Maryland Tutorials are designed specifically for the Maryland College and Career-Ready Standards to prepare students for the PARCC assessment, the Maryland School Assessment (MSA), and the Maryland High School Assessment (HSA).

Math Tutorials offer targeted instruction, practice and review designed to develop computational fluency, deepen conceptual understanding, and apply mathematical practices. They automatically identify and address learning gaps down to elementary-level content, using adaptive remediation to bring students to grade-level no matter where they start. Students engage with the content in an interactive, feedback-rich environment as they progress through standards-aligned modules. By constantly honing the ability to apply their knowledge in abstract and real world scenarios, students build the depth of knowledge and higher order skills required to demonstrate their mastery when put to the test.

In each module, the Learn It and Try It make complex ideas accessible to students through focused content, modeled logic and process, multi-modal representations, and personalized feedback as students reason through increasingly challenging problems. The Review It offers a high impact summary of key concepts and relates those concepts to students' lives. The Test It assesses students' mastery of the module's concepts, providing granular performance data to students and teachers after each attempt. To help students focus on the content most relevant to them, unit-level pretests and posttests can quickly identify where students are strong and where they're still learning.

### Unit 1: Real Number System and Equality

- **MONITORING PRECISION AND ACCURACY**
  - N.Q.2.A: Polynomial, Rational, and Radical Relationships Reason quantitatively and use units to solve problems. Define appropriate quantities for the purpose of descriptive modeling. Ability to select and use units of measure to accurately model a given real world scenario
- **AXIOMS OF EQUALITY**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.REI.1.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning 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. Ability to identify the mathematic al property (addition property of equality, distributive property, etc.) used at each step in the solution process as a means of justifying a step
- **LAWS OF EXPONENTS**


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- A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
- A.REI.1.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning 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. Ability to identify the mathematic al property (addition property of equality, distributive property, etc.) used at each step in the solution process as a means of justifying a step
- N.RN.1.A: Polynomial, Rational, and Radical Relationships Extend the properties of exponents to rational 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. Ability to use prior knowledge of properties of integer exponents to build understanding of rational exponents and radicals
- N.RN.2.A: Polynomial, Rational, and Radical Relationships Extend the properties of exponents to rational exponents. Rewrite expressions involving radicals and rational exponents using the properties of exponents. Knowledge of the connection between radical and exponential notation
- N.RN.2.B: Polynomial, Rational, and Radical Relationships Extend the properties of exponents to rational exponents. Rewrite expressions involving radicals and rational exponents using the properties of exponents. Ability to translate between radical and exponential notation

## Unit 2: Rational Relationships

- **SOLVING SQUARE ROOT EQUATIONS**
  - A.REI.2.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Ability to connect prior experience with solving simple equations in one variable to solving equations which require new strategies and additional steps
  - A.REI.1.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning 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. Ability to identify the mathematic al property (addition property of equality, distributive property, etc.) used at each step in the solution process as a means of justifying a step
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - A.REI.2.B: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable,


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and give examples showing how extraneous solutions may arise. Ability to make connections between the domain of a function and extraneous solutions

- A.REI.2.C: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Ability to identify extraneous solutions
- A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
- F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms

- **OPERATIONS WITH RATIONAL EXPRESSIONS**
  - A.APR.7.A: Polynomial, Rational, and Radical Relationships Rewrite rational expressions Understand that rational expressions form a system analogous to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression; add, subtract, multiply, and divide rational expressions. Ability to make connections between the algorithms for operations on rational numbers and operations on rational expressions
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
- **SOLVING RATIONAL EQUATIONS**
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - A.REI.1.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning 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


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original equation has a solution. Construct a viable argument to justify a solution method. Ability to identify the mathematic al property (addition property of equality, distributive property, etc.) used at each step in the solution process as a means of justifying a step

- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- A.REI.2.B: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Ability to make connections between the domain of a function and extraneous solutions
- A.REI.2.C: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Ability to identify extraneous solutions
- A.REI.2.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Ability to connect prior experience with solving simple equations in one variable to solving equations which require new strategies and additional steps

## Unit 3: Two-Variable Linear Systems

- **SOLVING SYSTEMS OF LINEAR EQUATIONS: GRAPHING**
  - A.REI.6.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to extend experiences with solving simultaneous linear equations from 8EE.8 b&c to include solving systems of three equations three unknowns
  - A.REI.6.B: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to solve systems using the most efficient method
- **SOLVING SYSTEMS OF LINEAR EQUATIONS: SUBSTITUTION**
  - A.REI.6.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to extend experiences with solving simultaneous linear equations from 8EE.8 b&c to include solving systems of three equations three unknowns
  - A.REI.6.B: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to solve systems using the most efficient method
- **SOLVING SYSTEMS OF LINEAR EQUATIONS: ELIMINATION**


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- A.REI.6.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to extend experiences with solving simultaneous linear equations from 8EE.8 b&c to include solving systems of three equations three unknowns
- A.REI.6.B: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to solve systems using the most efficient method

## Unit 4: Solving Systems Algebraically

- **SOLVING THREE-VARIABLE SYSTEMS OF LINEAR EQUATIONS**
  - A.REI.6.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to extend experiences with solving simultaneous linear equations from 8EE.8 b&c to include solving systems of three equations three unknowns
  - A.REI.6.B: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. Ability to solve systems using the most efficient method
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- **SYSTEMS OF NONLINEAR EQUATIONS**
  - A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
  - A.REI.11.A: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to connect experience with solving systems of equations graphically from Algebra I to solving systems that include polynomial, exponential, rational, root, absolute value and logarithmic functions
  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations


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## Unit 5: Solving Quadratic Equations

- **SOLVING QUADRATIC EQUATIONS BY FACTORING**
  - A.REI.4.b.1: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the quadratic equation has no real solutions. Ability to solve quadratic equations using various methods and recognize the most efficient method
  - A.APR.4.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Knowledge of the process for proving identities
  - A.APR.4.B: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Ability to see, use and manipulate the structure in an expression as needed to prove an identity
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations
  - F.BF.1.a.1: Modeling with Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Ability to connect experience with linear and exponential functions from Algebra I Unit 2 to quadratic functions
  - A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and


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graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions

- **QUADRATIC FORMULA**
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - N.CN.7.A: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Ability to use the quadratic formula and/or completing the square as a means of solving a quadratic equation
  - N.CN.7.B: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Knowledge that complex solutions occur in conjugate pairs
  - N.CN.7.C: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Ability to connect experience with solving quadratic equations from Algebra I to situations where analyzing the discriminant will reveal the nature of the solutions which would include complex solutions
  - A.REI.4.b.2: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the quadratic equation has no real solutions. Ability to use the value of the discriminant to determine if a quadratic equation has one double solution, two unique solutions or no real solutions
  - A.REI.4.b.2: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the quadratic equation has no real solutions. Ability to use the value of the discriminant to determine if a quadratic equation has one double solution, two unique solutions or no real solutions
  - A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model


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- A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
- F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
- F.BF.1.a.1: Modeling with Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Ability to connect experience with linear and exponential functions from Algebra I Unit 2 to quadratic functions
- F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
- A.REI.4.b.1: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the quadratic equation has no real solutions. Ability to solve quadratic equations using various methods and recognize the most efficient method

- **COMPLETING THE SQUARE**
  - N.CN.7.A: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Ability to use the quadratic formula and/or completing the square as a means of solving a quadratic equation
  - A.REI.4.b.1: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the quadratic equation has no real solutions. Ability to solve quadratic equations using various methods and recognize the most efficient method
  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations


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- A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model

## Unit 6: Polynomial Relationships

- **GRAPHS OF POLYNOMIAL FUNCTIONS**
  - F.IF.7.c.1: Polynomial, Rational, and Radical Relationships 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. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. Ability to connect experience with graphing linear, exponential and quadratic functions from Algebra I to graphing polynomial functions
  - F.IF.7.c.2: Polynomial, Rational, and Radical Relationships 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. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. Ability to identify key features of a function: max, min, intercepts, zeros, and end behaviors.
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - A.APR.2.C: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to use the graph of a polynomial to assist in the efficiency of the process for complicated cases
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions


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- A.APR.3.A: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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. Knowledge of the differences in the end behavior of the graphs as dictated by the leading coefficient and whether the function is even or odd
- A.APR.3.B: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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. Ability to capture the graphical behavior of polynomial functions which have roots with multiplicity greater than one
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.BF.3.A: Modeling with Functions 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. Ability to connect experience with this standard as it relates to linear, quadratic and exponential functions from Algebra I to all functions studied
- F.BF.3.B: Modeling with Functions 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. Ability to make generalizations about the changes that will take place in the graph of any function as a result of making a particular change to the algebraic representation of the function

- **PARABOLAS**
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - G.GPE.2.A: Polynomial, Rational, and Radical Relationships Translate between the geometric description and the equation for a conic section Derive the equation of a parabola given a focus and directrix. Ability to connect the distance formula and the definition of a parabola


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- G.GPE.2.B: Polynomial, Rational, and Radical Relationships Translate between the geometric description and the equation for a conic section Derive the equation of a parabola given a focus and directrix. Ability to connect the algebraic and geometric definitions of a parabola
- A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions

## Unit 7: Addition and Subtraction of Polynomials

- **POLYNOMIAL BASICS**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
- **ADDITION AND SUBTRACTION OF POLYNOMIALS**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression

## Unit 8: Multiplication and Division of Polynomials

- **MULTIPLICATION OF POLYNOMIALS**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
- **DIVISION OF POLYNOMIALS**
  - A.APR.2.B: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to use both long division and synthetic division
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
  - A.APR.2.B: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to use both long division and synthetic division
  - A.APR.2.B: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to use both long division and synthetic division


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- A.APR.6.A: Polynomial, Rational, and Radical Relationships Rewrite rational expressions 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. Ability to make connections to the Remainder Theorem

## Unit 9: Factoring

- **FACTORING SPECIAL CASES**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
  - A.APR.4.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Knowledge of the process for proving identities
  - A.APR.4.B: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Ability to see, use and manipulate the structure in an expression as needed to prove an identity
- **FACTORING CUBIC POLYNOMIALS**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
  - A.APR.4.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Knowledge of the process for proving identities
  - A.APR.4.B: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Ability to see, use and manipulate the structure in an expression as needed to prove an identity

## Unit 10: Factoring Higher-Order Polynomials

- **FACTORING HIGHER-ORDER POLYNOMIALS**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression


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- A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
- A.APR.2.A: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to make connections between factors, roots and evaluating functions
- A.APR.4.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Knowledge of the process for proving identities
- A.APR.4.B: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Ability to see, use and manipulate the structure in an expression as needed to prove an identity

- **FACTOR THEOREM AND REMAINDER THEOREM**
  - A.APR.2.B: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to use both long division and synthetic division
  - A.APR.2.A: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to make connections between factors, roots and evaluating functions
  - A.APR.2.B: Polynomial, Rational, and Radical Relationships Understand the relationship between zeros and factors of polynomials 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). Ability to use both long division and synthetic division
  - A.APR.6.A: Polynomial, Rational, and Radical Relationships Rewrite rational expressions 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. Ability to make connections to the Remainder Theorem

## Unit 11: Complex Numbers and Quadratic Functions

- **COMPLEX NUMBERS**
  - N.CN.1.A: Polynomial, Rational, and Radical Relationships Perform arithmetic operations with complex numbers. Know there is a complex number i such that i = 1, and every complex number has the form a + bi with a and b real. Ability to extend experience with solving quadratic equations with no real solution from Algebra I to the existence of complex numbers (e.g. use solving x + 1 = 0 as a way to introduce complex numbers)


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- N.CN.2.A: Polynomial, Rational, and Radical Relationships Perform arithmetic operations with complex numbers. Use the relation i = 1 and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. Knowledge of conjugate pairs and the nature of their products

- **COMPLEX NUMBERS AND QUADRATIC FUNCTIONS**
  - N.CN.7.A: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Ability to use the quadratic formula and/or completing the square as a means of solving a quadratic equation
  - N.CN.7.B: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Knowledge that complex solutions occur in conjugate pairs
  - N.CN.7.C: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Ability to connect experience with solving quadratic equations from Algebra I to situations where analyzing the discriminant will reveal the nature of the solutions which would include complex solutions
  - A.REI.4.b.2: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the quadratic equation has no real solutions. Ability to use the value of the discriminant to determine if a quadratic equation has one double solution, two unique solutions or no real solutions
  - N.CN.1.A: Polynomial, Rational, and Radical Relationships Perform arithmetic operations with complex numbers. Know there is a complex number i such that i = 1, and every complex number has the form a + bi with a and b real. Ability to extend experience with solving quadratic equations with no real solution from Algebra I to the existence of complex numbers (e.g. use solving x + 1 = 0 as a way to introduce complex numbers)
  - N.CN.1.A: Polynomial, Rational, and Radical Relationships Perform arithmetic operations with complex numbers. Know there is a complex number i such that i = 1, and every complex number has the form a + bi with a and b real. Ability to extend experience with solving quadratic equations with no real solution from Algebra I to the existence of complex numbers (e.g. use solving x + 1 = 0 as a way to introduce complex numbers)
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - A.REI.4.b.2: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 49), taking square roots, completing the square, the quadratic formula and factoring, as


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appropriate to the initial form of the equation. Recognize when the quadratic formula reveals that the quadratic equation has no real solutions. Ability to use the value of the discriminant to determine if a quadratic equation has one double solution, two unique solutions or no real solutions

- A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions

## Unit 12: Polynomial Identities

- **POLYNOMIAL IDENTITIES**
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
  - A.APR.4.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Knowledge of the process for proving identities
  - A.APR.4.B: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Ability to see, use and manipulate the structure in an expression as needed to prove an identity
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.APR.5.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Know and apply the Binomial Theorem for the expansion of (x + y) in powers of x and y for a positive integer n, where x and y are any numbers, with coefficients determined for example by Pascals Triangle. Ability to replicate Pascals triangle
- **POLYNOMIAL IDENTITIES AND COMPLEX NUMBERS**
  - N.CN.8.A: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Extend polynomial identities to the complex numbers. Knowledge that a negative number can be thought of as the square of an imaginary number (e.g. -4 = (-2i))
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
  - A.SSE.2.C: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to factor expressions completely over complex numbers


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- A.APR.4.A: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Knowledge of the process for proving identities
- A.APR.4.B: Polynomial, Rational, and Radical Relationships Use polynomial identities to solve problems Prove polynomial identities and use them to describe numerical relationships. Ability to see, use and manipulate the structure in an expression as needed to prove an identity
- N.CN.1.A: Polynomial, Rational, and Radical Relationships Perform arithmetic operations with complex numbers. Know there is a complex number i such that i = 1, and every complex number has the form a + bi with a and b real. Ability to extend experience with solving quadratic equations with no real solution from Algebra I to the existence of complex numbers (e.g. use solving x + 1 = 0 as a way to introduce complex numbers)
- N.CN.7.A: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Ability to use the quadratic formula and/or completing the square as a means of solving a quadratic equation
- N.CN.7.B: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Solve quadratic equations with real coefficients that have complex solutions. Knowledge that complex solutions occur in conjugate pairs
- N.CN.9.A: Polynomial, Rational, and Radical Relationships Use complex numbers in polynomial identities and equations. Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials. Knowledge of the connection between the number of roots and the degree of the polynomial; considering multiple roots, complex roots and distinct real roots

## Unit 13: Two-Variable Data and Trigonometric Functions

- **SCATTERPLOTS AND MODELING**
  - A.CED.1.B: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to distinguish between linear, quadratic, exponential, root and simple rational relationships given the verbal, numeric and/or graphic representations
  - S.ID.6.a.2: Trigonometric Functions Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Ability to create and use regression models to represent a contextual situation
  - S.ID.6.a.1: Trigonometric Functions Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Ability to recognize types of relationships that lend themselves to linear and exponential models
- **RADIANS AND THE UNIT CIRCLE**


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- F.TF.1.B: Trigonometric Functions 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. Ability to convert between degree and radian measure
- F.TF.1.A: Trigonometric Functions 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. Knowledge that angle measures in radians may be determined by a ratio of intercepted arc to radius
- F.TF.2.B: Trigonometric Functions 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. Ability to extend to angles beyond -2, 2, using counterclockwise as the positive direction of rotation
- F.TF.2.A: Trigonometric Functions 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. Ability to connect knowledge of special right triangles gained in Geometry to evaluating trigonometric functions at any domain value
- F.TF.2.B: Trigonometric Functions 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. Ability to extend to angles beyond -2, 2, using counterclockwise as the positive direction of rotation

- **TRIGONOMETRIC FUNCTIONS**
  - F.TF.2.A: Trigonometric Functions 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. Ability to connect knowledge of special right triangles gained in Geometry to evaluating trigonometric functions at any domain value
  - F.TF.2.B: Trigonometric Functions 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. Ability to extend to angles beyond -2, 2, using counterclockwise as the positive direction of rotation
  - F.TF.5.A: Trigonometric Functions Model periodic phenomena with trigonometric functions Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. Ability to connect contextual situations to appropriate trigonometric function: e.g. using sine or cosine to model cyclical behavior
  - F.TF.8.A: Trigonometric Functions Prove and apply trigonometric identities Prove the Pythagorean identity sin() + cos() = 1 and use it to find sin(), cos(), or tan() given sin(), cos(), or tan() and the quadrant of the angle. Ability to make connections to angles in standard position


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- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

## Unit 14: Sequences

- **SEQUENCES**
  - F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
  - F.BF.2.A: Modeling with Functions 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. See the skills and knowledge that are stated in the Standard.
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.IF.3.A: Modeling with Functions 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. See the skills and knowledge that are stated in the Standard.
- **ARITHMETIC AND GEOMETRIC SEQUENCES**
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - A.CED.1.B: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to distinguish between linear, quadratic, exponential, root and simple rational relationships given the verbal, numeric and/or graphic representations
  - F.BF.2.A: Modeling with Functions 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. See the skills and knowledge that are stated in the Standard.
  - F.IF.3.A: Modeling with Functions 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. See the skills and knowledge that are stated in the Standard.
- **SUMS OF GEOMETRIC SEQUENCES**


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- A.SSE.4.A: Polynomial, Rational, and Radical Relationships Write expressions in equivalent forms to solve problems 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. Knowledge of the difference between an infinite and a finite series
- A.SSE.4.B: Polynomial, Rational, and Radical Relationships Write expressions in equivalent forms to solve problems 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. Ability to apply the formula for the sum of a finite geometric series: Sn = a(1 - r)/(1 - r)
- A.SSE.4.B: Modeling with Functions Write expressions in equivalent forms to solve problems 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. Ability to apply the formula for the sum of a finite geometric series: S = a(1r/(1r)
- A.SSE.4.B: Polynomial, Rational, and Radical Relationships Write expressions in equivalent forms to solve problems 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. Ability to apply the formula for the sum of a finite geometric series: Sn = a(1 - r)/(1 - r)
- A.SSE.4.B: Modeling with Functions Write expressions in equivalent forms to solve problems 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. Ability to apply the formula for the sum of a finite geometric series: S = a(1r/(1r)

## Unit 15: Functions

- **FUNCTIONS AND RELATIONS**
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions


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- **INVERSE FUNCTIONS**
  - F.BF.4.a.3: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to determine if a function has an inverse
  - F.BF.4.a.1: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to connect experience with finding the inverse of a linear function from Algebra I to finding the inverse of simple exponential, root and rational functions
  - F.BF.4.a.3: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to determine if a function has an inverse
  - F.BF.4.a.2: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Knowledge of the connection of the domain and range of a function to its inverse
  - F.BF.4.a.3: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to determine if a function has an inverse

## Unit 16: Linear Relationships

- **SLOPE**
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.6.A: Modeling with Functions 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. Ability to apply this skill to linear, quadratic, polynomial, root and simple rational functions
  - F.LE.5.A: Modeling with Functions 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. Ability to interpret the slope and y-intercept of a linear model in terms of context
- **GRAPHING AND ANALYZING LINEAR FUNCTIONS**
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms


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- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.LE.5.A: Modeling with Functions 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. Ability to interpret the slope and y-intercept of a linear model in terms of context
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

- **GRAPHING AND MANIPULATING Y = MX + B**
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.LE.5.A: Modeling with Functions 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. Ability to interpret the slope and y-intercept of a linear model in terms of context


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- F.IF.6.A: Modeling with Functions 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. Ability to apply this skill to linear, quadratic, polynomial, root and simple rational functions
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

## Unit 17: Exponential Relationships

- **EXPONENTIAL FUNCTIONS**
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.8.b.1: Modeling with Functions 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. Use the properties of exponents to interpret expressions for exponential functions. Ability to connect experience with properties of exponents from Algebra I Unit 2 Linear and Exponential Relationships to more complex expressions.
  - F.LE.5.C: Modeling with Functions 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. Ability to interpret the rate of increase/decrease in an exponential model
  - F.IF.4.B: Modeling with Functions 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


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tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

- F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.7.e.1: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to connect experience with graphing linear and quadratic functions from Algebra I to graphing exponential and logarithmic functions
- A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
- F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
- F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
- A.SSE.3.c.1: Polynomial, Rational, and Radical Relationships Write expressions in equivalent forms to solve problems Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Use the properties of exponents to transform expressions for exponential functions. Ability to connect experience with properties of exponents from Unit 4 of Algebra I to more complex expressions
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- F.LE.5.B: Modeling with Functions 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. Ability to


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identify the initial amount present in an exponential model (f(0)=b + k = 1 + k)

- **EXPONENTIAL GROWTH AND DECAY**
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.8.b.1: Modeling with Functions 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. Use the properties of exponents to interpret expressions for exponential functions. Ability to connect experience with properties of exponents from Algebra I Unit 2 Linear and Exponential Relationships to more complex expressions.
  - F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.LE.5.C: Modeling with Functions 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. Ability to interpret the rate of increase/decrease in an exponential model
- **SOLVING EXPONENTIAL EQUATIONS**
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - F.IF.8.B: Modeling with Functions Analyze functions using different representations Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of


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the function. Ability to recognize functions in various forms

- F.BF.4.a.1: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to connect experience with finding the inverse of a linear function from Algebra I to finding the inverse of simple exponential, root and rational functions
- F.BF.4.a.2: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Knowledge of the connection of the domain and range of a function to its inverse
- A.SSE.3.c.1: Polynomial, Rational, and Radical Relationships Write expressions in equivalent forms to solve problems Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Use the properties of exponents to transform expressions for exponential functions. Ability to connect experience with properties of exponents from Unit 4 of Algebra I to more complex expressions
- F.IF.8.b.1: Modeling with Functions 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. Use the properties of exponents to interpret expressions for exponential functions. Ability to connect experience with properties of exponents from Algebra I Unit 2 Linear and Exponential Relationships to more complex expressions.
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.7.e.1: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to connect experience with graphing linear and quadratic functions from Algebra I to graphing exponential and logarithmic functions
- F.IF.7.e.2: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to produce a rough graph of the parent function for each type of function
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model

## Unit 18: Logarithmic Relationships


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- **LOGARITHMIC FUNCTIONS**
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.7.e.1: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to connect experience with graphing linear and quadratic functions from Algebra I to graphing exponential and logarithmic functions
  - F.IF.7.e.2: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to produce a rough graph of the parent function for each type of function
  - F.BF.4.a.1: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to connect experience with finding the inverse of a linear function from Algebra I to finding the inverse of simple exponential, root and rational functions
  - F.BF.4.a.3: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to determine if a function has an inverse
  - F.LE.4.A: Modeling with Functions Construct and compare linear, quadratic, and exponential models and solve problems For exponential models, express as a logarithm the solution to ab to the ct power = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology. Knowledge that logarithmic functions are inverses of exponential functions
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.BF.4.a.2: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Knowledge of the connection of the domain and range of a function to its inverse
  - F.IF.4.B: Modeling with Functions 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


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the relationship. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

- F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms

- **EVALUATING LOGARITHMIC EXPRESSIONS**
  - A.SSE.2.A: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to use properties of mathematics to alter the structure of an expression
  - A.SSE.2.B: Polynomial, Rational, and Radical Relationships Interpret the structure of expressions Use the structure of an expression to identify ways to rewrite it. Ability to select and then use an appropriate factoring technique
  - F.LE.4.B: Modeling with Functions Construct and compare linear, quadratic, and exponential models and solve problems For exponential models, express as a logarithm the solution to ab to the ct power = d where a, c, and d are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology. Knowledge of the properties of logarithms and exponents and their connection to one another
- **SOLVING LOGARITHMIC EQUATIONS**
  - F.BF.4.a.1: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to connect experience with finding the inverse of a linear function from Algebra I to finding the inverse of simple exponential, root and rational functions
  - F.BF.4.a.1: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to connect experience with finding the inverse of a linear function from Algebra I to finding the inverse of simple exponential, root and rational functions
  - F.BF.4.a.2: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Knowledge of the connection of the domain and range of a function to its inverse
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions


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- A.REI.1.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning 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. Ability to identify the mathematic al property (addition property of equality, distributive property, etc.) used at each step in the solution process as a means of justifying a step

## Unit 19: Modeling with Quadratic Functions

- **ANALYZING GRAPHS OF QUADRATIC FUNCTIONS**
  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations
  - F.IF.9.A: Modeling with Functions 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). Ability to recognize common attributes of functions from various representations
  - A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - A.REI.4.b.1: Polynomial, Rational, and Radical Relationships Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for x= 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 reveals that the


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quadratic equation has no real solutions. Ability to solve quadratic equations using various methods and recognize the most efficient method

- F.BF.1.a.1: Modeling with Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Ability to connect experience with linear and exponential functions from Algebra I Unit 2 to quadratic functions

- **REPRESENTATIONS OF QUADRATIC FUNCTIONS**

  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations
  - A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
  - F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.9.A: Modeling with Functions 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). Ability to recognize common attributes of functions from various representations
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms


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- F.BF.1.a.1: Modeling with Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Ability to connect experience with linear and exponential functions from Algebra I Unit 2 to quadratic functions
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
- F.BF.1.a.2: Modeling with Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from a context. Ability to write the algebraic representation of a quadratic function from a contextual situation

## Unit 20: Modeling with Radical and Rational Functions

- **ANALYZING GRAPHS OF SQUARE ROOT FUNCTIONS**
  - F.BF.3.A: Modeling with Functions 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. Ability to connect experience with this standard as it relates to linear, quadratic and exponential functions from Algebra I to all functions studied
  - F.BF.3.B: Modeling with Functions 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. Ability to make generalizations about the changes that will take place in the graph of any function as a result of making a particular change to the algebraic representation of the function
  - F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
  - F.BF.4.a.1: Modeling with Functions Build new functions from existing functions Find inverse functions. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an


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expression for the inverse. Ability to connect experience with finding the inverse of a linear function from Algebra I to finding the inverse of simple exponential, root and rational functions

- F.BF.4.a.3: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Ability to determine if a function has an inverse
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.BF.4.a.2: Modeling with Functions Build new functions from existing functions Find inverse functions. 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. Knowledge of the connection of the domain and range of a function to its inverse

- **ANALYZING GRAPHS OF RATIONAL FUNCTIONS**
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
  - A.REI.2.B: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable,


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and give examples showing how extraneous solutions may arise. Ability to make connections between the domain of a function and extraneous solutions

- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

- **MODELING SITUATIONS WITH RATIONAL FUNCTIONS**
  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations
  - A.CED.1.A: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to connect experience from Algebra I with creating linear, exponential and quadratic equations in one variable to include creating simple rational functions
  - F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
  - A.REI.2.A: Polynomial, Rational, and Radical Relationships Understand solving equations as a process of reasoning and explain the reasoning Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. Ability to connect prior experience with solving simple equations in one variable to solving equations which require new strategies and additional steps
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model

## Unit 21: Working with Functions

- **MULTIPLE REPRESENTATIONS OF FUNCTIONS**
  - A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations


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y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations

- A.CED.1.B: Modeling with Functions Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Ability to distinguish between linear, quadratic, exponential, root and simple rational relationships given the verbal, numeric and/or graphic representations
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
- F.IF.9.A: Modeling with Functions 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). Ability to recognize common attributes of functions from various representations
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
- A.REI.11.B: Polynomial, Rational, and Radical Relationships Represent and solve equations and inequalities graphically Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = (x) intersect are the solutions of the equation f(x) = (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 (x) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions. Ability to show the equality of two functions using multiple representations
- F.IF.4.B: Modeling with Functions 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


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the relationship. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

- F.IF.7.e.1: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to connect experience with graphing linear and quadratic functions from Algebra I to graphing exponential and logarithmic functions
- F.IF.7.e.2: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to produce a rough graph of the parent function for each type of function

- **ARITHMETIC OPERATIONS ON FUNCTIONS**
  - F.BF.1.b.1: Modeling with Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Combine standard function types using arithmetic operations. Ability to connect experience with adding, subtracting, multiplying and dividing linear, quadratic and exponential functions from Algebra I to adding, subtracting, multiplying and dividing any functions
  - F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
  - F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model

## Unit 22: Nonlinear Functions

- **LINEAR VERSUS NONLINEAR FUNCTIONS**
  - F.IF.6.A: Modeling with Functions 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. Ability to apply this skill to linear, quadratic, polynomial, root and simple rational functions
  - F.IF.7.e.1: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to connect experience with graphing linear and quadratic functions from Algebra I to graphing exponential and logarithmic functions


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- F.IF.7.e.2: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to produce a rough graph of the parent function for each type of function
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model
- F.LE.5.C: Modeling with Functions 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. Ability to interpret the rate of increase/decrease in an exponential model
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.LE.5.A: Modeling with Functions 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. Ability to interpret the slope and y-intercept of a linear model in terms of context
- F.IF.8.A: Modeling with Functions 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. Ability to connect experience with writing linear, quadratic and exponential functions in various forms from Algebra I to writing all functions in various forms
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.9.A: Modeling with Functions 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). Ability to recognize common attributes of functions from various representations
- F.IF.4.A: Modeling with Functions 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. Ability to connect appropriate function to context

- **ABSOLUTE VALUE FUNCTIONS**


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- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.8.B: Modeling with Functions 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. Ability to recognize functions in various forms
- F.LE.2.A: Modeling with Functions 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). Ability to produce an algebraic model

## Unit 23: Parent Functions and Transformations

- **PARENT FUNCTIONS**
  - F.IF.7.c.1: Polynomial, Rational, and Radical Relationships 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. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. Ability to connect experience with graphing linear, exponential and quadratic functions from Algebra I to graphing polynomial functions
  - F.BF.3.A: Modeling with Functions 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. Ability to connect experience with this standard as it relates to linear, quadratic and exponential functions from Algebra I to all functions studied
  - F.BF.3.B: Modeling with Functions 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. Ability to make generalizations about the changes that will take place in the graph of any function as a result of making a particular change to the algebraic representation of the function
  - A.REI.7.A: Polynomial, Rational, and Radical Relationships Solve systems of equations Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. Knowledge of the algebraic and graphic representations of quadratic relations as well as quadratic functions
  - F.LE.2.A: Modeling with Functions Construct and compare linear, quadratic, and exponential models and solve problems Construct linear and exponential functions, including arithmetic and geometric


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sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). Ability to produce an algebraic model

- F.IF.7.e.1: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to connect experience with graphing linear and quadratic functions from Algebra I to graphing exponential and logarithmic functions
- F.IF.7.e.2: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Ability to produce a rough graph of the parent function for each type of function
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions
- F.IF.4.B: Modeling with Functions 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. Knowledge of the key features of linear, exponential, polynomial, root, absolute value, piecewise, simple rational, logarithmic and trigonometric functions

- **TRANSFORMATIONS OF PARENT FUNCTIONS**
  - F.IF.7.c.1: Polynomial, Rational, and Radical Relationships 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. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. Ability to connect experience with graphing linear, exponential and quadratic functions from Algebra I to graphing polynomial functions
  - F.BF.3.A: Modeling with Functions 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. Ability to connect experience with this standard as it relates to linear, quadratic and exponential functions from Algebra I to all functions studied
  - F.BF.3.B: Modeling with Functions 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


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graphs and algebraic expressions for them. Ability to make generalizations about the changes that will take place in the graph of any function as a result of making a particular change to the algebraic representation of the function

- F.IF.7.e.3: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Knowledge of how parameters introduced into a function alter the shape of the graph of the parent function

- **MULTIPLE TRANSFORMATIONS OF PARENT FUNCTIONS**
  - F.BF.3.A: Modeling with Functions 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. Ability to connect experience with this standard as it relates to linear, quadratic and exponential functions from Algebra I to all functions studied
  - F.IF.7.c.1: Polynomial, Rational, and Radical Relationships 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. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. Ability to connect experience with graphing linear, exponential and quadratic functions from Algebra I to graphing polynomial functions
  - F.BF.3.B: Modeling with Functions 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. Ability to make generalizations about the changes that will take place in the graph of any function as a result of making a particular change to the algebraic representation of the function
  - F.IF.7.e.3: Modeling with Functions 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. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. Knowledge of how parameters introduced into a function alter the shape of the graph of the parent function

## Unit 24: Gathering Data

- **POPULATIONS AND SAMPLES**
  - S.IC.4.C: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Use data from a sample survey to estimate a


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population mean or proportion; develop a margin of error through the use of simulation models for random sampling. Ability to use sample means and sample proportions to estimate population values

- **EXPERIMENTAL AND OBSERVATIONAL DESIGN**
  - S.IC.3.A: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. Ability to conduct sample surveys, experiments and observational studies
  - S.IC.3.B: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. Understanding of the limitations of observational studies that do not allow major conclusions on treatments
  - S.IC.1.A: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Understand statistics as a process for making inferences about population parameters based on a random sample from that population. Knowledge of various sampling methods (e.g., simple random, convenience, stratified)
  - S.IC.3.C: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each. Ability to recognize and avoid bias
  - S.IC.1.A: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Understand statistics as a process for making inferences about population parameters based on a random sample from that population. Knowledge of various sampling methods (e.g., simple random, convenience, stratified)
  - S.IC.1.A: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Understand statistics as a process for making inferences about population parameters based on a random sample from that population. Knowledge of various sampling methods (e.g., simple random, convenience, stratified)
- **SIMULATIONS**
  - S.IC.2.C: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. Ability to design, conduct and interpret the results of simulations

## Unit 25: Statistical Analysis

- **ANALYZING STATISTICAL SAMPLES**
  - S.IC.1.C: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Understand statistics as a process for making inferences about population parameters based on a random sample from that population. Ability to explain in context the difference between values describing a population and a sample


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- S.IC.4.C: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies 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. Ability to use sample means and sample proportions to estimate population values
- S.IC.1.A: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Understand statistics as a process for making inferences about population parameters based on a random sample from that population. Knowledge of various sampling methods (e.g., simple random, convenience, stratified)
- S.IC.1.B: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Understand statistics as a process for making inferences about population parameters based on a random sample from that population. Ability to select an appropriate sampling technique for a given situation
- S.IC.4.A: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies 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. Ability to informally establish bounds as to when something is statistically significant
- S.IC.4.B: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies 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. Ability to conduct simulations and accurately interpret and use the results
- S.IC.5.C: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. Ability to determine the statistical significance of data

- **CONCLUSIONS IN DATA**
  - S.IC.4.B: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies 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. Ability to conduct simulations and accurately interpret and use the results
  - S.IC.5.B: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. Ability to draw conclusions based on comparisons of simulation versus experimental results
  - S.IC.5.A: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. Ability to set up and conduct a randomized experiment or investigation, collect data and interpret the results


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- S.IC.4.A: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies 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. Ability to informally establish bounds as to when something is statistically significant
- S.IC.5.C: Inferences and Conclusions from Data Make inferences and justify conclusions from sample surveys, experiments, and observational studies Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant. Ability to determine the statistical significance of data

- **NORMAL DISTRIBUTION**
  - S.ID.4.A: Inferences and Conclusions from Data Summarize, represent, and interpret data on a single count or measurement variable 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. Ability to construct, interpret and use normal curves, based on standard deviation
  - S.ID.4.B: Inferences and Conclusions from Data Summarize, represent, and interpret data on a single count or measurement variable 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. Ability to identify data sets as approximately normal or not
  - S.ID.4.C: Inferences and Conclusions from Data Summarize, represent, and interpret data on a single count or measurement variable 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. Ability to estimate and interpret area under curves using the Empirical Rule (689598.7)
  - S.ID.4.C: Inferences and Conclusions from Data Summarize, represent, and interpret data on a single count or measurement variable 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. Ability to estimate and interpret area under curves using the Empirical Rule (689598.7)
  - S.ID.4.C: Inferences and Conclusions from Data Summarize, represent, and interpret data on a single count or measurement variable 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. Ability to estimate and interpret area under curves using the Empirical Rule (689598.7)

## Unit 26: Introduction to Probability


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- **INTRODUCTION TO PROBABILITY**
  - S.CP.2.C: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine if two events are dependent or independent
  - S.CP.5.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. Ability to make connections between statistical concepts and real world situations
  - S.MD.7.B: Applications of Probability Use probability to evaluate outcomes of decisions Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game). Ability make connections between the numeric probabilities and context
  - S.CP.1.A: Applications of Probability Understand independence and conditional probability and use them to interpret data 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). Ability to describe a sample space
  - S.CP.7.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
  - S.CP.8.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to analyze a situation to determine the probability of a described event
  - S.CP.8.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
  - S.CP.7.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
  - S.CP.8.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to analyze a situation to determine the probability of a described event
  - S.CP.8.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to make connections between numeric results and context


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- **CALCULATING PROBABILITY**
  - S.CP.5.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. Ability to make connections between statistical concepts and real world situations
  - S.IC.2.A: Inferences and Conclusions from Data Understand and evaluate random processes underlying statistical experiments Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. Ability to calculate and analyze theoretical and experimental probabilities accurately

## Unit 27: Applications of Probability

- **CONDITIONAL PROBABILITY**
  - S.CP.2.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine the conditional probability of an event given that another event occurs
  - S.CP.4.B: Applications of Probability Understand independence and conditional probability and use them to interpret data 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. Knowledge of the characteristics of conditional probability
  - S.CP.6.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
  - S.CP.7.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
  - S.CP.7.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
  - S.CP.8.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to analyze a situation to determine the probability of a described event
  - S.CP.8.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability


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model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to make connections between numeric results and context

- S.CP.2.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine the conditional probability of an event given that another event occurs
- S.CP.2.C: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine if two events are dependent or independent
- S.CP.6.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
- S.CP.7.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
- S.CP.7.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
- S.CP.8.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to analyze a situation to determine the probability of a described event
- S.CP.8.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
- S.CP.4.A: Applications of Probability Understand independence and conditional probability and use them to interpret data 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. Ability to connect experience with two-way frequency tables from Algebra I to sample spaces
- S.CP.2.C: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine if two events are dependent or independent


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- S.CP.2.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine the conditional probability of an event given that another event occurs
- S.CP.3.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand the conditional probability of given as ( and )/(), and interpret independence of and as saying that the conditional probability of given is the same as the probability of , and the conditional probability of given is the same as the probability of . Understanding of and ability to use set notation, key vocabulary and graphic organizers linked to this standard
- S.CP.6.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
- S.CP.7.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
- S.CP.2.A: Applications of Probability Understand independence and conditional probability and use them to interpret data Understand that two events and are independent if the probability of and occurring together is the product of their probabilities, and use this characterization to determine if they are independent. Ability to determine the conditional probability of an event given that another event occurs
- S.CP.6.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Find the conditional probability of given as the fraction of s outcomes that also belong to , and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
- S.CP.7.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to analyze a situation to determine the conditional probability of a described event given that another event occurs
- S.CP.7.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
- S.CP.8.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to analyze a situation to determine the probability of a described event


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- S.CP.8.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
- S.CP.1.B: Applications of Probability Understand independence and conditional probability and use them to interpret data 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). Understanding of and ability to use set notation, key vocabulary and graphic organizers linked to this standard

- **COMBINATIONS AND PERMUTATIONS**
  - S.CP.7.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the Addition Rule, ( or ) = () + () ( and ), and interpret the answer in terms of the model. Ability to make connections between numeric results and context


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- S.CP.8.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Apply the general Multiplication Rule in a uniform probability model, ( and ) = ()() = ()(), and interpret the answer in terms of the model. Ability to make connections between numeric results and context
- S.CP.9.A: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Use permutations and combinations to compute probabilities of compound events and solve problems. Ability to use formulas containing factorial notation
- S.CP.9.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Use permutations and combinations to compute probabilities of compound events and solve problems. Ability to analyze a situation to determine the probability of a described event

- **ANALYZING DECISIONS IN PROBABILITY**
  - S.MD.7.A: Inferences and Conclusions from Data Use probability to evaluate outcomes of decisions Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game). Ability to synthesize and apply various probability concepts to evaluate decisions
  - S.CP.9.B: Applications of Probability Use the rules of probability to compute probabilities of compound events in a uniform probability model Use permutations and combinations to compute probabilities of compound events and solve problems. Ability to analyze a situation to determine the probability of a described event
  - S.MD.6.A: Applications of Probability Use probability to evaluate outcomes of decisions Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). Ability make connections between the numeric probabilities and context


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- S.MD.7.B: Applications of Probability Use probability to evaluate outcomes of decisions Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game). Ability make connections between the numeric probabilities and context


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