Alaska Tutorials are designed specifically for Alaska Standards and prepare students for the PEAKS exams in English and Mathematics.

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. EQUATIONS AND INEQUALITIES

- **FORMULATING AND SOLVING EQUATIONS FROM WORD PROBLEMS**
  - **F-LE.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values.*
  - **F-LE.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
  - **A-CED.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A-SSE.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*

- **FORMULATING AND SOLVING INEQUALITIES FROM WORD PROBLEMS**
  - **A-SSE.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A-CED.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A-CED.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.*
  - **A-REI.3** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*

## 2. LITERAL EQUATIONS AND GEOMETRIC SEQUENCES

- **LITERAL EQUATIONS**
  - **A-CED.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A-REI.3** *Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.*
  - **A-CED.4** *Rearrange formulas (literal equations) to highlight a quantity of interest, using the same reasoning as in solving equations.*

- **SUMS OF GEOMETRIC SEQUENCES**
  - **A-SSE.4** *Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems.*

## 3. FUNCTIONS

- **FUNCTIONS AND RELATIONS**

- **F-IF.2** *Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.*
- **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **F-IF.7.b** *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*

### DOMAIN AND RANGE

- **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

### INVERSE FUNCTIONS

- **F-BF.4.c** *Read values of an inverse function from a graph or a table, given that the function has an inverse.*
- **F-BF.4.a** *Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.*
- **F-BF.4.b** *Verify by composition that one function is the inverse of another.*
- **F-BF.4.d** *Produce an invertible function from a non-invertible function by restricting the domain.*

## 4. LINEAR FUNCTIONS, EQUATIONS, AND INEQUALITIES

### SLOPE

- **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
- **F-IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*
- **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **G-GPE.5** *Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems (e.g., find the equation of a line parallel or perpendicular to a given line that passes through a given point).*

### GRAPHING AND ANALYZING LINEAR FUNCTIONS

- **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
- **F-LE.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values.*
- **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
- **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
- **F-IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

### GRAPHING AND MANIPULATING Y = MX + B

- **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
- **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
- **F-LE.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values.*
- **S-ID.7** *Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*
- **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
- **F-IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified*

- **F-LE.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
- **F-LE.5** *Interpret the parameters in a linear or exponential function in terms of a context.*
- **F-IF.7.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*

## 5. EXPONENTIAL FUNCTIONS

- **EXPONENTIAL FUNCTIONS**
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.8.b** *Use the properties of exponents to interpret expressions for exponential functions.*
  - **F-LE.1.c** *Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.*
  - **F-IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*
  - **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
  - **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **F-IF.7.e** *Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-SSE.3.c** *Use the properties of exponents to transform expressions for exponential functions.*
  - **A-CED.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
  - **F-LE.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values.*
  - **F-LE.5** *Interpret the parameters in a linear or exponential function in terms of a context.*

- **EXPONENTIAL GROWTH AND DECAY**
  - **F-IF.8.b** *Use the properties of exponents to interpret expressions for exponential functions.*
  - **F-LE.1.a** *Show that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.*
  - **F-LE.5** *Interpret the parameters in a linear or exponential function in terms of a context.*
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **F-LE.1.c** *Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.*
  - **F-LE.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values.*
  - **S-ID.6.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. Emphasize linear, quadratic, and exponential models.*
  - **F-LE.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
  - **F-LE.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.*
  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

## 6. LOGARITHMIC EXPRESSIONS AND FUNCTIONS

- **EVALUATING LOGARITHMIC EXPRESSIONS**
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **F-LE.4** *For exponential models, express as a logarithm the solution to $abc^t = d$ where a, c, and d are numbers and the*

- **LOGARITHMIC FUNCTIONS**
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-BF.4.a** *Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse.*
  - **F-BF.4.c** *Read values of an inverse function from a graph or a table, given that the function has an inverse.*
  - **F-BF.5** *Understand the inverse relationship between exponents and logarithms and use this relationship to solve problems involving logarithms and exponents.*
  - **F-LE.4** *For exponential models, express as a logarithm the solution to $abct = d$ where $a$, $c$, and $d$ are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*
  - **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **F-IF.7.e** *Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*

## 7. SOLVING EXPONENTIAL AND LOGARITHMIC EQUATIONS AND INEQUALITIES

- **SOLVING EXPONENTIAL EQUATIONS**
  - **A-SSE.3.c** *Use the properties of exponents to transform expressions for exponential functions.*
  - **F-IF.8.b** *Use the properties of exponents to interpret expressions for exponential functions.*
  - **F-BF.4.a** *Solve an equation of the form $f(x) = c$ for a simple function f that has an inverse and write an expression for the inverse.*
  - **F-LE.4** *For exponential models, express as a logarithm the solution to $abct = d$ where $a$, $c$, and $d$ are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.7.e** *Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*

- **SOLVING EXPONENTIAL INEQUALITIES**
  - **A-CED.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.*
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-CED.1** *Create equations and inequalities in one variable and use them to solve problems.*
  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
  - **F-LE.1.c** *Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.*

- **SOLVING LOGARITHMIC EQUATIONS**
  - **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and $x$ is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input $x$. The graph of f is the graph of the equation $y = f(x)$.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-LE.4** *For exponential models, express as a logarithm the solution to $abct = d$ where $a$, $c$, and $d$ are numbers and the base b is 2, 10, or e; evaluate the logarithm using technology.*

## 8. ARITHMETIC WITH POLYNOMIALS 1

- **POLYNOMIAL BASICS**
  - **A-SSE.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.1** *Add, subtract, and multiply polynomials. Understand that polynomials form a system similar to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication.*

- **ADDITION AND SUBTRACTION OF POLYNOMIALS**
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.1** *Add, subtract, and multiply polynomials. Understand that polynomials form a system similar to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication.*

## 9. ARITHMETIC WITH POLYNOMIALS 2

- **MULTIPLICATION OF POLYNOMIALS**
  - **A-APR.1** *Add, subtract, and multiply polynomials. Understand that polynomials form a system similar to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication.*
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*

- **DIVISION OF POLYNOMIALS**
  - **A-APR.2** *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 $p(x)$.*
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.6** *Rewrite simple rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $(x)$, $q(x)$, 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.*

## 10. GRAPHS AND REPRESENTATIONS OF QUADRATIC FUNCTIONS

- **ANALYZING GRAPHS OF QUADRATIC FUNCTIONS**
  - **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If $f$ is a function and $x$ is an element of its domain, then $f(x)$ denotes the output of $f$ corresponding to the input $x$. The graph of $f$ is the graph of the equation $y = f(x)$.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.7.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
  - **F-BF.3** *Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of (both positive and negative); find the value of $k$ given the graphs.*
  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.*
  - **F-IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions).*

- **REPRESENTATIONS OF QUADRATIC FUNCTIONS**
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-REI.4.a** *Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x − p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.*
  - **F-IF.8.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.*
  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
  - **A-CED.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.*
  - **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If $f$ is a function and $x$ is an element of its domain, then $f(x)$ denotes the output of $f$ corresponding to the input $x$. The graph of $f$ is the graph of the equation $y = f(x)$.*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **A-SSE.3.a** *Factor a quadratic expression to reveal the zeros of the function it defines.*

- **A-APR.3** *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.*
- **F-IF.7.c** *Graph polynomial functions, identifying zeros (using technology) or algebraic methods when suitable factorizations are available, and showing end behavior.*
- **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*

- ### MULTIPLE REPRESENTATIONS OF FUNCTIONS

  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
  - **F-IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions).*

## 11. SOLVING QUADRATIC EQUATIONS 1

- ### SOLVING QUADRATIC EQUATIONS BY FACTORING

  - **A-SSE.3.a** *Factor a quadratic expression to reveal the zeros of the function it defines.*
  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.*
  - **F-IF.8.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.*
  - **A-APR.4** *Prove polynomial identities and use them to describe numerical relationships.*
  - **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If $f$ is a function and $x$ is an element of its domain, then $f(x)$ denotes the output of $f$ corresponding to the input $x$. The graph of $f$ is the graph of the equation $y = f(x)$.*
  - **F-IF.7.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*

- ### QUADRATIC FORMULA

  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.*
  - **N-CN.7** *Solve quadratic equations with real coefficients that have complex solutions.*
  - **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If $f$ is a function and $x$ is an element of its domain, then $f(x)$ denotes the output of $f$ corresponding to the input $x$. The graph of $f$ is the graph of the equation $y = f(x)$.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.7.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*
  - **A-CED.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.*

## 12. SOLVING QUADRATIC EQUATIONS 2

- ### COMPLETING THE SQUARE

  - **A-REI.4.a** *Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x − p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.*
  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.*
  - **F-IF.8.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.*
  - **A-SSE.3.b** *Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.*
  - **F-IF.7.a** *Graph linear and quadratic functions and show intercepts, maxima, and minima.*

- **COMPLEX NUMBERS AND QUADRATIC FUNCTIONS**
  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for* $x^2 = 49$*), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as* $a \pm bi$ *for real numbers* $a$ *and* $b$*.*
  - **N-CN.7** *Solve quadratic equations with real coefficients that have complex solutions.*
  - **N-CN.1** *Know there is a complex number* $i$ *such that* $i^2 = -1$*, and every complex number has the form* $a + bi$ *with* $a$ *and* $b$ *real.*
  - **N-CN.2** *Use the relation* $i^2 = -1$ *and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.*

## 13. FACTORING POLYNOMIALS

- **FACTORING SPECIAL CASES**
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.4** *Prove polynomial identities and use them to describe numerical relationships.*
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-APR.3** *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.*

- **FACTORING CUBIC POLYNOMIALS**
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.4** *Prove polynomial identities and use them to describe numerical relationships.*
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-APR.3** *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.*

## 14. FACTORING HIGHER-ORDER POLYNOMIALS

- **FACTORING HIGHER-ORDER POLYNOMIALS**
  - **A-SSE.1.a** *Interpret parts of an expression, such as terms, factors, and coefficients.*
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-APR.3** *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.*
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.4** *Prove polynomial identities and use them to describe numerical relationships.*

- **FACTOR THEOREM AND REMAINDER THEOREM**
  - **A-APR.6** *Rewrite simple rational expressions in different forms; write* $a(x)/b(x)$ *in the form* $q(x) + r(x)/b(x)$*, where* $a(x)$*, (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.*
  - **F-IF.2** *Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.*
  - **A-APR.2** *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* $p(x)$*.*

## 15. POLYNOMIAL FUNCTIONS AND COMPLEX NUMBERS

- **GRAPHS OF POLYNOMIAL FUNCTIONS**
  - **A-APR.3** *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.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.7.c** *Graph polynomial functions, identifying zeros (using technology) or algebraic methods when suitable factorizations are available, and showing end behavior.*

- F-IF.4.b *sketch graphs showing key features given a verbal description of the relationship.*
- **F-BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of (both positive and negative); find the value of k given the graphs.*

- **COMPLEX NUMBERS**
  - **N-CN.1** *Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with $a$ and $b$ real.*
  - **N-CN.2** *Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.*

# 16. POLYNOMIAL IDENTITIES AND COMPLEX NUMBERS

- **POLYNOMIAL IDENTITIES**
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.4** *Prove polynomial identities and use them to describe numerical relationships.*
  - **A-REI.4.a** *Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.*
  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.*
  - **A-APR.5** *Know and apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of x and y for a positive integer , where $x$ and $y$ are any numbers, with coefficients determined for example by Pascal's Triangle.*

- **POLYNOMIAL IDENTITIES AND COMPLEX NUMBERS**
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*
  - **A-APR.4** *Prove polynomial identities and use them to describe numerical relationships.*
  - **N-CN.8** *Extend polynomial identities to the complex numbers. For example, rewrite $x^2 + 4$ as $(x + 2i)(x - 2i)$.*
  - **A-REI.4.b** *Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers $a$ and $b$.*
  - **N-CN.7** *Solve quadratic equations with real coefficients that have complex solutions.*
  - **N-CN.9** *Know the Fundamental Theorem of Algebra; show that it is true for quadratic polynomials.*

# 17. RADICAL FUNCTIONS AND EQUATIONS

- **ANALYZING GRAPHS OF SQUARE ROOT FUNCTIONS**
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of (both positive and negative); find the value of k given the graphs.*
  - **G-CO.6** *Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.*
  - **F-IF.7.b** *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*
  - **F-BF.4.a** *Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse.*
  - **F-BF.4.c** *Read values of an inverse function from a graph or a table, given that the function has an inverse.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

- **SOLVING SQUARE ROOT EQUATIONS**
  - **A-REI.2** *Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*

# 18. RATIONAL EXPRESSIONS AND EQUATIONS

- ## OPERATIONS WITH RATIONAL EXPRESSIONS
  - **A-APR.7** *Add, subtract, multiply, and divide rational expressions. Understand that rational expressions form a system similar to the rational numbers, closed under addition, subtraction, multiplication, and division by a nonzero rational expression.*
  - **A-SSE.2** *Use the structure of an expression to identify ways to rewrite it.*

- ## SOLVING RATIONAL EQUATIONS
  - **A-REI.2** *Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.*
  - **F-IF.7.d** *Graph rational functions, identifying zeros and discontinuities (asymptotes/holes) using technology, and algebraic methods when suitable factorizations are available, and showing end behavior.*
  - **A-CED.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.*

# 19. RATIONAL FUNCTIONS

- ## ANALYZING GRAPHS OF RATIONAL FUNCTIONS
  - **F-BF.3** *Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of (both positive and negative); find the value of $k$ given the graphs.*
  - **F-IF.7.d** *Graph rational functions, identifying zeros and discontinuities (asymptotes/holes) using technology, and algebraic methods when suitable factorizations are available, and showing end behavior.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

- ## MODELING SITUATIONS WITH RATIONAL FUNCTIONS
  - **A-SSE.1.b** *Interpret complicated expressions by viewing one or more of their parts as a single entity.*
  - **A-CED.2** *Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.*
  - **A-CED.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.*
  - **F-BF.1.a** *Determine an explicit expression, a recursive process, or steps for calculation from a context.*
  - **A-REI.2** *Solve simple rational and radical equations in one variable, and give examples showing how extraneous solutions may arise.*

# 20. NONLINEAR FUNCTIONS

- ## LINEAR VERSUS NONLINEAR FUNCTIONS
  - **F-LE.1.a** *Show that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.*
  - **F-LE.1.b** *Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.*
  - **F-LE.2** *Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input-output table of values.*
  - **F-IF.6** *Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-LE.1.c** *Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.9** *Compare properties of two functions each represented in a different way (algebraically, graphically, numerically, in tables, or by verbal descriptions).*

- ## ABSOLUTE VALUE FUNCTIONS

- **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
- **F-IF.1** *Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then f(x) denotes the output of f corresponding to the input x. The graph of f is the graph of the equation y = f(x).*
- **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
- **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
- **F-IF.7.b** *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*
- **F-BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of (both positive and negative); find the value of k given the graphs.*

- ### ARITHMETIC OPERATIONS ON FUNCTIONS
  - **F-BF.1.b** *Combine standard function types using arithmetic operations.*

## 21. TRIGONOMETRY AND TRIGONOMETRIC FUNCTIONS

- ### RADIANS AND THE UNIT CIRCLE
  - **F-TF.1** *Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.*
  - **F-TF.2** *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.*
  - **G-C.5** *Use and apply the concepts of arc length and areas of sectors of circles. Determine or derive using similarity the fact that the length of the arc intercepted by an angle is proportional to the radius, and define the radian measure of the angle as the constant of proportionality; derive the formula for the area of a sector.*
  - **F-TF.3** *Use special triangles to determine geometrically the values of sine, cosine, tangent for $\pi/3$, $\pi/4$ and $\pi/6$, and use the unit circle to express the values of sine, cosines, and tangent for $\pi - x$, $\pi + x$, and $2\pi - x$ in terms of their values for x, where x is any real number.*
  - **F-TF.4** *Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions.*
  - **G-CO.1** *Demonstrates understanding of key geometrical definitions, including angle, circle, perpendicular line, parallel line, line segment, and transformations in Euclidian geometry. Understand undefined notions of point, line, distance along a line, and distance around a circular arc.*
  - **G-SRT.8** *Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.*

- ### TRIGONOMETRIC FUNCTIONS
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.7.e** *Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*
  - **F-TF.2** *Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle.*
  - **F-TF.5** *Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.*
  - **F-TF.8** *Prove the Pythagorean identity $\sin^2(\theta) + \cos^2(\theta) = 1$ and use it to calculate trigonometric ratios.*

## 22. PARENT FUNCTIONS AND TRANSFORMATIONS

- ### PARENT FUNCTIONS
  - **F-IF.7.c** *Graph polynomial functions, identifying zeros (using technology) or algebraic methods when suitable factorizations are available, and showing end behavior.*
  - **F-IF.4.a** *interpret key features of graphs and tables in terms of the quantities, and*
  - **F-IF.5** *Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - **F-BF.3** *Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of (both positive and negative); find the value of k given the graphs.*
  - **F-IF.4.b** *sketch graphs showing key features given a verbal description of the relationship.*
  - **F-IF.7.b** *Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*
  - **F-IF.7.e** *Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*

- **TRANSFORMATIONS OF PARENT FUNCTIONS**
  - *F-IF.4.b sketch graphs showing key features given a verbal description of the relationship.*
  - *F-IF.7.b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*
  - *F-IF.7.c Graph polynomial functions, identifying zeros (using technology) or algebraic methods when suitable factorizations are available, and showing end behavior.*
  - *F-IF.7.e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*
  - *F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of (both positive and negative); find the value of $k$ given the graphs.*
  - *F-IF.4.a interpret key features of graphs and tables in terms of the quantities, and*
  - *G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.*
  - *F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*

- **MULTIPLE TRANSFORMATIONS OF PARENT FUNCTIONS**
  - *F-IF.4.a interpret key features of graphs and tables in terms of the quantities, and*
  - *F-IF.4.b sketch graphs showing key features given a verbal description of the relationship.*
  - *F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of (both positive and negative); find the value of $k$ given the graphs.*
  - *G-CO.6 Use geometric descriptions of rigid motions to transform figures and to predict the effect of a given rigid motion on a given figure; given two figures, use the definition of congruence in terms of rigid motions to decide if they are congruent.*
  - *F-IF.5 Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.*
  - *F-IF.7.c Graph polynomial functions, identifying zeros (using technology) or algebraic methods when suitable factorizations are available, and showing end behavior.*
  - *G-CO.2 Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).*
  - *F-IF.7.b Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.*
  - *F-IF.7.e Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.*

## 23. SYSTEMS OF EQUATIONS

- **SOLVING THREE-VARIABLE SYSTEMS OF LINEAR EQUATIONS**
  - *A-CED.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.*
  - *A-REI.5 Show that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.*

- **SYSTEMS OF NONLINEAR EQUATIONS**
  - *A-REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.*
  - *A-REI.11 Explain why the $x$-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.*
  - *A-REI.5 Show that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.*
  - *A-CED.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.*
  - *A-REI.6 Solve systems of linear equations exactly and approximately, e.g., with graphs or algebraically, focusing on pairs of linear equations in two variables.*

# 24. STATISTICAL DESIGN AND ANALYSIS

- **ANALYZING STATISTICAL SAMPLES**
  - **S-IC.1** *Understand statistics as a process for making inferences about population parameters based on a random sample from that population.*
  - **S-IC.4** *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.*
  - **S-IC.2** *Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.*

- **EXPERIMENTAL AND OBSERVATIONAL DESIGN**
  - **S-IC.3** *Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.*

- **CONCLUSIONS IN DATA**
  - **S-IC.5** *Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.*
  - **S-IC.6** *Evaluate reports based on data.*

# 25. STATISTICS AND PROBABILITY

- **NORMAL DISTRIBUTION**
  - **S-ID.3** *Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*
  - **S-ID.4** *Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*
  - **S-IC.4** *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.*

- **ANALYZING DECISIONS IN PROBABILITY**
  - **S-MD.6** *Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator).*
  - **S-MD.7** *Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game).*