PARCC MODEL CONTENT FRAMEWORK FOR ALGEBRA 3-4

Building on their work in Algebra I with linear and quadratic functions, students in Algebra II expand their repertoire by working with rational and exponential expressions; polynomial, exponential and logarithmic functions; trigonometric functions with real number domain; and sequences and series. Students work closely with the expressions that define the functions and continue to expand and hone their abilities to model situations and solve equations. Exponential functions, trigonometric functions, and sequences and series all provide opportunities for modeling. As students encounter more and more varied mathematical expressions and functions, general principles they encountered in Algebra I remain relevant, unifying the material in the course.

Students in Algebra II continue their work with Statistics and Probability. They explore and investigate the randomness underlying statistical experiments and make inferences and justify conclusions from sample surveys, experiments and observational studies. They also use probability to evaluate the outcomes of more complex situations than they previously encountered in Geometry.

The critical areas in Algebra II include polynomials (including the structural similarities between the system of polynomials and the system of integers) and polynomial equations, unit circle trigonometry, families of functions (the culmination of all of the types of functions that have been studied and the addition of trigonometric and logarithmic functions), and statistical and probabilistic modeling. The Standards for Mathematical Practice apply throughout the Algebra II course and, when connected meaningfully with the content standards, allow for students to experience mathematics as a coherent, useful and logical subject. Details about the content and practice standards follow in this analysis.

Creating mathematical models is a culminating learning experience for this course. Modeling is defined as:

- identifying variables in the situation and selecting those that represent essential features,
- formulating a model by creating and selecting geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between the variables,
- analyzing and performing operations on these relationships to draw conclusions,
- interpreting the results of the mathematics in terms of the original situation,
- validating the conclusions by comparing them with the situation, and then either improving the model or, if it is acceptable,
- reporting on the conclusions and the reasoning behind them.

Whenever graphing a function, students will be asked to identify domain, range, intercepts, zeroes (especially in polynomials), end behavior, symmetry, even and off functions, and intervals that increase or decrease. Students will be asked to discuss transformations when graphing (vertical and horizontal shifts, dilations, reflection, and rotations). When making learning targets, ensure students are creating multiple representations of their mathematical models (verbal, numerical, symbolic and graphical).
### Algebra 3-4 Learning Outcomes

<table>
<thead>
<tr>
<th>Linear Functions and Equations (15 days)</th>
<th>Quadratic Functions and Equations (16 days)</th>
<th>Polynomial Functions (16 days)</th>
<th>Rational Functions (16 days)</th>
<th>Radical Functions (17 days)</th>
<th>Exponential Functions and Logarithms (20 days)</th>
<th>Trigonometric Functions (20 days)</th>
<th>Statistics (20 days)</th>
<th>Probability (17 days)</th>
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<tbody>
<tr>
<td>F-IF.C.7b #</td>
<td>F-IF.B.6*#</td>
<td>F-IF.B.5</td>
<td>F-IF.B.4 *#</td>
<td>F-BF.B.3 *#</td>
<td>F-IF.C.8b</td>
<td>F-TF.C.8</td>
<td>S-IC.B.5</td>
<td>S-CP.B.7</td>
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<tr>
<td>F-BF.A.2#</td>
<td>F-IF.C.7a #</td>
<td>F-IF.C.7c</td>
<td>F-IF.B.6*#</td>
<td>F-IF.C.9 *#</td>
<td>F-BF.B.3 *#</td>
<td>S-IC.B.6</td>
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<tr>
<td>F-BF.B.3*#</td>
<td>F-IF.C.8</td>
<td>F-IF.C.9 *#</td>
<td>F-BF.B.3 *#</td>
<td>F-BF.A.2#</td>
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<td>F-LE.A.2 **#</td>
<td>F-IF.C.9 *#</td>
<td>F-BF.B.3 *#</td>
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<td>F-BF.B.3 *#</td>
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<tr>
<td>F-LE.B.5 **#</td>
<td>F-BF.A.1*</td>
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<td>F-BF.A.1*</td>
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<td>N-Q.A.2 *</td>
<td>F-BF.B.1b</td>
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<td>G-GPE.A.2</td>
<td>F-BF.B.3 *#</td>
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<td>F-LE.A.4</td>
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</tbody>
</table>

* = standards are addressed in multiple courses (See Assessment Limits on page 21)
# = standards are addressed in multiple units

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**Major Cluster**
**Supporting Cluster**
**Additional Cluster**
# Unit 1: Linear Functions and Equations

## Enduring Understandings:
Graphing a relationship allows us to model real world situations and visualize the relationship between 2 variables.

## Essential Questions:
- How are the solutions of an equation related to the graph of a function?
- What is the relationship between the graph, the equation and table of values?
- What is the purpose of the line of best fit?
- How are piecewise functions represented algebraically and graphically?

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Technology Standards</th>
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</table>
| A. Reason quantitatively and use units to solve problems | ● I can identify and create the correct type of measurement to represent a real life situation  
● I can solve a real-world problem by writing and solving an appropriate linear equation or inequality.  
● I can graph and explain the solution to a system of equation.  
● I can connect arithmetic sequence to linear function to solve the real world problem.  
● I can recognize that a pattern of numbers can be written as a function.  
● I can find the average rate of change from a function given symbolically, graphically or in a table.  
● I can write the equation of a linear function if I am given a graph, a | *Use a graphing calculator to:  
● Solve linear equations and inequalities graphically.  
● graph an absolute value and piecewise functions  
● Use the domain and range of a function to set an appropriate window.  
● Use the TRACE and CALCulate features to find a specific value.  
● Experiment with changing the parameters of the equations of basic functions and determine their effect on the graph.  
● Create a scatter plot and then use linear regression |
| N-Q.A.2 | Define appropriate quantities for the purpose of descriptive modeling. | |
| A. Create equations that describe numbers or relationships | C. Solve systems of equations | |
| A-CED.A.1 | Create equations and inequalities in one variable and use them to solve problems that can be modeled with linear functions. | |
| A-REI.C.6 | Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables. | |
| D. Represent and solve equations and inequalities graphically | A-REI.D.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. |
| F-BF.A.2 | Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms. | |
| F-BF.B.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 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. | |

## Key Vocabulary
- Variable, linear equation
- algebraic model, linear inequality
- compound inequality, absolute value
- coordinate plane, graph
- solution, relation
- function, ordered pair
- slope
- slope-intercept form
- standard form
## A. Understand the concept of a function and use function notation

**F-IF.A.3**

Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by \( f(0) = f(1) = 1, \)
\[ f(n+1) = f(n) + f(n-1) \text{ for } n \geq 1. \]

**Supporting Cluster**

- I can apply the meaning of the parameters in a linear function to a real-world situation.

<table>
<thead>
<tr>
<th>Description of a linear relationship, the coordinates of two ordered pairs from the graph or a table of values.</th>
</tr>
</thead>
<tbody>
<tr>
<td>scatter plot, domain, range, independent variable, piecewise function, input variable, output variable, horizontal intercept, vertical intercept</td>
</tr>
</tbody>
</table>

## C. Analyze functions using different representations

**F-IF.C.7a**

Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. ★

- a. Graph linear functions and show intercepts. ★
- b. Graph piecewise-defined functions, including step functions and absolute value functions. ★

## B. Interpret functions that arise in applications in terms of the context

**F-IF.B.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. ★

## A. Construct and compare linear, quadratic, and exponential models and solve problems

**F-LE.A.2**

Construct linear and exponential functions, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table). ★ (limit to arithmetic)

**B. Interpret expressions for functions in terms of the situation they model**

**F-LE.B.5**

Interpret the parameters in a linear or exponential function in terms of a context. ★
### Unit 2: Quadratic Functions and Equations

**Enduring Understandings:**
Graphing a function allows us to model real world situations and visualize the relationship between 2 variables. The graph of a quadratic function will always be a symmetrical parabola with predictable characteristics.

**Essential Questions:**
- What connections can be made between graphic and algebraic representations of a quadratic?
- What information can I determine from the equation about the graph, and vice versa?
- What is the purpose of a complex number in a quadratic equation?
- What contextual situations can be modeled by quadratic equation?

<table>
<thead>
<tr>
<th>Standard</th>
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</thead>
</table>
| A. Perform arithmetic operations with complex numbers | • I can graph a quadratic function using various methods.  
• I can find the vertex of a quadratic function in standard form using \( x = -\frac{b}{2a} \).  
• I can find the intercepts of the graph of a quadratic function.  
• I can determine the maximum or minimum value of a quadratic function.  
• I can write the equation of a quadratic function based on the shifts and rate of change.  
• I can use the factored form of the equation of a quadratic function to determine the zeros of the function.  
• I can complete the square to write the equation of a quadratic function in vertex form.  
• I can use the vertex form of the equation of a quadratic function to find the vertex of the parabola.  
• I can compare two functions represented in different ways.  
• I can solve a quadratic equation by taking square roots, by factoring, by completing the square, graphically, and using the quadratic formula.  
• I can solve a quadratic equation by using the TRACE and calculate (CALC) features of a calculator to find the zeros, specific values, intercepts, relative maxima and minima of the related quadratic function.  
• I can set an appropriate window to graph quadratic functions.  
• I can use the domain and range of a quadratic function to set an appropriate window for graphing. | *Use a graphing calculator to:  
• Solve quadratic equations and inequalities graphically.  
• Solve a quadratic equation by using the TRACE and calculate (CALC) features of a calculator to find the zeros, specific values, intercepts, relative maxima and minima of the related quadratic function.  
• Set an appropriate window to graph quadratic functions.  
• Use the domain and range of a quadratic function to set an appropriate window for graphing. |

<table>
<thead>
<tr>
<th>Standard</th>
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</tr>
</thead>
<tbody>
<tr>
<td>N-CN.A.1</td>
<td>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.</td>
</tr>
<tr>
<td>N-CN.A.2</td>
<td>Use the relation ( i^2 = -1 ) and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.</td>
</tr>
<tr>
<td>N-CN.C.7</td>
<td>Solve quadratic equations with real coefficients that have complex solutions.</td>
</tr>
</tbody>
</table>

**Standard**

A-Create equations that describe numbers or relationships

A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems that can be modeled with quadratic functions.★

B. Solve equations and inequalities in one variable

A-REI.B.4b

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 \( b \).

C. Solve systems of equations

A-REI.C.7

Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line \( y = -3x \) and the circle \( x^2 + y^2 = 3 \).
<table>
<thead>
<tr>
<th>Major Cluster</th>
<th>Supporting Cluster</th>
<th>Additional Cluster</th>
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</thead>
<tbody>
<tr>
<td><strong>B. Interpret functions that arise in applications in terms of the context</strong></td>
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<tr>
<td>F-IF.B.6</td>
<td>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.★</td>
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<tr>
<td><strong>F-IF.B.6</strong></td>
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<tr>
<td>C. Analyze functions using different representations</td>
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<tr>
<td>F-IF.C.7a</td>
<td>Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.★&lt;br&gt;a. Graph linear functions and show intercepts.★</td>
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<tr>
<td>F-IF.C.7a</td>
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<tr>
<td>F-IF.C.8</td>
<td>Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.</td>
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<td>F-IF.C.8</td>
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<tr>
<td>F-IF.C.9</td>
<td>Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has a larger maximum.</td>
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<tr>
<td>F-IF.C.9</td>
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<tr>
<td><strong>A. Build a function that models a relationship between two quantities</strong></td>
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<tr>
<td>F-BF.A.1a</td>
<td>Write a function that describes a relationship between two quantities.★&lt;br&gt;a. Determine an explicit expression, a recursive process, or steps for calculation from a context.&lt;br&gt;b. Combine standard function types using arithmetic operations. For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these (Where do these go?)&lt;br&gt;c.</td>
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<tr>
<td>F-BF.A.1a</td>
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<td>F-BF.A.1b</td>
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<tr>
<td><strong>F-BF.A.1b</strong></td>
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<tr>
<td><strong>B. Build new functions from existing functions</strong></td>
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<tr>
<td>F-BF.B.3</td>
<td>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</td>
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<tr>
<td>F-BF.B.3</td>
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</table>

**Key Vocabulary**

- standard form
- quadratic function
- vertex form
- quadratic form
- parabola
- factoring
- quadratic equation
- solution of the function
- zero of the function
- square root
- complex number
- imaginary number
- completing the square
- quadratic formula
- discriminant
<table>
<thead>
<tr>
<th>Major Cluster</th>
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<th>Additional Cluster</th>
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<tbody>
<tr>
<td>graphs and algebraic expressions for them. <em>(limit to linear function)</em></td>
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<tr>
<td><strong>A. Translate between the geometric description and the equation for a conic section</strong></td>
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<tr>
<td>G-GPE.A.2  Derive the equation of a parabola given a focus and directrix.</td>
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</table>
# Unit 3: Polynomial Functions

## Enduring Understandings:
- If there is no remainder after synthetic division, then the divisor is a factor.
- The solutions for a function are the points where the graph crosses the x-axis.
- The degree of the polynomial determines the number of solutions both real and complex.
- End behaviors are determined by the leading coefficient and the degree of the polynomial.

## Essential Questions:
- What is the relation between synthetic substitution and synthetic division?
- How are the factors of a polynomial equation related to the graph of the function?
- What is the difference between and among: factors, zeros, x-intercepts, roots, and solutions?
- How can the end behavior be related to the leading term of the polynomial?

## Standard

### B. Understand the relationship between zeros and factors of polynomials

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<thead>
<tr>
<th>Standard</th>
<th>Learning Targets</th>
<th>Technology Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-APR.B.2</td>
<td>● I can use the Fundamental Theorem of Algebra to determine the number of zeros in a polynomial function. ● I can apply the Remainder Theorem to determine if (x – a) is a factor of p(x).</td>
<td>Use a graphing calculator ● To graph a polynomial function ● Use various Zoom features and window settings to find an appropriate window. ● Use the domain and range and the end behavior ● Graph polynomials and use the Zero features on a calculator to find the real zeros. ● Solve a polynomial equation by graphing the related function and finding the zeros.</td>
</tr>
<tr>
<td>A-APR.B.3</td>
<td>● I can factor a polynomial to identify the zeros of the function. ● I can find the rational zeros of a polynomial function by graphing. ● I can use the rational zeros (found by using a graphing calculator) and synthetic division to reduce the degree of a polynomial function so it can be factored. ● I can sketch a graph of the polynomial using the zeros and end behavior. ● I can rewrite a polynomial to reveal zeros of the function. ● I can use zeros from a graph or given to write a polynomial function. ● I can use long division and synthetic division to divide polynomials.</td>
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</tbody>
</table>

### C. Use polynomial identities to solve problems

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A-APR.C.4</td>
<td>● Prove polynomial identities and use them to describe numerical relationships. For example, the polynomial identity (x^2 + y^2)^2 = (x^2 – y^2)^2 + (2xy)^2 can be used to generate Pythagorean triples.</td>
</tr>
</tbody>
</table>

### D. Represent and solve equations and inequalities graphically

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A-REI.D.11</td>
<td>● 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. ★</td>
</tr>
</tbody>
</table>

### Major Cluster: Polynomial Functions

### Supporting Cluster: Synthetic Division and Remainder Theorem

### Additional Cluster: Graphing Polynomials and Finding Zeros
### B. Build new functions from existing functions

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>F-BF.B.3</td>
<td>Identify the effect on the graph of replacing ( f(x) ) by ( f(x) + 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.</td>
</tr>
</tbody>
</table>

- I can use the zeros of a polynomial function and its end behavior to sketch its graph.
- I can write a polynomial equation that models a real-world problem and use the equation to solve the problem.
- I can justify each step used to solve an equation.

### Key Vocabulary
- factoring
- polynomial function
- degree of a polynomial function
- end behavior
- synthetic substitution
- synthetic division
- polynomial long division
- remainder theorem
- factor theorem
- rational zero theorem
- fundamental theorem of algebra
- rational root
- complex root
- multiplicity
- possible solution
- complex root
- real root

### B. Interpret functions that arise in applications in terms of the context

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<tr>
<td>F-IF.B.4</td>
<td>For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: domain and range, intercepts; intervals where the function is increasing, decreasing, positive, or negative, and symmetries. ★</td>
</tr>
</tbody>
</table>

- Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function \( h(n) \) gives the number of person-hours it takes to assemble \( n \) engines in a factory, then the positive integers would be an appropriate domain for the function. ★ *(limit to linear, exponential, and quadratic)*

- 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. ★

### C. Analyze functions using different representations

<table>
<thead>
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<tbody>
<tr>
<td>F-IF.C.7c</td>
<td>Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. ★</td>
</tr>
</tbody>
</table>

- Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a graph of one quadratic function and an algebraic expression for another, say which has a larger maximum
Major Cluster  

Supporting Cluster  

Additional Cluster  

## Unit 4: Rational Functions and Equations

### Enduring Understandings:

A rational equation, expression or function has a variable in the denominator.

An extraneous solution is an algebraically found number that causes the rational expression to be undefined.

The zeros of a function are the points where the graph crosses the x-axis.

An asymptote identifies a location on a graph where no point exists.

### Essential Questions:

What causes a rational equation to have an extraneous solution?

What causes a rational function to have a vertical asymptote?

What is the difference between and among: factors, zeros, x-intercepts, roots, solutions and asymptotes?

### Standard Learning Targets

#### A. Interpret the structure of expressions

- **A-SSE.A.2**
  - Use the structure of an expression to identify ways to rewrite it. For example, see \( x^4 - y^4 \) as \( (x^2)^2 - (y^2)^2 \), thus recognizing it as a difference of squares that can be factored as \( (x^2 - y^2)(x^2 + y^2) \).

#### A. Understand solving equations as a process of reasoning and explain the reasoning

- **A-REI.A.1**
  - Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

- **A-REI.A.2**
  - Solve rational equations in one variable, and give examples showing how extraneous solutions may arise.

#### D. Represent and solve equations and inequalities graphically

- **A-REI.D.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.

### Technology Standards

- *Use a graphing calculator
- To graph a rational function
- Use various Zoom features and window settings to find an appropriate window.
- Use the domain and range and the end behavior
- Use the Zero feature on a calculator to find the zeros.
- Use the Table function to find the location of any asymptotes
- Solve a rational equation by graphing the related function and finding the zeros

★
### D. Rewrite rational expressions

**A-APR.D.6**

Rewrite simple rational expressions in different forms; write \( \frac{a(x)}{b(x)} \) in the form \( q(x) + \frac{r(x)}{b(x)} \), 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.

---

### A. Create equations that describe numbers or relationships

**A-CED.A.1**

Create equations in one variable and use them to solve problems. Include equations arising from rational functions. ★

---

### B. Build new functions from existing functions

**F-BF.B.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 \( k \) (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.

---

### B. Interpret functions that arise in applications in terms of the context

**F-IF.B.4**

For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. Key features include: domain and range, intercepts; intervals where the function is increasing, decreasing, positive, or negative, and symmetries. ★

**F-IF.B.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. ★

---

**Key Vocabulary**

- Rational expression
- Rational equation
- Extranous solution
- Rational function
- Zeros of a function
- Vertical asymptote
- Horizontal asymptote
- Degree of a polynomial
- End behavior
- Division by zero

---

**in creating its graph**

- I can find the horizontal asymptotes of a rational function and use the asymptotes and end behavior of the function in creating its graph.
- I can identify the domain and range of a rational function.
- I can identify intervals where a rational function is increasing, decreasing, positive or negative.
- I can graph a rational function using technology and find zeros, intercepts, asymptotes, domain and range.
- I can explain what causes a graph of a basic rational function to shift vertically or horizontally.
- I can explain what causes a graph of a basic rational function to stretch vertically or horizontally.
- I can find the average rate of change of a rational function presented symbolically or as a table over a specified interval.
- I can apply the meaning of the zeros, y-intercept and asymptotes of a rational function to the context a real world problem.
## Unit 5: Radical Functions and Equations

### Enduring Understandings:
Extend the properties of exponents to rational exponents.  
The solutions for a radical function are the points where the graph crosses the x-axis.

### Essential Questions:
- Why rewrite radical expressions to rational exponents?  
- What is the difference between real solutions and extraneous solutions?  
- How are the solutions of a radical equation related to the graph of the function?  
- How is the graph affected by changing the function $f(x)$ to $f(x) + k$, $k f(x)$, $f(kx)$, and $f(x + k)$ for specific values of $k$ (both positive and negative)?

<table>
<thead>
<tr>
<th>Standard</th>
<th>Learning Targets</th>
<th>Technology Standards</th>
</tr>
</thead>
</table>
| A-SSE.B.3c** | I can model the properties of integer exponents to derive the rules for rational exponents. | *Use a graphing calculator  
\- To graph a radical function  
\- Use various Zoom features and window settings to find an appropriate window.  
\- Graph multiple radical functions at one time to determine transformations.  
\- Use the Zero feature on a calculator to find the real zeros.  
\- Graph radicals and find the real zeros of a radical function.  
\- Solve a radical equation by finding the intersection of the left and right side of the equation. |
| N-RN.A.1** | I can change a radical expression to an exponential expression and apply the properties of exponents.  
\- I can explain why solutions are extraneous. |
| N-RN.A.2** | I can find the inverse of a radical equation and identify the domain.  
\- I can sketch a graph of the radical function using the key features of the graph to include: zeros, end behavior, and asymptotes. |
| A-REI.A.2 | I can describe the transformation of a radical function.  
\- I can justify each step used to solve an equation.  
\- I can solve a radical equation, remembering to check for extraneous solutions. |

** Standard (A) indicates Major Cluster, (B) indicates Supporting Cluster, and (C) indicates Additional Cluster.
| F-BF.B.4a | Solve an equation of the form \( f(x) = c \) for a simple function \( f \) that has an inverse and write an expression for the inverse. For example, \( f(x) = 2x^3 \) for \( x > 0 \) or \( f(x) = \frac{x + 1}{x - 1} \) for \( x \neq 1 \). | **Key Vocabulary**
- rational root
- complex root
- multiplicity
- possible solution
- extraneous solutions
- domain
- real root
- inverse
- transformations
- zeros
- asymptotes |

| F-IF.C.7b | Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. ★

b. Graph piecewise-defined functions, including step functions and absolute value functions. ★ |
# Unit 6: Exponential Functions and Logarithms

## Enduring Understandings:
The characteristics of exponential and logarithmic functions and their representations are useful in solving real-world problems.

## Essential Questions:
- How do exponential functions model real-world problems and their solutions?
- How do logarithmic functions model real-world problems and their solutions?
- How are expressions involving exponents and logarithms related?

<table>
<thead>
<tr>
<th>Standard</th>
<th>Learning Targets</th>
<th>Technology Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>B. Write expressions in equivalent forms to solve problems</strong></td>
<td>● I can model the properties of integer exponents to derive the rules for rational exponents.</td>
<td>*Use a graphing calculator to: ● determine an appropriate window for graphing it on a calculator. ● use the data points of a real-world application to create a scatter plot and then use the graph to determine whether the data is more appropriately modeled by a linear model or an exponential model. ● experiment with the graphs of linear and exponential functions and use the graphs to determine differences in their rates of growth (or decay). ● Evaluate a logarithmic function using technology.</td>
</tr>
<tr>
<td>A-SSE.B.3c Use the properties of exponents to transform expressions for exponential functions. For example the expression 1.15t can be rewritten as (1.151/12)12t ≈ 1.01212t to reveal the approximate equivalent monthly interest rate if the annual rate is 15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-SSE.B.4 Derive the formula for the sum of a finite geometric series (when the common ratio is not 1), and use the formula to solve problems. For example, calculate mortgage payments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A. Create equations that describe numbers or relationships</strong></td>
<td>● I can develop the formula for the sum of a finite geometric series.</td>
<td></td>
</tr>
<tr>
<td>A-CED.A.1 Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and exponential functions.</td>
<td>● I can find the sum of a finite geometric series.</td>
<td></td>
</tr>
<tr>
<td><strong>B. Interpret functions that arise in applications in terms of the context</strong></td>
<td>● I can find the sum of an infinite geometric series.</td>
<td></td>
</tr>
<tr>
<td>F-IF.B.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.</td>
<td>● I can apply the formulas for finite geometric series to real-world problems.</td>
<td></td>
</tr>
<tr>
<td><strong>C. Analyze functions using different representations</strong></td>
<td>● I can find the inverse of a function using an algebraic process.</td>
<td></td>
</tr>
<tr>
<td>F-IF.C.7e Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. d. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.</td>
<td>● I can use the y-intercept, the asymptote and the end behavior to graph an exponential function.</td>
<td></td>
</tr>
</tbody>
</table>

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**Page 14 of 29**
| F-IF.C.8b | Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.  
  b. Use the properties of exponents to interpret expressions for exponential functions. | properties of exponents.  
  ● I can write the equation of an exponential function if I am given a graph, a description of an exponential relationship, the coordinates of two ordered pairs from the graph or a table of values.  
  ● I can determine whether an exponential or a linear model is more appropriate for a set of data and write the corresponding equation.  
  ● I can apply the meaning of the parameters in an exponential function to a real-world situation.  
  ● I can express a logarithm as a solution to an exponential function.  
  ● I can evaluate a logarithmic function using technology. | Key Vocabulary  
  exponential function  
  asymptote  
  exponential growth function  
  exponential decay function  
  exponential function  
  asymptote  
  exponential growth function  
  exponential decay function  
  natural base  
  logarithm of \(y\) with base \(b\)  
  common logarithm  
  natural logarithm  
  logistic growth function  
  natural log  
  base \(e\)  
  common log  
  logarithmic form  
  exponential form |
|-----------------|------------------------------------------------|---------------------|
| A. Build a function that models a relationship between two quantities | **F-BF.A.2**  
  Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.★ | A. Construct and compare linear, quadratic, and exponential models and solve problems |
| B. Build new functions from existing functions | **F-BF.B.3**  
  Identify the effect on the graph by replacing \(f(x)\) with \(f(x) + k\), \(kf(x)\), \(f(kx)\), 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. | **F-BF.B.4a**  
  Solve an equation of the form \(f(x) = c\) for a simple function \(f\) that has an inverse and write an expression for the inverse. For example, \(f(x) = 2x^3\) for \(x > 0\) or \(f(x) = \frac{x+1}{x-1}\) for \(x \neq 1\). |
| F-BF.B.4a | Solve an equation of the form \(f(x) = c\) for a simple function \(f\) that has an inverse and write an expression for the inverse. For example, \(f(x) = 2x^3\) for \(x > 0\) or \(f(x) = \frac{x+1}{x-1}\) for \(x \neq 1\). | A. Construct and compare linear, quadratic, and exponential models and solve problems |
| F-BF.B.4a | Solve an equation of the form \(f(x) = c\) for a simple function \(f\) that has an inverse and write an expression for the inverse. For example, \(f(x) = 2x^3\) for \(x > 0\) or \(f(x) = \frac{x+1}{x-1}\) for \(x \neq 1\). | B. Interpret expressions for functions in terms of the situation they model |
| A. Construct and compare linear, quadratic, and exponential models and solve problems | **F-LE.A.2**  
  Construct linear and exponential functions, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).★ | **F-LE.A.4**  
  For exponential models, express as a logarithm the solution to \(ab^x = d\) where \(a\), \(c\), and \(d\) are numbers and the base \(b\) is 2, 10, or \(e\); evaluate the logarithm using technology. |
| F-LE.A.4 | For exponential models, express as a logarithm the solution to \(ab^x = d\) where \(a\), \(c\), and \(d\) are numbers and the base \(b\) is 2, 10, or \(e\); evaluate the logarithm using technology. | B. Interpret expressions for functions in terms of the situation they model |
| F-LE.B.5 | Interpret the parameters in a linear or exponential function in terms of a context.★ | F-LE.B.5 | Interpret the parameters in a linear or exponential function in terms of a context.★ |
## Unit 7: Trigonometric Functions

### Enduring Understandings:
There are many methods used to find angle measures, lengths, and areas. The relationship of the unit circle to trigonometric ratios.

### Essential Questions:
- How can measurements be used to solve trigonometric problems?
- How is a unit circle important in trigonometry?

<table>
<thead>
<tr>
<th>Standard</th>
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<th>Technology Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Define trigonometric ratios and solve problems involving right triangles</td>
<td>- I can use the trigonometric ratios to solve right triangle applied problems. ★ (REVIEW)</td>
<td>- Evaluate all six trigonometric functions of angles in degree measure using the calculator in degree mode.</td>
</tr>
<tr>
<td>G-SRT.C.8</td>
<td>Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems. ★</td>
<td>- Use a calculator (in degree mode) to find sin⁻¹, cos⁻¹, and tan⁻¹.</td>
</tr>
<tr>
<td>C. Analyze functions using different representations</td>
<td>- I can graph trigonometric functions and identify key features of each graph.</td>
<td>- Use the inverse functions on a graphing calculator to find an angle if I am given two sides of a right triangle.</td>
</tr>
<tr>
<td>F-IF.C.7e</td>
<td>I can compare the properties of trigonometric functions represented in different ways.</td>
<td>- Evaluate all six trigonometric functions of angles in radian measure using the calculator in radian mode.</td>
</tr>
<tr>
<td>F-IF.C.9</td>
<td>I can convert degree to radian measures and radian to degree measures.</td>
<td>- Use a calculator (in radian mode) to find sin⁻¹, cos⁻¹, and tan⁻¹.</td>
</tr>
<tr>
<td>F-IF.C.7e</td>
<td>I understand how a radian measure is derived</td>
<td>- Graph sine, cosine and tangent functions.</td>
</tr>
<tr>
<td></td>
<td>I can create a unit circle with all trigonometric functions.</td>
<td></td>
</tr>
<tr>
<td>A. Extend the domain of trigonometric functions using the unit circle</td>
<td>I can explain how trigonometric graphs are transformed.</td>
<td></td>
</tr>
<tr>
<td>F-TF.A.1</td>
<td>I can prove and apply the Pythagorean identity ( \sin^2(θ) + \cos^2(θ) = 1 ).</td>
<td></td>
</tr>
<tr>
<td>F-TF.A.2</td>
<td>I can model periodic phenomena with specified amplitude, frequency and midline using the appropriate trigonometric function.</td>
<td></td>
</tr>
<tr>
<td>F-TF.B.5</td>
<td>Understand radian measure of an angle as the length of the arc on the unit circle subtended by the angle.</td>
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<tr>
<td></td>
<td>Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as angles traversed counterclockwise around the unit circle.</td>
<td></td>
</tr>
<tr>
<td>B. Model periodic phenomena with trigonometric functions</td>
<td>Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline.★</td>
<td></td>
</tr>
</tbody>
</table>

### Key vocabulary
- Sine
- Cosine
- Tangent
- Cotangent
- Secant
- Cosecant
- Law of Sines
- Law of Cosines
### C. Prove and apply trigonometric identities

| F-TF.C.8 | Prove the Pythagorean identity \( \sin^2(\theta) + \cos^2(\theta) = 1 \) and use it to calculate trigonometric ratios. |

### B. Build new functions from existing functions

| F-BF.B.3 | Identify the effect on the graph by replacing \( f(x) \) with \( f(x) + k \), \( kf(x) \), \( f(kx) \), 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. | Pythagorean Theorem
Unit Circle
Pythagorean Identity
Amplitude
Frequency
Midline |
## Unit 8: Statistics

### Enduring Understandings:
Data can be represented using different types of graphs. The shape of a distribution can be described by its center, spread and used to compare it to other data distributions. Draw inferences of the population based on random samples of the population. The regression can be assessed using a plot and analysis of the residuals. A correlation coefficient can be calculated and used to interpret a linear regression. Categorical data is graphically represented in different ways than quantitative data.

### Essential Questions:
- What does a correlation coefficient tell us about a linear fit?
- How are the residuals used to assess the fit of a regression model?
- How do you estimate the area under a normal curve?
- How can two data distributions be compared using the center and spread?
- How can random samples be used to make inferences on the population?
- How do you determine the best graph to use to display the quantitative or categorical data?

### Standard

<table>
<thead>
<tr>
<th>A. Summarize, represent, and interpret data on a single count or measurement variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S-ID.A.4</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Summarize, represent, and interpret data on two categorical and quantitative variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>S-ID.B.6a</strong></td>
</tr>
</tbody>
</table>

### Learning Targets

- I can use the mean and standard deviation to construct a Normal Curve Distribution.
- I can calculate the population percentages from a Normal Curve using z-scores.
- I can create a scatterplot from two quantitative variables and interpret in context.
- I can use a scatterplot to determine the appropriate regression model.
- I can define and identify population, population parameter, sample, and sample statistics, along with their respective notations.
- I can use simulations to justify theoretical models.
- I can identify situations as sample survey, experiment, or observational study.

### Technology Standards

*Use a graphing calculator to:
- Use the stats function to turn the list of data into multiple displays and to calculate mean, median, quartile 1, quartile 3, standard deviation, variance and correlation coefficient.
- Calculate the area under the normal curve and z-score.
- Run a linear, quadratic, or exponential regression
- Plot the residual graph for analysis.
| S-IC.A.2 | Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. For example, a model says a spinning coin falls heads up with probability 0.5. Would a result of 5 tails in a row cause you to question the model? | • I can use sample proportions or sample means to estimate population parameters.  
• I can conduct a simulation of two treatments and use results to determine if the differences in the parameters are significant.  
• I can present a summary report based on data addressing the sampling techniques, inferences made, and any possible flaws. | Key Vocabulary  
Median, Mean, interquartile range, standard deviation, normal distribution, categorical data, population, two-way frequency table, joint relative frequency marginal, marginal relative frequency conditional relative frequency residual, correlation coefficient association, outlier, variance qualitative data, z-score |
<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Make inferences and justify conclusions from sample surveys, experiments, and observational studies</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>S-IC.B.3</td>
<td>Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S-IC.B.4</td>
<td>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.</td>
<td></td>
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</tr>
<tr>
<td>S-IC.B.5</td>
<td>Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.</td>
<td></td>
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</tr>
<tr>
<td>S-IC.B.6</td>
<td>Evaluate reports based on data.</td>
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</tr>
</tbody>
</table>
## Enduring Understandings:
Decisions can be made based on the theoretical probability of an event occurring. A probability distribution can be found for a random variable and used to calculate theoretical probabilities.

## Essential Questions:
How is a probability distribution created for a random variable?

<table>
<thead>
<tr>
<th>Standard</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Understand independence and conditional probability and use them to interpret data</strong></td>
<td><strong>I can describe events as subsets of a sample space (the set of outcomes) using following: A union (or) of subsets. An intersection (and) of subsets. Complement (not) of a subset.</strong>&lt;br&gt;**I can understand that ( P(A</td>
</tr>
<tr>
<td><strong>S-CP.A.1</strong></td>
<td><strong>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”).</strong></td>
</tr>
<tr>
<td><strong>S-CP.A.2</strong></td>
<td><strong>Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent.</strong></td>
</tr>
<tr>
<td><strong>S-CP.A.3</strong></td>
<td><strong>Understand the conditional probability of A given B as ( \frac{P(A \cap B)}{P(B)} ), and interpret independence of A and B as saying that the conditional probability of A given B is the same as the probability of A, and the conditional probability of B given A is the same as the probability of B.</strong></td>
</tr>
<tr>
<td><strong>S-CP.A.4</strong></td>
<td><strong>Construct and interpret two-way frequency tables of data when two categories are associated with each object being classified. Use the two-way table as a sample space to decide if events are independent and to approximate conditional probabilities. For example, collect data from a random sample of students in your school on their favorite subject among math, science, and English. Estimate the probability that a randomly selected student from your school will favor science given that the student is in tenth grade. Do the same for other subjects and compare the results.</strong></td>
</tr>
</tbody>
</table>

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**Key Vocabulary**
- sample space
- probability distribution
- random variable
- theoretical probability
- outcome
- mean
- standard deviation
- event
- payoff or payout

---

*Use a graphing calculator to calculate probability, expected value and expected payoff.*
### A. Understand independence and conditional probability and use them to interpret data

| S-CP.A.5 | Recognize and explain the concepts of conditional probability and independence in everyday language and everyday situations. For example, compare the chance of having lung cancer if you are a smoker with the chance of being a smoker if you have lung cancer. |

### B. Use the rules of probability to compute probabilities of compound events in a uniform probability model

| S-CP.B.6 | Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model. |
| S-CP.B.7 | Apply the Addition Rule, \( P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B) \), and interpret the answer in terms of the model. |
Assessment Limits for Standards Assessed on More Than One End-of-Course Test: Al-G-All Pathway

<table>
<thead>
<tr>
<th>CCSSM Cluster</th>
<th>CCSSM Key</th>
<th>CCSSM Standard</th>
<th>Algebra I Assessment Limits and Clarifications</th>
<th>Algebra II Assessment Limits and Clarifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reason quantitatively and use units to solve problems</td>
<td>N-Q.A.2</td>
<td>Define appropriate quantities for the purpose of descriptive modeling.</td>
<td>This standard will be assessed in Algebra I by ensuring that some modeling tasks (involving Algebra I content or securely held content from grades 6-8) require the student to create a quantity of interest in the situation being described (i.e., a quantity of interest is not selected for the student by the task). For example, in a situation involving data, the student might autonomously decide that a measure of center is a key variable in a situation, and then choose to work with the mean.</td>
<td>This standard will be assessed in Algebra II by ensuring that some modeling tasks (involving Algebra II content or securely held content from previous grades and courses) require the student to create a quantity of interest in the situation being described (i.e., this is not provided in the task). For example, in a situation involving periodic phenomena, the student might autonomously decide that amplitude is a key variable in a situation, and then choose to work with peak amplitude.</td>
</tr>
</tbody>
</table>
| Interpret the structure of expressions             | A-SSE.A.2 | Use the structure of an expression to identify ways to rewrite it. For example, see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$. | i) Tasks are limited to numerical expressions and Polynomial expressions in one variable.  
ii) Examples: Recognize $53^2 - 47^2$ as a difference of squares and see an opportunity to rewrite it in the easier-to-evaluate form $(53+47)(53-47)$. See an opportunity to rewrite $a^2 + 9a + 14$ as $(a+7)(a+2)$. | i) Tasks are limited to polynomial, rational, or exponential expressions.  
ii) Examples: see $x^4 - y^4$ as $(x^2)^2 - (y^2)^2$, thus recognizing it as a difference of squares that can be factored as $(x^2 - y^2)(x^2 + y^2)$. In the equation $x^2 + 2x + 1 + y^2 = 9$, see an opportunity to rewrite the first three terms as $(x+1)^2$, thus recognizing the equation of a circle with radius 3 and center (-1, 0). See $(x^2 + 4)/(x^2 + 3)$ as $(x^2+3) + 1/(x^2+3)$, thus recognizing an opportunity to write it as $1 + 1/(x^2 + 3)$. |
<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Write expressions in equivalent forms to solve problems</td>
<td>A-SSE.B.3c</td>
<td>Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. (c) Use the properties of exponents to transform expressions for exponential functions. For example the expression $1.15^t$ can be rewritten as $(1.15^{1/12})^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.</td>
<td>i) Tasks have a real-world context. As described in the standard, there is an interplay between the mathematical structure of the expression and the structure of the situation such that choosing and producing an equivalent form of the expression reveals something about the situation. ii) Tasks are limited to exponential expressions with integer exponents.</td>
<td>i) Tasks have a real-world context. As described in the standard, there is an interplay between the mathematical structure of the expression and the structure of the situation such that choosing and producing an equivalent form of the expression reveals something about the situation. ii) Tasks are limited to exponential expressions with rational or real exponents.</td>
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<td>Understand the relationship between zeros and factors of polynomials</td>
<td>A-APR.B.3</td>
<td>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.</td>
<td>i) Tasks are limited to quadratic and cubic polynomials in which linear and quadratic factors are available. For example, find the zeros of $(x - 2)(x^2 - 9)$.</td>
<td>i) Tasks include quadratic, cubic, and quartic polynomials and polynomials for which factors are not provided. For example, find the zeros of $(x^2 - 1)(x^2 + 1)$</td>
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<tr>
<td>Create equations that describe numbers or relationships</td>
<td>A-CED.A.1</td>
<td>Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.</td>
<td>i) Tasks are limited to linear, quadratic, or exponential equations with integer exponents.</td>
<td>i) Tasks are limited to exponential equations with rational or real exponents and rational functions. II) Tasks have a real-world context.</td>
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<td>Understand solving equations as a process of reasoning and explain the reasoning</td>
<td>A-REI.A.1</td>
<td>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.</td>
<td>i) Tasks are limited to quadratic equations.</td>
<td>i) Tasks are limited to simple rational or radical equations.</td>
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<td>Solve equations and inequalities in one variable</td>
<td>A-REI.B.4b</td>
<td>Solve quadratic equations in one variable.</td>
<td>i) Tasks do not require students to write solutions for quadratic equations that have roots with nonzero imaginary parts. However, tasks can require the student to recognize cases in which a quadratic equation has no real solutions. Note, solving a quadratic equation by factoring relies on the connection between zeros and factors of polynomials (cluster A-APR.B). Cluster A-APR.B is formally assessed in A2.</td>
<td>i) In the case of equations that have roots with nonzero imaginary parts, students write the solutions as $a \pm bi$ for real numbers $a$ and $b$.</td>
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<td>Solve systems of equations</td>
<td>A-REI.C.6</td>
<td>Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</td>
<td>i) Tasks have a real-world context.</td>
<td>i) Tasks are limited to 3x3 systems.</td>
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| Represent and solve equations and inequalities graphically | A-REI.D.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. | i) Tasks that assess conceptual understanding of the indicated concept may involve any of the function types mentioned in the standard except exponential and logarithmic functions.  
ii) Finding the solutions approximately is limited to cases where $f(x)$ and $g(x)$ are polynomial functions. | i) Tasks may involve any of the function types mentioned in the standard. |
<p>| Understand the concept of a function and use function notation | F-IF.A.3 | Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. For example, the Fibonacci sequence is defined recursively by $f(0) = f(1) = 1$, $f(n-1) = f(n) - f(n-1)$ for $n \geq 1$. | i) This standard is part of the Major work in Algebra I and will be assessed accordingly. | i) This standard is Supporting work in Algebra II. This standard should support the Major work in F-BF.A.2 for coherence. |</p>
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<td>Interpret functions that arise in applications in terms of a context</td>
<td>F-IF.B.4</td>
<td>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. <em>Key features include:</em> intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.</td>
<td>i) Tasks have a real-world context. ii) Tasks are limited to linear functions, quadratic functions, square root functions, cube root functions, piecewise-defined functions (including step functions and absolute value functions), and exponential functions with domains in the integers.</td>
<td>i) Tasks have a real-world context. ii) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions. <em>Compare note (ii) with standard F-IF.C.7.</em> The function types listed here are the same as those listed in the Algebra II column for standards F-IF.B.6 and F-IF.C.9.</td>
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<tr>
<td>Interpret functions that arise in applications in terms of a context</td>
<td>F-IF.B.6</td>
<td>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. *</td>
<td>i) Taskshave a real-world context. ii) Tasks are limited to linear functions, quadratic functions, square root functions, cube root functions, piecewise-defined functions (including step functions and absolute value functions), and exponential functions with domains in the integers. The function types listed here are the same as those listed in the Algebra I column for standards F-IF.B.4 and F-IF.C.9.</td>
<td>i) Tasks have a real-world context. ii) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions. The function types listed here are the same as those listed in the Algebra II column for standards F-IF.B.4 and F-IF.C.9.</td>
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<td>Analyze functions using different representations</td>
<td>F-IF.C.9</td>
<td>Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions.) For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.</td>
<td>i) Tasks are limited to linear functions, quadratic functions, square root functions, cube root functions, piecewise-defined functions (including step functions and absolute value functions), and exponential functions with domains in the integers. The function types listed here are the same as those listed in the Algebra I column for standards F-IF.B.4 and F-IF.B.6.</td>
<td>i) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions.</td>
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<td>Build a function that models a relationship between two quantities</td>
<td>F-BF.A.1a</td>
<td>Write a function that describes a relationship between two quantities. a) Determine an explicit expression, a recursive process, or steps for calculation from a context.</td>
<td>i) Tasks have a real-world context. ii) Tasks are limited to linear context. quadratic functions, exponential functions, and functions with domains in the integers.</td>
<td>i) Tasks have a real-world context. ii) Tasks may involve linear functions, quadratic functions, and exponential functions.</td>
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<td>Build new functions from existing functions</td>
<td>F-BF.B.3</td>
<td>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.</td>
<td>i) Identifying 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) is limited to linear and quadratic functions. ii) Experimenting with cases and illustrating an explanation of the effects on the graph using technology is limited to linear functions, quadratic functions, square root functions, cube root functions, piecewise-defined functions (including step functions and absolute value functions), and exponential functions.</td>
<td>i) Tasks may involve polynomial, exponential, logarithmic, and trigonometric functions. ii) Tasks may involve recognizing even and odd functions. The function types listed in note (i) are the same as those listed in the Algebra II column for standards F-IF.B.4, F-IF.B.6, and F-IF.C.9.</td>
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<td><strong>Construct and compare linear, quadratic, and exponential models and solve problems</strong></td>
<td>F-LE.A.2</td>
<td>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).</td>
<td>i) Tasks are limited to constructing linear and exponential functions in simple context (not multi-step).</td>
<td>i) Tasks will include solving multi-step problems by constructing linear and exponential functions.</td>
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<td><strong>Interpret expressions for functions in terms of the situation they model</strong></td>
<td>F-LE.B.5</td>
<td>Interpret the parameters in a linear or exponential function in terms of a context.</td>
<td>i) Tasks have a real-world context. ii) Exponential functions are limited to those with domains in the integers.</td>
<td>i) Tasks have a real-world context. ii) Tasks are limited to exponential functions with domains not in the integers.</td>
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<td>Summarize, represent, and interpret data on two categorical and quantitative variables</td>
<td>S-ID.B.6a</td>
<td>Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. 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.</td>
<td>i) Tasks have a real-world context. ii) Exponential functions are limited to those with domains in the integers.</td>
<td>i) Tasks have a real-world context. ii) Tasks are limited to exponential functions with domains not in the integers and trigonometric functions.</td>
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