as Fahrenheit/Celsius or three-dimensional geometry formulas. In items that require students to solve literal equations and formulas, the term of interest can be quadratic, a cubic in a monomial term, a linear term in the denominator of rational equation, a linear term in a square root equation, or a linear term as the base of an exponential equation with a rational number as the value for the exponent. Items should not require more than four procedural steps to isolate the variable of interest. Items will not assess inequalities.
Stimulus Attributes	Items should be set in a real-world context. Items can use function notation. Items may require the student to choose and interpret units.
Response Attribute	Items may require students to recognize equivalent expressions.
Calculator	Neutral

MAFS.912.A-CED.1.2 Also assesses MAFS.912.A-CED.1.3 Also assesses MAFS.912.A-REI.3.6 Also assesses MAFS.912.A-REI.3.7	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.* Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. *For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.*
Item Types	Equation response – May require creating an equation, an inequality, or a value. Graphic response – May require graphing a representation of an equation or a solution. Hot spot response – May require selecting a solution region. Multiple-choice response – May require identifying an equation or a value from a list of four possible choices, identifying graphs, or identifying inequalities. Multi-select response – May require identifying equations or inequalities.
Clarifications	Students will identify the quantities in a real-world situation that should be represented by distinct variables. Students will write a system of equations given a real-world situation. Students will graph a system of equations that represents a real-world context using appropriate axis labels and scale. Students will solve systems of linear equations. Student will write a system of equations for a modeling context that is best represented by a system of equations. Student will write a system of inequalities for a modeling context that is best represented by a system of inequalities. Students will interpret the solution of a real-world context as viable or not viable. Students will solve a simple system of a linear equation and a quadratic equation in two variables algebraically. Students will solve a simple system of a linear equation and a quadratic equation in two variables graphically.
Assessment Limits	Items that require a student to write a system of equations using a real-world context are limited to: • a system of 2 x 2 linear equations with rational coefficients; • a system of 3 x 3 linear equations with rational coefficients; • a system of two equations with a linear equation with rational coefficients and a quadratic of the form $y = ax^2 + bx + c$, where a, b, and c are integers; and

	• a system of two equations with a linear equation with rational coefficients and a quadratic of the form $ax^2 + by^2 = c$, where a, b, and c are integers. Items that require a student to graph a system of equations are limited to a 2 x 2 system.
Stimulus Attributes	Items can be set in a real-world or mathematical context. Items may result in infinitely many solutions or no solution.
Response Attributes	Items may require the student to choose and interpret the scale in a graph. Items may require the student to graph a circle whose center is (0, 0). Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.A-REI.1.1	Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.
Item Types	Drag and drop response – May require rearranging equations or justifications. Equation response – May require creating an expression. Movable text response – May require ordering steps. Multiple-choice response – May require identifying expressions or statements. Natural Language response – May require creating a written response. Selectable text response – May require highlighting a step in an informal argument.
Clarifications	Students will complete an algebraic proof to explain steps for solving a simple equation. Students will construct a viable argument to justify a solution method.
Assessment Limit	Items will not require the student to recall names of properties from memory.
Stimulus Attributes	Items should be set in a mathematical context. Items can use function notation. Coefficients can be a rational number or a variable that represents any real number.
Response Attribute	Items will not ask the student to provide the solution.
Calculator	No

MAFS.912.A-REI.4.11	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.
Item Types	Equation response – May require creating a value or an expression. Multiple-choice response – May require selecting a value or an expression from a list. Multi-select response – May require selecting multiple values. Natural Language response – May require creating a written response. Simulation response – May require inputting values. Table response – May require completing missing cells in a table.
Clarifications	Students will find an approximate solution for f(x) = g(x) using a graphing tool. Students will find an approximate solution for f(x) = g(x) using a table of values. Students will find an approximate solution for f(x) = g(x) using successive approximations that gives the solution to a given place value. Students will demonstrate why the intersection of two functions is a solution to f(x) = g(x).
Assessment Limit	Functions are restricted to exponential with a rational exponent, polynomial of degree greater than 2, rational, absolute value, and logarithmic.
Stimulus Attributes	Items should be set in a mathematical context. Items can use function notation. Items will designate the place value accuracy necessary for approximate solutions.
Response Attributes	Items may require the student to complete a missing step in an algebraic justification of the solution of f(x) = g(x). Items may require the student to know the role of the x-coordinate and the y-coordinate in the intersection of f(x) = g(x).
Calculator	Neutral

MAFS.912.A-SSE.2.3 Also assesses MAFS.912.A-SSE.1.1 Also assesses MAFS.912.A-SSE.1.2	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions. *For example, the expression 1.15^t can be rewritten as (1.15$^{1/12}$)^{12} ≈ (1.012)^{12t} to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.* Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret P(1+r)^n as the product of P and a factor not depending on P.* Use the structure of an expression to identify ways to rewrite it. *For example, see x^4 - y^4 as (x^2)^2 – (y^2)^2, thus recognizing it as a difference of squares that can be factored as (x^2 – y^2)(x^2 + y^2).*
Item Types	Drag and drop response – May require sorting expressions. Equation response – May require creating an equivalent expression or numerical response. Multiple-choice response – May require selecting an expression or a value from a set of options. Multi-select response – May require selecting expressions or values from a set of options. Natural Language response – May require constructing a written response.
Clarifications	Students will use equivalent forms of a quadratic expression to interpret the expression's terms, factors, zeros, maximum, minimum, coefficients, or parts in terms of the real-world situation the expression represents. Students will use equivalent forms of an exponential expression to interpret the expression's terms, factors, coefficients, or parts in terms of the real-world situation the expression represents. Students will rewrite algebraic expressions in different equivalent forms by recognizing the expression's structure. Students will rewrite algebraic expressions in different equivalent forms using factoring techniques (e.g., common factors, grouping, the difference of two squares, the sum or difference of two cubes, or a combination of methods to factor completely) or simplifying expressions (i.e., combining like terms, using the distributive property, and using other operations with polynomials).
Assessment Limits	In items that require students to factor quadratics, the quadratic can have rational coefficients. Items can have a greatest common factor that is a monomial with no more than two variables. In items that require students to write equivalent expressions by

	factoring, the given expression can be a difference of two squares, a quadratic with rational coefficients, a sum and difference of cubes, or a polynomial with the highest degree of 3.
Stimulus Attributes	Items that require interpretation should be set in a real-world context. Items that require an equivalent expression found by factoring can be in a real-world or mathematical context. Items can use function notation.
Response Attribute	Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.N-CN.3.7 Also assesses MAFS.912.A-REI.2.4	Solve quadratic equations with real coefficients that have complex solutions. Solve quadratic equations in one variable. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form. b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.
Item Types	Drag and drop response – May require rearranging equations. Equation response – May require creating a value or an expression. Multiple-choice response – May require selecting a value or an expression from a list. Multi-select response – May require selecting multiple values.
Clarifications	Students will rewrite a quadratic equation in vertex form by completing the square. Students will solve a quadratic equation by choosing an appropriate method (i.e., completing the square, the quadratic formula, or factoring).
Assessment Limits	Items may have complex solutions. Items may require the student to recall from memory the quadratic formula.
Stimulus Attributes	Items should be set in a mathematical context. Items can use function notation.
Response Attribute	Items may require the student to recognize equivalent solutions to the quadratic equation.
Calculator	Neutral

MAFS.912.G-GPE.1.2	Derive the equation of a parabola given a focus and directrix.
Item Type	Equation response – May require constructing an equation for a parabola.
Clarification	Students will write the equation of a parabola when given the focus and directrix.
Assessment Limit	The directrix should be parallel to a coordinate axis.
Stimulus Attributes	Items can be set in a mathematical or real-world context. Items can use function notation.
Response Attribute	Items may require the student to recognize equivalent forms of an equation.
Calculator	Neutral

MAFS.912.F-BF.1.2 Also assesses MAFS.912.F-BF.1.1	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. 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 to a decaying exponential, and relate these functions to the model.* c. 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.*
Also assesses MAFS.912.A-SSE.2.4	Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. *For example, calculate mortgage payments.*
Item Types	Equation response – May require creating a value, an expression, or a function or showing steps for a calculation. Movable text response – May require ordering steps. Multiple-choice response – May require selecting a choice from a set of possible choices. Natural Language response – May require explaining and interpreting a resulting function. Table response – May require completing missing cells in a table.
Clarifications	Students will write an arithmetic sequence using a recursive formula to model a real-world context. Students will write an arithmetic sequence using an explicit formula to model a real-world context. Students will write a geometric sequence using a recursive formula to model a real-world context. Students will write a geometric sequence using an explicit formula to model a real-world context. Students will rewrite recursive formulas using an explicit formula and vice versa. Students will write an explicit function, define a recursive process, or complete a table of calculations that can be used to mathematically define a real-world context. Students will write a function that combines functions using arithmetic operations and relate the result to the context of the problem. Students will write a function to model a real-world context by composing functions and the information within the context. Students will use the formula for a sum of a finite geometric series to solve real-world problems. Students will derive the formula for a sum of a finite geometric series where r is not equal to 1.

Assessment Limit	Items will not expect the student to find the sum of an infinite geometric series.
Stimulus Attributes	Items should be set in a real-world context. Items can use function notation. In items where students have to find the sum of a finite geometric series, the student will be expected to know the formula. A series can be written in summation notation.
Response Attributes	In items where students have to give a recursive formula, the student will be expected to give the initial condition and the recursion formula. Items may require the student to complete algebraic steps in a deviation of the formula for the sum of a geometric series. Items may require the student to rearrange steps in an algebraic deviation of the formula for the sum of a geometric series. Items that ask the student to derive the formula for the sum of a geometric series may use equivalent forms of the formula. Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.F-BF.2.3	Identify the effect on the graph of replacing f(x) by f(x) + *k*, *k*f(x), f(*k*x), 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*
Item Types	Drag and drop response – May require rearranging equations. Equation response – May require creating a value or an expression. Graphic response – May require plotting points or a transformed function. Multiple-choice response – May require selecting a graph or a table from a list.
Clarifications	Students will determine the value of *k* when given a graph of the function and its transformation. Students will identify differences and similarities between a function and its transformation. Students will identify a graph of a function given a graph or a table of a transformation and the type of transformation that is represented. Students will graph by applying a given transformation to a function. Students will identify ordered pairs of a transformed graph. Students will complete a table for a transformed function. Students will recognize even and odd functions from their graphs and equations.
Assessment Limits	Functions can be linear, quadratic, or exponential with integral exponents. Functions can also be represented using tables or graphs. Functions can have closed domains. Functions can be discontinuous. Items should have at least two transformations.
Stimulus Attributes	Items should be set in a mathematical context. Items can use function notation.
Response Attributes	Items may require the student to explain or justify a transformation that has been applied to a function. Items may require students to explain how a graph is affected by a value of *k*. Items may require students to find the value of *k*. Items may require a student to complete a table of values.
Calculator	Neutral

MAFS.912.F-BF.2.4	Find inverse functions. a. 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, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.* b. Verify by composition that one function is the inverse of another. c. Read values of an inverse function from a graph or a table, given that the function has an inverse. d. Produce an invertible function from a non-invertible function by restricting the domain.
Item Types	Equation response – May require expressing a function or showing steps to find the inverse of a function. Graphic response – May require plotting points on a coordinate plane. Multiple-choice response – May require selecting a choice from a set of possible choices.
Clarifications	Students will find the inverse of a function. Students will use composition of functions to determine if two functions are inverses. Students will use a graph or a table of a function to determine values of the function's inverse. Students will restrict the domain of a function whose inverse is not a function so that the inverse will be a function.
Assessment Limit	In items that require the student to find the inverse of a function, functions can consist of linear functions, quadratics of the form $f(x) = ax^2 + c$, radical functions with a linear function as the radicand, and rational functions whose numerator is a integer and whose denominator is a linear function.
Stimulus Attributes	Items can be set in a real-world or mathematical context. Items can use function notation.
Response Attribute	Interval notation may be used to represent the domain.
Calculator	Neutral

MAFS.912.F-IF.2.4 Also assesses MAFS.912.F-IF.3.9 Also assesses MAFS.912.F-IF.2.5 Also assesses MAFS.912.F-LE.2.5	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.* 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.* 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.* Interpret the parameters in a linear or an exponential function in terms of a context.
Item Types	Drag and drop response – May require rearranging comparisons and labeling key features. Equation response – May require expressing a value, an inequality, an expression, or a function. Multiple-choice response – May require selecting a choice from a set of possible choices. Natural Language response – May require explaining the relationship of key features. Table response – May require completing a table of values.
Clarifications	Students will determine and relate the key features of a function within a real-world context by examining the function's table. Students will determine and relate the key features of a function within a real-world context by examining the function's graph. Students will use a given verbal description of the relationship between two quantities to label key features of a graph of a function that models the relationship. Students will differentiate between different types of functions using a variety of descriptors (e.g., graphical, verbal, numerical, and algebraic). Students will compare properties of two functions using a variety of function representations (e.g., algebraic, graphical, numerical in tables, or verbal descriptions). Students will interpret the domain of a function within the real-world context given. Students will interpret statements that use function notation within the real-world context given. Students will determine the feasible domain of a function in relation to its graph and/or the quantitative relationship it describes. Students will interpret the rate of change and the intercepts of a linear function given in a real-world context.

	Students will interpret the parameters of an exponential function given in a real-world context.
Assessment Limits	Functions can be polynomial, rational, square root, absolute value, piece-wise, exponential, or logarithmic. In items requiring students to find the domain from graphs, relationships can be on a closed or open interval. In items requiring students to find the domain from graphs, relationships may be discontinuous. Items may have domains expressed using inequalities or interval notation. Key features include x-intercepts; y-intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.
Stimulus Attributes	Items should be set in a real-world context. Items can use function notation.
Response Attributes	Items may require students to write domains using inequalities or interval notation. Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.F-IF.3.8 Also assesses MAFS.912.A-APR.2.3 Also assesses MAFS.912.F-IF.2.6 Also assesses MAFS.912.F-IF.3.7a, b, c, d, and e.	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. 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. b. Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, *and* $y = (1.2)^{1/10}$ *and classify them as representing exponential growth or decay.* Identify zeros of polynomials when suitable factorizations are available and use the zeros to construct a rough graph of the function defined by the polynomial. 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. Graph functions expressed symbolically and show key features of the graph by hand in simple cases and using technology for more complicated cases. a. Graph linear and quadratic functions and show intercepts, maxima, and minima. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. c. Graph polynomial functions, identifying zeros when suitable factorizations are available and showing end behavior. d. Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude and using phase shift
Item Types	Drag and drop response – May require identifying key features. Equation response – May require creating a value, an expression, or an equation. Graphic response – May require plotting points, key features, or an equation on a graph. Hot spot response – May require selecting key features on a graph. Multiple-choice response – May require selecting from a list, a statement about the rate of a data display, an interpretation, or context. Multi-select response – May require selecting multiple responses or multiple statements about the rate of change. Natural Language response – May require explaining and interpreting a function.

Clarifications	Students will calculate and interpret the average rate of change of a continuous function that is represented algebraically, in a table of values, on a graph, or as a set of data with a real-world context. Students will identify zeros, extreme values, and symmetry of a quadratic function written symbolically. Students will classify the exponential function as exponential growth or decay by examining the base, and students will give the rate of growth or decay. Students will use the properties of exponents to write an exponential function defined by an expression in different but equivalent forms to reveal and explain different properties of the function, and students will determine which form of the function is the most appropriate for interpretation for a real-world context. Students will find the zeros of a polynomial function when the polynomial is in factored form. Students will identify a rough graph of a polynomial function in factored form by examining the zeros of the function. Students will use the x-intercepts of a polynomial function and end behavior to graph the function. Students will identify x- and y-intercepts and the slope of the graph of a linear function. Students will identify zeros, extreme values, and symmetry of the graph of a quadratic function symbolically. Students will identify intercepts and end behavior for an exponential function. Students will graph a linear function using key features. Students will graph a quadratic function using key features. Students will graph an exponential function using key features. Students will identify and interpret key features of a graph within the real-world context that the function represents.
Assessment Limit	In items that require the student to graph polynomial functions, the polynomial's degree should be no greater than 6.
Stimulus Attributes	Items can be set in a mathematical or real-world context. Items can use function notation. Items should not require the student to complete a sign chart for a polynomial.
Response Attribute	Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.F-LE.1.4 Also assesses MAFS.912.F-BF.2.a	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. Use the change of base formula.
Item Types	Equation response – May require creating a value, an expression, or an equation. Multi-select response – May require selecting responses from a set of possible choices.
Clarifications	Students will use logarithms to solve exponential functions with a base of 2, 10, or e. Students will use the base change formula to find values of logarithms with bases other than 10 and e.
Assessment Limit	N/A
Stimulus Attributes	Items should be set in a real-world context. Items can use function notation.
Response Attribute	Items may require the student to leave the answer as a logarithm or to find the value using a calculator.
Calculator	Neutral

MAFS.912.F-TF.1.2 Also assesses MAFS.912.F-TF.1.1 Also assesses MAFS.912.F-TF.3.8	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. Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle; convert between degrees and radians. Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to calculate trigonometric ratios.
Item Types	Equation response – May require creating a value, an expression, or an equation. Graphic response – May require drawing an angle or plotting a point on the unit circle. Hot spot response – May require ordering the steps in a proof. Movable text response – May require ordering the steps in a proof. Natural Language response – May require explaining a relationship. Selectable text response – May require highlighting a step in an informal argument.
Clarifications	Students will extend right triangle trigonometry to the unit circle to determine an ordered pair that lies on the unit circle. Students will explain how using the radian measure of an angle traversed allows for trigonometric functions to be extended to all real numbers. Students will explain how the radian measure of an angle is the length of the arc on the unit circle subtended by the angle. Students will convert the degree measure to radian measure. Students will convert the radian measure to degree measure. Students will use their knowledge of trigonometric ratios and the Pythagorean theorem to prove the Pythagorean identity. Students will use the Pythagorean identity to calculate trigonometric ratios.
Assessment Limits	In items where students extend right triangle trigonometry to the unit circle, the items should give an angle that is measured counterclockwise from the positive ray of the x-axis. Trigonometric functions are limited to sine and cosine. In items where students have to calculate trigonometric ratios, the value of either sine or cosine of an unknown angle must be given. Common sine and cosine ratios such as $\frac{1}{2}, \frac{\sqrt{2}}{2}$ and $\frac{\sqrt{3}}{2}$ should not be used in these items.
Stimulus Attributes	Items should be set in a mathematical or real-world context. Items can use function notation.
Response Attribute	Items may ask the student to complete steps in a proof of the Pythagorean identity.
Calculator	Neutral

MAFS.912.F-TF.2.5	Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.
Item Types	Equation response – May require creating a value or an equation. Graphic response – May require plotting a point. Multiple-choice response – May require selecting a choice from a set of possible choices. Multi-select response – May require selecting multiple statements about a given trigonometric function.
Clarification	Students will interpret a real-world context to choose a trigonometric function that models it.
Assessment Limit	Trigonometric functions are limited to sine and cosine functions that model simple periodic phenomena such as harmonic motion.
Stimulus Attributes	Items should be set in a real-world context. Items can use function notation. Items may provide a graph of a trigonometric function that models a real-world situation.
Response Attributes	Students may be asked to complete a function that models a real-world context by providing missing values. Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.N-CN.1.2 Also assesses MAFS.912.N-CN.1.1	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. Know there is a complex number, *i,* such that $i^2 = -1$, and every complex number has the form a + b*i* with a and b real.
Item Types	Equation response – May require providing a numeric value or an expression. Multi-select response – May require selecting a choice from a set of possible choices.
Clarification	Students will add, subtract, and multiply complex numbers and use $i^2 = -1$ to write the answer as a complex number.
Assessment Limit	Items should not require the student to perform more than 5 mathematical operations.
Stimulus Attribute	Items can be set in a mathematical or real-world context.
Response Attribute	Items will require the student to use the relation $i^2 = -1$ to convert imaginary numbers with an even power to a real number.
Calculator	No

MAFS.912.N-RN.1.2 Also assesses MAFS.912.N-RN.1.1	Rewrite expressions involving radicals and rational exponents using the properties of exponents. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define* $5^{(\frac{1}{3})}$ *to be the cube root of* 5 *because we want* $(5^{(\frac{1}{3})})^3 = 5^{(\frac{1}{3})3}$ *to hold, so* $(5^{(\frac{1}{3})})^3$ *must equal* 5.
Item Types	Drag and drop response – May require identifying parts of an algebraic proof. Equation response – May require creating a value or an expression. Movable text response – May require ordering steps in an algebraic proof. Multiple-choice response – May require selecting a value or an expression from a list. Multi-select response – May require selecting multiple values. Natural Language response – May require explaining why two rational exponent expressions are equivalent or why two expressions are equivalent. Selectable text response – May require highlighting a step in an informal argument.
Clarifications	Students will use the properties of exponents to rewrite a radical expression as an expression with a rational exponent. Students will use the properties of exponents to rewrite an expression with a rational exponent to a radical expression. Students will apply the properties of operations of integer exponents to expressions with rational exponents. Students will apply the properties of operations of integer exponents to radical expressions.
Assessment Limit	N/A
Stimulus Attribute	Items should be set in a mathematical context.
Response Attribute	Items may require students to determine equivalent expressions or equations.
Calculator	No

MAFS.912.S-CP.1.1	Describe events as subsets of a sample space (the set of outcomes) using characteristics (or categories) of the outcomes, or as unions, intersections, or complements of other events ("or," "and," "not").
Item Types	Drag and drop response – May require interacting with a Venn diagram by placing numeric values accordingly. Equation response – May require writing a sample space. Hot Spot response – May require clicking areas within a Venn diagram to illustrate subsets. Multiple-choice response – May require choosing a sample space. Multi-select response – May require choosing lists.
Clarifications	Students will determine events that are subsets of a sample space. Students will determine the sample space of an event by describing it as a union of the subsets of other sample spaces. Students will determine the sample space of an event by describing it as an intersection of the subsets of other sample spaces. Students will determine the sample space of an event by describing it as a complement of another sample space.
Assessment Limits	Unions can be described verbally or use the notation $A \cup B$. Intersections can be described verbally or use the notation $A \cap B$. Complements can be described verbally or use the notation ~A. Items should not ask the student to determine probability. Items should not require the student to apply understanding of independence or dependence.
Stimulus Attribute	Items should be set in a real-world context.
Response Attribute	Sample spaces can be written as a set, a list, in a table, or in a Venn diagram.
Calculator	No

MAFS.912.S-CP.1.5 Also assesses MAFS.912.S-CP.1.4 Also assesses MAFS.912.S-CP.1.2 Also assesses MAFS.912.S-CP.1.3 Also assesses MAFS.912.S-CP.2.6	Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. *For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer.* Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. *For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.* Understand that two events *A* and *B* are independent if the probability of *A* and *B* occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Understand the conditional probability of *A* given *B* as *P*(*A* and *B*)/*P*(*B*), and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of *A* and the conditional probability of *B* given *A* is the same as the probability of *B*. Find the conditional probability of A given B as the fraction of B's outcomes that also belong to A, and interpret the answer in terms of the model.
Item Types	Drag and drop response – May require constructing a frequency table with data to create independent or disjoint events or constructing probabilities for events *A* and *B*. Equation response – May require providing a numeric value or constructing an expression. Multiple-choice response – May require selecting a numeric value, specific sample groups within a given context, or a statement regarding the probability of an event or a set of data. Multi-select response – May require selecting sets of data that have independent events. Natural Language response – May require explaining an interpretation of an event's probability. Table response – May require completing missing cells in a table.
Clarifications	Students will determine probability or independence in a real-world context. Students will explain the concepts of probability and independence found within a real-world context. Students will construct a two-way frequency table when two categories are associated with each object being classified. Students will use a two-way frequency table to determine the independence of events. Students will use a two-way frequency table to approximate conditional probabilities. Students will find the probability of two independent events occurring

	together. Students will use given probabilities to determine if two events are independent. Students will find the conditional probability of A given B and the conditional probability of B given A to determine if A and B are independent events. Students will find the conditional probability of A given B as the fraction of B's outcomes that belong to A. Students will interpret a conditional probability in terms of a real-world context.
Assessment Limits	Items may use Venn diagrams. Unions can be described verbally or use the notation $A \bigcup B$. Intersections can be described verbally or use the notation $A \bigcap B$. Complements can be described verbally or use the notation ~A.
Stimulus Attribute	Items should be set in a real-world context.
Response Attribute	Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.S-CP.2.7	Apply the Addition Rule, P(A or B) = P(A) + P(B) – P(A and B), and interpret the answer in terms of the model.
Item Types	Equation response – May require identifying a value. Multiple-choice response – May require selecting a numeric value. Natural Language response – May require interpreting the Addition Rule within a context.
Clarification	Students will find probabilities using the Addition Rule and interpret the answer within the real-world context.
Assessment Limit	Data can be displayed in a two-way table, a Venn diagram, a tree diagram, or simply described.
Stimulus Attribute	Items should be set in a real-world context.
Response Attribute	Students may be asked to find the unknown value when given three of the values in P(A or B) = P(A) + P(B) – P(A and B).
Calculator	Neutral

MAFS.912.S-IC.1.1	Understand statistics as a process for making inferences about population parameters based on a random sample from that population.
Item Types	Equation response – May require the student identifying a quantity. Multiple-choice response – May require selecting a choice from a set of possible choices. Natural Language response – May require describing flaws in data collection or interpretation or recommending a correct course of action.
Clarifications	Students will use observed results from a random sample to make an inference about the population.
Assessment Limits	Items may require students to distinguish between a statistic and a parameter. Items may require a student to be familiar with different kinds of sampling methods but not the specific names of the methods. Items may require a student to be familiar with the process of statistical inference but not require the student to state the process.
Stimulus Attribute	Items should be set in a real-world context.
Response Attribute	Items may require the student to choose and interpret units.
Calculator	No

MAFS.912.S-IC.2.3 Also assesses MAFS.912.S-IC.1.2 Also assesses MAFS.912.S-IC.2.4 Also assesses MAFS.912.S-IC.2.5 Also assesses MAFS.912.S-IC.2.6	Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. Decide if a specified model is consistent with results from a given data-generating process (e.g., using simulation). *For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model?* Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. Evaluate reports based on data.
Item Types	Equation response – May require identifying a quantity. Multiple-choice response – May require identifying a survey type or a sample. Natural Language response – May require discussing aspects of a survey, explaining data reports, describing flaws in data collection, or recommending a correct course of action. Simulation response – May require selecting from different options to construct a model, performing a simulation to model data, or designing and performing an experiment.
Clarifications	Students will use the purpose of a sample survey, experiment, and observational study to determine which would be the best statistical model for a given context. Students will understand the role of randomization in a sample survey, experiment, and observational study. Students will evaluate the randomization method chosen for a sample survey, experiment, or observational study to determine its probable effectiveness. Student will determine if a simulation is consistent with the theoretical probability. Students will design and perform a randomized experiment. Students will evaluate reports based on data.
Assessment Limits	Items should not require the student to complete a survey, perform an experiment, or do an observational study. Items will not require the student to perform a simulation.
Stimulus Attribute	Items should be set in a real-world context.
Response Attribute	Items may require the student to choose and interpret units.
Calculator	Neutral

MAFS.912.S-ID.1.4	Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.
Item Types	Multiple-choice response – May require selecting a correct comparison. Multi-select response – May require choosing statements about a comparison. Natural Language response – May require explaining a comparison.
Clarifications	Student will calculate the z-score and use it to compare a data point to the population. Student will calculate the z-score and use it to compare two data points.
Assessment Limit	Items should contain data that are approximately normally distributed.
Stimulus Attributes	Items should be set in a real-world context. Items should include a partial or full standard normal distribution table. Items should give the mean and standard deviation of the data set.
Response Attribute	Items should be set in a real-world context.
Calculator	Neutral