Tennessee Tutorials are designed specifically for the Tennessee Academic Standards to prepare students for the Tennessee Comprehensive Assessment Program (TCAP) and the TNReady assessments.

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.

1. REAL NUMBER SYSTEM

- **LAWS OF EXPONENTS**
  - **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A1.A.SSE.B.3.c** *Use the properties of exponents to rewrite exponential expressions.*
  - **A1.A.REI.A.1** *Explain each step in solving an 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.*

- **MONITORING PRECISION AND ACCURACY**
  - **A1.N.Q.A.1** *Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
  - **A1.N.Q.A.2** *Identify, interpret, and justify appropriate quantities for the purpose of descriptive modeling.*
  - **A1.N.Q.A.3** *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

2. EQUATIONS AND INEQUALITIES

- **ONE-STEP EQUATIONS AND INEQUALITIES**
  - **A1.A.CED.A.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
  - **A1.A.REI.B.2** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
  - **A1.A.REI.A.1** *Explain each step in solving an 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.*
  - **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*

- **MULTI-STEP EQUATIONS AND INEQUALITIES**
  - **A1.A.CED.A.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and*

interpret solutions as viable or nonviable options in a modeling context.

- **A1.A.REI.A.1** *Explain each step in solving an 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.*
- **A1.A.REI.B.2** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

3. APPLYING PROPERTIES OF EQUATIONS AND INEQUALITIES

AXIOMS OF EQUALITY

- **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
- **A1.A.REI.A.1** *Explain each step in solving an 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.*

LITERAL EQUATIONS

- **A1.A.CED.A.1** *Create equations and inequalities in one variable and use them to solve problems.*
- **A1.A.REI.B.2** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
- **A1.A.CED.A.4** *Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.*

4. WRITING EXPRESSIONS AND EQUATIONS

FORMULATING AND SIMPLIFYING ALGEBRAIC EXPRESSIONS

- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
- **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
- **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
- **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
- **A1.A.SSE.B.3.c** *Use the properties of exponents to rewrite exponential expressions.*

FORMULATING AND SOLVING EQUATIONS FROM WORD PROBLEMS

- **A1.A.CED.A.1** *Create equations and inequalities in one variable and use them to solve problems.*
- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
- **A1.F.LE.A.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **A1.F.IF.B.3** *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.*
- **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*

FORMULATING AND SOLVING INEQUALITIES FROM WORD PROBLEMS

- **A1.A.CED.A.1** *Create equations and inequalities in one variable and use them to solve problems.*
- **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
- **A1.A.REI.B.2** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

5. FUNCTIONS

FUNCTIONS AND RELATIONS

- **A1.F.IF.A.2** *Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each*

element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).

- **A1.F.IF.B.3** *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.*
- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **A1.F.IF.C.6.b** *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*

DOMAIN AND RANGE

- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

EVALUATING FUNCTIONS

- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.A.2** *Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.*
- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*

6. GRAPHS OF LINEAR EQUATIONS AND INEQUALITIES 1

SLOPE

- **A1.F.IF.B.5** *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.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.B.3** *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.*

GRAPHING AND ANALYZING LINEAR FUNCTIONS

- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
- **A1.F.IF.B.3** *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.*
- **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*

7. GRAPHS OF LINEAR EQUATIONS AND INEQUALITIES 2

GRAPHING AND MANIPULATING Y = MX + B

- **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.B.5** *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.*

- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
- **A1.S.ID.C.5** *Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
- **A1.F.IF.B.3** *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.*
- **A1.F.LE.A.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
- **F.LE.B.4** *Interpret the parameters in a linear or exponential function in terms of a context.*

GRAPHS OF LINEAR INEQUALITIES

- **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
- **A1.A.REI.D.7** *Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.*
- **A1.A.REI.B.2** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

8. LINEAR EQUATIONS

SLOPE-INTERCEPT FORM OF A LINEAR EQUATION

- **A1.S.ID.C.5** *Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
- **A1.F.IF.B.5** *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.*

POINT-SLOPE FORM OF A LINEAR EQUATION

- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*

9. TWO-VARIABLE LINEAR SYSTEMS

SOLVING SYSTEMS OF LINEAR EQUATIONS: GUESS AND CHECK

- **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
- **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
- **A1.A.REI.C.4** *Write and solve a system of linear equations in context.*
- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*

SOLVING SYSTEMS OF LINEAR EQUATIONS: GRAPHING

- **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
- **A1.A.REI.C.4** *Write and solve a system of linear equations in context.*
- **A1.A.REI.D.6** *Explain why the x-coordinates of the points where the graphs of the equations y = f(x) and y = g(x) intersect are*

the solutions of the equation f(x) = g(x); find the approximate solutions using technology.

- **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*

10. SOLVING TWO-VARIABLE LINEAR SYSTEMS ALGEBRAICALLY

- **SOLVING SYSTEMS OF LINEAR EQUATIONS: SUBSTITUTION**
  - **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
  - **A1.A.REI.C.4** *Write and solve a system of linear equations in context.*
  - **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*

- **SOLVING SYSTEMS OF LINEAR EQUATIONS: ELIMINATION**
  - **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
  - **A1.A.REI.C.4** *Write and solve a system of linear equations in context.*
  - **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*

- **SOLVING SYSTEMS OF LINEAR INEQUALITIES**
  - **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
  - **A1.A.REI.D.7** *Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.*

11. EXPONENTIAL FUNCTIONS, EQUATIONS, AND INEQUALITIES

- **EXPONENTIAL FUNCTIONS**
  - **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A1.F.LE.A.1.a** *Recognize that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.*
  - **A1.F.IF.B.5** *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.*
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
  - **A1.F.LE.A.3** *Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*
  - **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **A1.F.IF.B.3** *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.*
  - **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **A1.A.CED.A.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
  - **A1.F.LE.A.1.c** *Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*
  - **F.LE.B.4** *Interpret the parameters in a linear or exponential function in terms of a context.*

- **EXPONENTIAL GROWTH AND DECAY**
  - **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*

- **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
- **A1.F.LE.A.1.a** *Recognize that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.*
- **A1.F.LE.A.1.c** *Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*
- **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
- **F.LE.B.4** *Interpret the parameters in a linear or exponential function in terms of a context.*
- **A1.F.LE.A.3** *Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*
- **A1.F.LE.A.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
- **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*

- **SOLVING EXPONENTIAL INEQUALITIES**
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
  - **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*
  - **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
  - **A1.F.LE.A.1.c** *Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*

12. SEQUENCES

- **SEQUENCES**
  - **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*

- **ARITHMETIC AND GEOMETRIC SEQUENCES**
  - **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*

13. POLYNOMIALS

- **POLYNOMIAL BASICS**
  - **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*

- **ADDITION AND SUBTRACTION OF POLYNOMIALS**
  - **A1.A.APR.A.1** *Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.*

- **MULTIPLICATION OF POLYNOMIALS**
  - **A1.A.APR.A.1** *Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.*

14. FACTORING QUADRATICS

- **FACTORING QUADRATIC TRINOMIALS**
  - **A1.A.SSE.B.3.a** *Factor a quadratic expression to reveal the zeros of the function it defines.*
  - **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A1.A.REI.B.3.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.*

- **FACTORING SPECIAL CASES**
  - **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A1.A.APR.B.2** *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.*

15. GRAPHS AND REPRESENTATIONS OF QUADRATIC FUNCTIONS

- **QUADRATIC FUNCTIONS**
  - **A1.F.IF.B.3** *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.*
  - **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
  - **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
  - **A1.A.SSE.B.3.b** *Complete the square in a quadratic expression in the form $Ax^2 + Bx + C$ where $A = 1$ to reveal the maximum or minimum value of the function it defines.*
  - **A1.F.IF.C.7.a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
  - **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*

- **ANALYZING GRAPHS OF QUADRATIC FUNCTIONS**
  - **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A1.F.IF.C.8** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*
  - **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **A1.F.IF.B.3** *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.*
  - **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
  - **A1.A.APR.B.2** *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.*
  - **A1.A.REI.B.3.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.*
  - **A1.F.IF.C.7.a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*

- **REPRESENTATIONS OF QUADRATIC FUNCTIONS**
  - **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A1.A.REI.B.3.a** *Use the method of completing the square to rewrite any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.*

- **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.B.3** *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.*
- **A1.F.IF.C.8** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*
- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
- **A1.F.IF.C.7.a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*

16. SOLVING QUADRATIC FUNCTIONS

SOLVING QUADRATIC EQUATIONS BY FACTORING

- **A1.A.SSE.B.3.a** *Factor a quadratic expression to reveal the zeros of the function it defines.*
- **A1.A.REI.B.3.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.*
- **A1.F.IF.C.7.a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
- **A1.A.APR.B.2** *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.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*

COMPLETING THE SQUARE

- **A1.A.SSE.B.3.b** *Complete the square in a quadratic expression in the form $Ax^2 + Bx + C$ where $A = 1$ to reveal the maximum or minimum value of the function it defines.*
- **A1.A.REI.B.3.a** *Use the method of completing the square to rewrite any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.*
- **A1.A.REI.B.3.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.*
- **A1.F.IF.C.7.a** *Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.*
- **A1.A.SSE.A.2** *Use the structure of an expression to identify ways to rewrite it.*
- **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*

QUADRATIC FORMULA

- **A1.A.SSE.A.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
- **A1.A.SSE.A.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
- **A1.A.REI.B.3.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions.*
- **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **A1.F.IF.B.3** *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.*
- **A1.A.CED.A.3** *Represent constraints by equations or inequalities and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.*

- **A1.A.REI.B.3.a** *Use the method of completing the square to rewrite any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.*
- **A1.F.BF.A.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*

17. PARENT FUNCTIONS

- **LINEAR AND EXPONENTIAL PARENT FUNCTIONS**
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
  - **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **A1.F.IF.B.3** *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.*
  - **A1.F.LE.A.1.c** *Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*

- **QUADRATIC PARENT FUNCTION**
  - **A1.F.IF.C.6.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
  - **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

18. TRANSFORMATIONS OF PARENT FUNCTIONS

- **TRANSFORMATIONS OF THE LINEAR AND EXPONENTIAL PARENT FUNCTIONS**
  - **A1.F.BF.B.2** *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.*

- **TRANSFORMATIONS OF THE QUADRATIC PARENT FUNCTION**
  - **A1.F.BF.B.2** *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.*
  - **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

19. NONLINEAR FUNCTIONS

- **LINEAR VERSUS NONLINEAR FUNCTIONS**
  - **A1.F.IF.B.5** *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.*
  - **A1.F.LE.A.1.a** *Recognize that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.*
  - **A1.F.LE.A.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
  - **A1.F.IF.C.8** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*
  - **A1.F.IF.B.3** *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.*

- **A1.F.LE.A.1.c** *Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*

- **ABSOLUTE VALUE FUNCTIONS**
  - **A1.F.IF.A.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **A1.F.IF.B.4** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **A1.F.BF.B.2** *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.*
  - **A1.F.IF.C.6.b** *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*

- **MULTIPLE REPRESENTATIONS OF FUNCTIONS**
  - **A1.A.CED.A.2** *Create equations in two or more variables to represent relationships between quantities; graph equations with two variables on coordinate axes with labels and scales.*
  - **A1.F.IF.B.3** *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.*
  - **A1.F.IF.C.8** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).*
  - **A1.F.LE.A.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a table, a description of a relationship, or input-output pairs.*
  - **A1.F.LE.A.1.a** *Recognize that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.*

20. STATISTICS AND SCATTERPLOTS

- **DATA ANALYSIS**
  - **A1.S.ID.A.1** *Represent single or multiple data sets with dot plots, histograms, stem plots (stem and leaf), and box plots.*
  - **A1.S.ID.A.2** *Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*
  - **A1.S.ID.A.3** *Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

- **SCATTERPLOTS**
  - **A1.S.ID.B.4.a** *Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context.*
  - **A1.S.ID.B.4.b** *Fit a linear function for a scatter plot that suggests a linear association.*
  - **A1.S.ID.C.7** *Distinguish between correlation and causation.*
  - **A1.F.IF.B.5** *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.*
  - **A1.S.ID.C.5** *Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

- **SCATTERPLOTS AND MODELING**
  - **A1.S.ID.B.4.a** *Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context.*
  - **A1.S.ID.B.4.b** *Fit a linear function for a scatter plot that suggests a linear association.*
  - **A1.S.ID.C.6** *Use technology to compute and interpret the correlation coefficient of a linear fit.*
  - **A1.S.ID.C.5** *Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
  - **A1.F.LE.A.1.a** *Recognize that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals.*
  - **A1.F.LE.A.1.c** *Recognize situations in which a quantity grows or decays by a constant factor per unit interval relative to another.*