Core Content Connectors

Algebra 1

ARIZONA DEPARTMENT OF EDUCATION
HIGH ACADEMIC STANDARDS FOR STUDENTS
December, 2016

Algebra 1 Overview

NUMBER AND QUANTITY - N

The Real Number System (N-RN)

- Use properties of rational and irrational numbers.

Quantities (N-Q)

- Reason quantitatively and use units to solve problems.

ALGEBRA - A

Seeing Structure in Expressions (A-SSE)

- Interpret the structure of expressions.
- Write expressions in equivalent forms to solve problems.

Arithmetic with Polynomials and Rational Expressions (A-APR)

- Perform arithmetic operations on polynomials.
- Understand the relationship between zeros and factors of polynomials.

Creating Equations (A-CED)

- Create equations that describe numbers or relationships.

Reasoning with Equations and Inequalities (A-REI)

- Understand solving equations as a process of reasoning and explain the reasoning.
- Solve equations and inequalities in one variable.
- Solve systems of equations.
- Represent and solve equations and inequalities graphically.

FUNCTIONS - F

Interpreting Functions (F-IF)

- Understand the concept of a function and use function notation.
- Interpret functions that arise in applications in terms of context.
- Analyze functions using different representations.

Building Functions (F-BF)

- Build a function that models a relationship between two quantities.
- Build new functions from existing functions.

Linear, Quadratic, and Exponential Models (F-LE)

- Construct and compare linear, quadratic, and exponential models and solve problems.
- Interpret expressions for functions in terms of the situation they model.

STATISTICS AND PROBABILITY - S

Interpreting Categorical and Quantitative Data (S-ID)

- Summarize, represent, and interpret data on a single count or measurement variable.
- Summarize, represent, and interpret data on two categorical and quantitative variables.
- Interpret linear models.

Conditional Probability and the Rules of Probability (S-CP)

- Understand independence and conditional probability and use them to interpret data.

Standards for Mathematical Practices (MP)

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Algebra 1: Critical Areas

For the high school Algebra I course, instructional time should focus on three critical areas:

1. Deepen and extend understanding of linear and exponential relationships.
2. Engage in methods for analyzing, solving, and using quadratic functions.
3. Apply linear models to data that exhibit a linear trend.

(1) In earlier grades, students have learned to solve linear equations in one variable and have applied graphical and algebraic methods to analyze and solve systems of linear equations in two variables. In Algebra I, students analyze and explain the process of solving an equation and justify the process used in solving a system of equations. Students develop fluency writing, interpreting, and translating among various forms of linear equations and inequalities, and use them to solve problems. They can solve linear equations and apply related techniques along with the laws of exponents to solve simple exponential equations. Students expand their experience with functions to include more specialized functions – absolute value, and those that are piecewise – defined.

(2) In Algebra I, students learn function notation and develop the concepts of domain and range. They focus on linear, quadratic, and exponential functions, including sequences, and also explore absolute value, and piecewise-defined functions; they interpret functions given graphically, numerically, symbolically, and verbally; translate between representations; and understand the limitations of various representations. Students build on and extend their understanding of integer exponents to consider exponential functions. Students compare the key characteristics of quadratic functions to those of linear and exponential functions. Students can identify the real solutions of those functions.

(3) Building upon their prior experiences with data, students explore a more formal means of assessing how a model fits data. Students use regression techniques to describe approximately linear relationships between quantities. They use graphical representations and knowledge of context to make judgments about the appropriateness of linear models. With linear models, they look at residuals to analyze the goodness of fit.

The Standards for Mathematical Practice complement the content standards so that students increasingly engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle, and high school years. Mathematical modeling is integrated throughout Algebra 1 by utilizing real world context.

Arizona Mathematics Standards Algebra 1

Number and Quantity - N		
The Real Number System (N-RN)		
A1.N-RN.B **Use properties of rational and irrational numbers.**	**A1.N-RN.B.3**	Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational. **HS.NO.2b1 Explain the pattern for the sum or product for combinations of rational and irrational numbers.**
Quantities (N-Q)		
A1.N-Q.A **Reason quantitatively and use units to solve problems.**	**A1.N-Q.A.1**	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays, include utilizing real-world context. **H.ME.1a1 Determine the necessary unit(s) to use to solve real world problems.** **H.ME.1a2 Solve real world problems involving units of measurement.**
	A1.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context. **No CCC developed for this standard.**
	A1.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context. **H.ME.2a1 Describe the accuracy of measurement when reporting quantity (you can lessen your limitations by measuring precisely)**
Algebra - A		
Seeing Structure in Expressions (A-SSE)		
A1.A-SSE.A **Interpret the structure of expressions.**	**A1.A-SSE.A.1**	Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret expressions by viewing one or more of their parts as a single entity. **H.PRF.2a1 Translate an algebraic expression into a word problem.**
	A1.A-SSE.A.2	Use structure to identify ways to rewrite numerical and polynomial expressions. Focus on polynomial multiplication and factoring patterns. **H.NO.2c1 Simplify expressions that include exponents.** **H.NO.2c2 Rewrite expressions that include rational exponents.**

A1.A-SSE.B **Write expressions in equivalent forms to solve problems.**	**A1.A-SSE.B.3**	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. **H.NO.3a2 Rewrite mathematical statements (e.g., an expression) in multiple forms.**

Arizona Mathematics Standards Algebra 1

Arithmetic with Polynomials and Rational Expressions (A-APR)		
A1.A-APR.A **Perform arithmetic operations on polynomials.**	**A1.A-APR.A.1**	Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials. **No CCC developed for this standard.**
A1.A-APR.B **Understand the relationship between zeros and factors of polynomials.**	**A1.A-APR.B.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. Focus on quadratic and cubic polynomials in which linear and quadratic factors are available. **No CCC developed for this standard.**
Creating Equations (A-CED)		
A1.A-CED.A **Create equations that describe numbers or relationships.**	**A1.A-CED.A.1**	Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **H.PRF.2b1 Translate a real-world problem into a one variable linear equation.**
	A1.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. **H.PRF.2b2 Solve equations with one or two variables using equations or graphs**
	A1.A-CED.A.3	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. **No CCC developed for this standard.**
	A1.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* **No CCC developed for this standard.**
Reasoning with Equations and Inequalities (A-REI)		
A1.A-REI.A **Understand solving equations as a process of reasoning and explain the reasoning.**	**A1.A-REI.A.1**	Explain each step in solving linear and quadratic equations 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. **H.PRF.2b2 Solve equations with one or two variables using equations or graphs**
A1.REI.B **Solve equations and inequalities in one variable.**	**A1.A-REI.B.3**	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. **H.PRF.2b2 Solve equations with one or two variables using equations or graphs** **H.ME.1b2 Solve a linear equation to find a missing attribute given the area, surface area, or volume and the other attribute.**

	A1.A-REI.B.4	Solve quadratic equations in one variable. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - k)^2 = q$ that has the same solutions. Derive the quadratic formula from this form. b. Solve quadratic equations by inspection (e.g., $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Focus on solutions for quadratic equations that have real roots. Include cases that recognize when a quadratic equation has no real solutions. **No CCC developed for this standard.**

A1.A-REI.C **Solve systems of equations.**	**A1.A-REI.C.5**	Prove 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. **No CCC developed for this standard.**
	A1.A-REI.C.6	Solve systems of linear equations exactly and approximately, focusing on pairs of linear equations in two variables. Include problem solving opportunities utilizing real-world context. **No CCC developed for this standard.**
A1.A-REI.D **Represent and solve equations and inequalities graphically.**	**A1.A-REI.D.10**	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve, which could be a line. **No CCC developed for this standard.**
	A1.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). Focus on cases where $f(x)$ and/or $g(x)$ are linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**
	A1.A-REI.D.12	Graph the solutions to a linear inequality in two variables as a half-plane, excluding the boundary in the case of a strict inequality, and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. **No CCC developed for this standard.**
Functions - F		
Interpreting Functions (F-IF)		
A1.F-IF.A **Understand the concept of a function and use function notation.**	**A1.F-IF.A.1**	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$. **No CCC developed for this standard.**
	A1.F-IF.A.2	Evaluate a function for inputs in the domain, and interpret statements that use function notation in terms of a context. **No CCC developed for this standard.**
	A1.F-IF.A.3	Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. **No CCC developed for this standard.**

A1.F-IF.B **Interpret functions that arise in applications in terms of the context**	**A1.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. Include problem-solving opportunities utilizing real-world context. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**
	A1.F-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. *No CCC developed for this standard.*
A1.F-IF.B (cont.)	**A1.F-IF.B.6**	Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Estimate the rate of change from a graph. Include problem-solving opportunities utilizing real-world context. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**
A1.F-IF.C **Analyze functions using different representations.**	**A1.F-IF.C.7**	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**
	A1.F-IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square of a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. **No CCC developed for this standard.**
	A1.F-IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**
Building Functions (F-BF)		
A1.F-BF.A **Build a function that models a relationship between two quantities.**	**A1.F-BF.A.1**	Write a function that describes a relationship between two quantities. Determine an explicit expression, a recursive process, or steps for calculation from real-world context. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**

A1.F-BF.B **Build new functions from existing functions.**	**A1.F-BF.B.3**	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, and $f(x+k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph. Focus on linear, quadratic, exponential and piecewise-defined functions (limited to absolute value and step). **No CCC developed for this standard.**
Linear, Quadratic, and Exponential Models (F-LE)		
A1.F-LE.A **Construct and compare linear, quadratic, and exponential models and solve problems.**	**A1.F-LE.A.1**	Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. **H.PRF.1c1 Select the appropriate graphical representation of a linear model based on real world events.** **H.PRF.1b1 In a linear situation using graphs or numbers, predicts the change in rate based on a given change in one variable (e.g., If I have been adding sugar at a rate of 1T per cup of water, what happens to my rate if I switch to 2T of sugar for every cup of water?).**
A1.F-LE.A (cont.)	**A1.F-LE.A.2**	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or input/output pairs. **No CCC developed for this standard.**
	A1.F-LE.A.3	Observe, using graphs and tables, that a quantity increasing exponentially eventually exceeds a quantity increasing linearly or quadratically. **No CCC developed for this standard.**
A1.F-LE.B **Interpret expressions for functions in terms of the situation they model.**	**A1.F-LE.B.5**	Interpret the parameters in a linear or exponential function with integer exponents utilizing real world context. **No CCC developed for this standard.**
Statistics and Probability - S		
Summarize, represent, and interpret data on a single count or measurement variable. (S-ID)		
A1.S-ID.A **Summarize, represent, and interpret data on a single**	**A1.S-ID.A.1**	Represent real-value data with plots for the purpose of comparing two or more data sets. **H.DPS.1b1 Complete a graph given the data, using dot plots, histograms, or box plots.**
	A1.S-ID.A.2	Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread

count or measurement variable.		(interquartile range, standard deviation) of two or more different data sets. **H.DPS.1c2 Compare means, median, and range of 2 sets of data.**
	A1.S-ID.A.3	Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of outliers if present. **No CCC developed for this standard.**
A1.S-ID.B **Summarize, represent, and interpret data on two categorical and quantitative variables.**	**A1.S-ID.B.5**	Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data, including joint, marginal, and conditional relative frequencies. Recognize possible associations and trends in the data. **H.DPS.1a1 Design study using categorical and continuous data, including creating a question, identifying a sample, and making a plan for data collection.** **H.DPS.1c1 Use descriptive statistics: range, median, mode, mean, outliers/gaps to describe the data set.**
	A1.S-ID.B.6	Represent data on two quantitative variables on a scatter plot, and describe how the quantities are related. a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Focus on linear models. b. Informally assess the fit of a function by plotting and analyzing residuals. **H.DPS.1a1 Design study using categorical and continuous data, including creating a question, identifying a sample, and making a plan for data collection.** **H.DPS.1c1 Use descriptive statistics: range, median, mode, mean, outliers/gaps to describe the data set.**
A1.S-ID.C **Interpret linear models.**	**A1.S-ID.C.7**	Interpret the slope as a rate of change and the constant term of a linear model in the context of the data. **H.PRF.1a1 Interpret the rate of change using graphical representations**.
	A1.S-ID.C.8	Compute and interpret the correlation coefficient of a linear relationship. **No CCC developed for this standard.**
	A1.S-ID.C.9	Distinguish between correlation and causation. **No CCC developed for this standard.**

Arizona Mathematics Standards Algebra 1

Conditional Probability and the rules of Probability (S-CP)		
A1.S-CP.A **Understand independence and conditional probability and use them to interpret data.**	**A1.S-CP.A.1**	Describe events as subsets of a sample space using characteristics of the outcomes, or as unions, intersections, or complements of other events. **No CCC developed for this standard.**
	A1.S-CP.A.2	Use the Multiplication Rule for independent events to 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. **No CCC developed for this standard.**

Standards for Mathematical Practice *No CCCs developed for Mathematical Practices*	
A1.MP.1	**Make sense of problems and persevere in solving them.** Mathematically proficient students explain to themselves the meaning of a problem, look for entry points to begin work on the problem, and plan and choose a solution pathway. While engaging in productive struggle to solve a problem, they continually ask themselves, "Does this make sense?" to monitor and evaluate their progress and change course if necessary. Once they have a solution, they look back at the problem to determine if the solution is reasonable and accurate. Mathematically proficient students check their solutions to problems using different methods, approaches, or representations. They also compare and understand different representations of problems and different solution pathways, both their own and those of others.
A1.MP.2	**Reason abstractly and quantitatively.** Mathematically proficient students make sense of quantities and their relationships in problem situations. Students can contextualize and decontextualize problems involving quantitative relationships. They contextualize quantities, operations, and expressions by describing a corresponding situation. They decontextualize a situation by representing it symbolically. As they manipulate the symbols, they can pause as needed to access the meaning of the numbers, the units, and the operations that the symbols represent. Mathematically proficient students know and flexibly use different properties of operations, numbers, and geometric objects and when appropriate they interpret their solution in terms of the context.
A1.MP.3	**Construct viable arguments and critique the reasoning of others.** Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents. Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.
A1.MP.4	**Model with mathematics.** Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. When given a problem in a contextual situation, they identify the mathematical elements of a situation and create a mathematical model that represents those mathematical elements and the relationships among them. Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

A1.MP.5	**Use appropriate tools strategically.** Mathematically proficient students consider available tools when solving a mathematical problem. They choose tools that are relevant and useful to the problem at hand. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful; recognizing both the insight to be gained and their limitations. Students deepen their understanding of mathematical concepts when using tools to visualize, explore, compare, communicate, make and test predictions, and understand the thinking of others.
A1.MP.6	**Attend to precision.** Mathematically proficient students clearly communicate to others using appropriate mathematical terminology, and craft explanations that convey their reasoning. When making mathematical arguments about a solution, strategy, or conjecture, they describe mathematical relationships and connect their words clearly to their representations. Mathematically proficient students understand meanings of symbols used in mathematics, calculate accurately and efficiently, label quantities appropriately, and record their work clearly and concisely.
A1.MP.7	**Look for and make use of structure.** Mathematically proficient students use structure and patterns to assist in making connections among mathematical ideas or concepts when making sense of mathematics. Students recognize and apply general mathematical rules to complex situations. They are able to compose and decompose mathematical ideas and notations into familiar relationships. Mathematically proficient students manage their own progress, stepping back for an overview and shifting perspective when needed.
A1.MP.8	**Look for and express regularity in repeated reasoning.** Mathematically proficient students look for and describe regularities as they solve multiple related problems. They formulate conjectures about what they notice and communicate observations with precision. While solving problems, students maintain oversight of the process and continually evaluate the reasonableness of their results. This informs and strengthens their understanding of the structure of mathematics which leads to fluency.

Core Content Connectors

Geometry

ARIZONA DEPARTMENT OF EDUCATION
HIGH ACADEMIC STANDARDS FOR STUDENTS
December, 2016

Geometry Overview

NUMBER AND QUANTITY - N

Quantity (N-Q)

- Reason quantitatively and use units to solve problems.

GEOMETRY - G

Congruence (G-CO)

- Experiment with transformations in the plane.
- Understand congruence in terms of rigid motions.
- Prove geometric theorems.
- Make geometric constructions.

Similarity, Right Triangles, and Trigonometry (G-SRT)

- Understand similarity in terms of similarity transformations.
- Prove theorems involving similarity.
- Define trigonometric ratios and solve problems involving right triangles.

Circles (G-C)

- Understand and apply theorems about circles.
- Find arc lengths and areas of sectors of circles.

Expressing Geometric Properties with Equations (G-GPE)

- Translate between the geometric description and the equation for a conic section.
- Use coordinates to prove geometric theorems algebraically.

Geometric Measurement and Dimension (G-GMD)

- Explain volume formulas and use them to solve problems.
- Visualize relationships between two-dimensional and three-dimensional objects.

Modeling with Geometry (G-MG)

- Apply geometric concepts in modeling situations.

Standards for Mathematical Practices (MP)

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Geometry: Critical Areas

For the high school Geometry course, instructional time should focus on five critical areas:

1. Establishing criteria for congruence of geometric figures based on rigid motions.
2. Establishing criteria for similarity of geometric figures based on dilations and proportional reasoning.
3. Develop understanding of informal explanations of circumference, area, and volume formulas.
4. Proving geometric theorems.
5. Solve problems involving right triangles.

(1) Students have prior experience with drawing triangles based on given measurements and performing rigid motions including translations, reflections, and rotations. They have used these to develop notions about what it means for two objects to be congruent. Students establish triangle congruence criteria, based on analyses of rigid motions and formal constructions. They use triangle congruence as a familiar foundation for the development of formal proof. They apply reasoning to complete geometric constructions throughout the course and explain why these constructions work.

(2) Students apply their earlier experience with dilations and proportional reasoning to build a formal understanding of similarity. They identify criteria for similarity of geometric figures, use similarity to solve problems (including utilizing real-world contexts), and apply similarity in right triangles to understand right triangle trigonometry. When studying properties of circles, students develop relationships among segments on chords, secants, and tangents as an application of similarity.

(3) Students' experience with three-dimensional objects is extended to developing informal explanations of circumference, area, and volume formulas. Radians are introduced for the first time as a unit of measure – which prepares students for work done with the Unit Circle in the Algebra II course. Students have opportunities to apply their understanding of volume formulas to real-world modeling contexts. Additionally, students apply their knowledge of two-dimensional shapes to consider the shapes of cross-sections and the result of rotating a two-dimensional object about a line.

(4) Students prove theorems—using a variety of formats including deductive and inductive reasoning and proof by contradiction—and solve problems about triangles, quadrilaterals, circles, and other polygons. Relating back to work in previous courses, students apply the Pythagorean Theorem in the Cartesian coordinate system to prove geometric relationships and slopes of parallel and perpendicular lines. Continuing in the Cartesian coordinate system, students graph circles by manipulating their algebraic equations and apply techniques for solving quadratic equations – all of which relates back to work done in the Algebra I course.

(5) Students define the trigonometric ratios of sine, cosine, and tangent for acute angles using the foundation of right triangle similarity. Students use these trigonometric ratios with the Pythagorean Theorem to find missing measurements in right triangles and solve problems in real-world contexts – which prepares students for work done with trigonometric functions in the Algebra II course.

The Standards for Mathematical Practice complement the content standards so that students increasingly engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle, and high school years. Mathematical modeling is integrated throughout Geometry by utilizing real world context.

Arizona Mathematics Standards Geometry

Number and Quantity - N		
Quantities (N-Q)		
Quantities (N-Q) **Reason quantitatively and use units to solve problems.**	**G.N-Q.A.1**	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays, include utilizing real-world context. **H.ME.1a1 Determine the necessary unit(s) to use to solve real world problems.** **H.ME.1a2 Solve real world problems involving units of measurement.**
	G.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context. **No CCC developed for this standard.**
	G.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context. **H.ME.2a1 Describe the accuracy of measurement when reporting quantity (you can lessen your limitations by measuring precisely)**
Geometry - G		
Congruence (G-CO)		
G.G-CO.A **Experiment with transformations in the plane.**	**G.G-CO.A.1**	Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc. **No CCC developed for this standard.**
	G.G-CO.A.2	Represent and describe transformations in the plane 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. **No CCC developed for this standard.**
	G.G-CO.A.3	Given a rectangle, parallelogram, trapezoid, or regular polygon, describe the rotations and reflections that carry it onto itself. **H.GM.1c1 Construct, draw or recognize a figure after its rotation, reflection, or translation.**
	G.G-CO.A.4	Develop definitions of rotations, reflections, and translations in terms of angles, circles, perpendicular lines, parallel lines, and line segments. **No CCC developed for this standard.**
	G.G-CO.A.5	Given a geometric figure and a rotation, reflection, or translation draw the transformed figure. Specify a sequence of transformations that will carry a given figure onto another. **H.GM.1c1 Construct, draw or recognize a figure after its rotation, reflection, or translation.**

G.G-CO.B **Understand congruence in terms of rigid motions.**	**G.G-CO.B.6**	Use geometric definitions 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. **No CCC developed for this standard.**
	G.G-CO.B.7	Use the definition of congruence in terms of rigid motions to show that two triangles are congruent if and only if corresponding pairs of sides and corresponding pairs of angles are congruent. **H.GM.1b1 Use definitions to demonstrate congruency and similarity in figures.**
	G.G-CO.B.8	Explain how the criteria for triangle congruence (ASA, AAS, SAS, and SSS) follow from the definition of congruence in terms of rigid motions. **No CCC developed for this standard.**

G.G-CO.C **Prove geometric theorems.**	**G.G-CO.C.9**	Prove theorems about lines and angles. Theorems include: vertical angles are congruent; when a transversal crosses parallel lines, alternate interior angles are congruent and corresponding angles are congruent; points on a perpendicular bisector of a line segment are exactly those equidistant from the segment's endpoints. **No CCC developed for this standard.**
	G.G-CO.C.10	Prove theorems about triangles. Theorems include: measures of interior angles of a triangle sum to 180°; base angles of isosceles triangle are congruent; the segment joining midpoints of two sides of a triangle is parallel to the third side and half the length; the medians of a triangle meet at a point. **No CCC developed for this standard.**
	G.G-CO.C.11	Prove theorems about parallelograms. Theorems include: opposite sides are congruent, opposite angles are congruent, the diagonals of a parallelogram bisect each other, and rectangles are parallelograms with congruent diagonals. **No CCC developed for this standard.**
G.G-CO.D **Make geometric constructions.**	**G.G-CO.D.12**	Make formal geometric constructions with a variety of tools and methods. Constructions include: copying segments; copying angles; bisecting segments; bisecting angles; constructing perpendicular lines, including the perpendicular bisector of a line segment; and constructing a line parallel to a given line through a point not on the line. **H.GM.1e1 Make formal geometric constructions with a variety of tools and methods.**
	G.G-CO.D.13	Construct an equilateral triangle, a square, and a regular hexagon inscribed in a circle; with a variety of tools and methods. **No CCC developed for this standard.**
Similarity, Right Triangles, and Trigonometry (G-SRT)		
G.G-SRT.A **Understand similarity in terms of similarity transformations.**	**G.G-SRT.A.1**	Verify experimentally the properties of dilations given by a center and a scale factor: a. Dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged. b. The dilation of a line segment is longer or shorter in the ratio given by the scale factor. **H.ME.2b1 Determine the dimensions of a figure after dilation**
	G.G-SRT.A.2	Given two figures, use the definition of similarity in terms of similarity transformations to decide if they are similar; explain using similarity transformations the meaning of similarity for triangles as the equality of all corresponding pairs of angles and the proportionality of all corresponding pairs of sides. **H.ME.2b2 Determine if two figures are similar.** **H.ME.2b3 Describe or select why two figures are or are not similar.** **H.GM.1b1 Use definitions to demonstrate congruency and similarity in figures.** **H.GM.1d1 Use the reflections, rotations, or translations in the coordinate plane to solve problems**

		with right angles.
	G.G-SRT.A.3	Use the properties of similarity transformations to establish the AA, SAS, and SSS criterion for two triangles to be similar. **No CCC developed for this standard.**
G.G-SRT.B **Prove theorems involving similarity.**	G.G-SRT.B.4	Prove theorems about triangles. Theorems include: an interior line parallel to one side of a triangle divides the other two proportionally, and conversely; the Pythagorean Theorem proved using triangle similarity. **No CCC developed for this standard.**
	G.G-SRT.B.5	Use congruence and similarity criteria to prove relationships in geometric figures and solve problems utilizing real-world context. **No CCC developed for this standard.**

G.G-SRT.C **Define trigonometric ratios and solve problems involving right triangles.**	**G.G-SRT.C.6**	Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles. **No CCC developed for this standard.**
	G.G-SRT.C.7	Explain and use the relationship between the sine and cosine of complementary angles. **No CCC developed for this standard.**
	G.G-SRT.C.8	Use trigonometric ratios (including inverse trigonometric ratios) and the Pythagorean Theorem to find unknown measurements in right triangles utilizing real-world context. **No CCC developed for this standard.**
Circles (G-C)		
G.G-C.A **Understand and apply theorems about circles.**	**G.G-C.A.1**	Prove that all circles are similar. **No CCC developed for this standard.**
	G.G-C.A.2	Identify and describe relationships among inscribed angles, radii, and chords. Include the relationship between central, inscribed, and circumscribed angles; inscribed angles on a diameter are right angles; the radius of a circle is perpendicular to the tangent where the radius intersects the circle. **No CCC developed for this standard.**
	G.G-C.A.3	Construct the inscribed and circumscribed circles of a triangle, and prove properties of angles for a quadrilateral inscribed in a circle. **No CCC developed for this standard.**
G.G-C.B **Find arc lengths and areas of sectors of circles.**	**G.G-C.B.5**	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. Convert between degrees and radians. **H.ME.2b4 Apply the formula to the area of a sector (e.g., area of a slice of pie).**
Expressing Geometric Properties with Equations (G-GPE)		
G.G-GPE.A **Translate between the geometric description and the equation for a conic section.**	**G.G-GPE.A.1**	Derive the equation of a circle of given center and radius using the Pythagorean Theorem; complete the square to find the center and radius of a circle given by an equation. **No CCC developed for this standard.**
G.G-GPE.B **Use coordinates to prove geometric theorems algebraically.**	**G.G-GPE.B.4**	Use coordinates to algebraically prove or disprove geometric relationships. Relationships include: proving or disproving geometric figures given specific points in the coordinate plane; and proving or disproving if a specific point lies on a given circle. **No CCC developed for this standard.**
	G.G-GPE.B.5	Prove the slope criteria for parallel and perpendicular lines and use them to solve geometric problems, including finding the equation of a line parallel or perpendicular to a given line that passes through a given

		point. **No CCC developed for this standard.**
	G.G-GPE.B.6	Find the point on a directed line segment between two given points that partitions the segment in a given ratio. **No CCC developed for this standard.**
	G.G-GPE.B.7	Use coordinates to compute perimeters of polygons and areas of triangles and rectangles. **No CCC developed for this standard.**

Arizona Mathematics Standards Geometry

Geometric Measurement and Dimension (G-GMD)		
G.G-GMD.A **Explain volume formulas and use them to solve problems.**	**G.G-GMD.A.1**	Analyze and verify the formulas for the volume of a cylinder, pyramid, and cone. **No CCC developed for this standard.**
	G.G-GMD.A.3	Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems utilizing real-world context. **No CCC developed for this standard.**
G.G-GMD.B **Visualize relationships between two-dimensional and three-dimensional objects.**	**G.G-GMD.B.4**	Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects. **No CCC developed for this standard.**
Modeling with Geometry (G-MG)		
G.G-MG-A **Apply geometric concepts in modeling situations.**	**G.G-MG.A.1**	Use geometric shapes, their measures, and their properties to describe objects utilizing real-world context. **H.ME.1b1 Describe the relationship between the attributes of a figure and the changes in the area or volume when 1 attribute is changed.**
	G.G-MG.A.2	Apply concepts of density based on area and volume in modeling situations utilizing real-world context. **No CCC developed for this standard.**
	G.G-MG.A.3	Apply geometric methods to solve design problems utilizing real-world context. **H.ME.2b5 Apply the formula of geometric figures to solve design problems (e.g., designing an object or structure to satisfy physical restraints or minimize cost).**

Standards for Mathematical Practice	
G.MP.1	**Make sense of problems and persevere in solving them.** Mathematically proficient students explain to themselves the meaning of a problem, look for entry points to begin work on the problem, and plan and choose a solution pathway. While engaging in productive struggle to solve a problem, they continually ask themselves, “Does this make sense?" to monitor and evaluate their progress and change course if necessary. Once they have a solution, they look back at the problem to determine if the solution is reasonable and accurate. Mathematically proficient students check their solutions to problems using different methods, approaches, or representations. They also compare and understand different representations of problems and different solution pathways, both their own and those of others.
G.MP.2	**Reason abstractly and quantitatively.** Mathematically proficient students make sense of quantities and their relationships in problem situations. Students can contextualize and decontextualize problems involving quantitative relationships. They contextualize quantities, operations, and expressions by describing a corresponding situation. They decontextualize a situation by representing it symbolically. As they manipulate the symbols, they can pause as needed to access the meaning of the numbers, the units, and the operations that the symbols represent. Mathematically proficient students know and flexibly use different properties of operations, numbers, and geometric objects and when appropriate they interpret their solution in terms of the context.
G.MP.3	**Construct viable arguments and critique the reasoning of others.** Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents. Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.
G.MP.4	**Model with mathematics.** Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. When given a problem in a contextual situation, they identify the mathematical elements of a situation and create a mathematical model that represents those mathematical elements and the relationships among them. Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

G.MP.5	**Use appropriate tools strategically.** Mathematically proficient students consider available tools when solving a mathematical problem. They choose tools that are relevant and useful to the problem at hand. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful; recognizing both the insight to be gained and their limitations. Students deepen their understanding of mathematical concepts when using tools to visualize, explore, compare, communicate, make and test predictions, and understand the thinking of others.
G.MP.6	**Attend to precision.** Mathematically proficient students clearly communicate to others using appropriate mathematical terminology, and craft explanations that convey their reasoning. When making mathematical arguments about a solution, strategy, or conjecture, they describe mathematical relationships and connect their words clearly to their representations. Mathematically proficient students understand meanings of symbols used in mathematics, calculate accurately and efficiently, label quantities appropriately, and record their work clearly and concisely.
G.MP.7	**Look for and make use of structure.** Mathematically proficient students use structure and patterns to assist in making connections among mathematical ideas or concepts when making sense of mathematics. Students recognize and apply general mathematical rules to complex situations. They are able to compose and decompose mathematical ideas and notations into familiar relationships. Mathematically proficient students manage their own progress, stepping back for an overview and shifting perspective when needed.
G.MP.8	**Look for and express regularity in repeated reasoning.** Mathematically proficient students look for and describe regularities as they solve multiple related problems. They formulate conjectures about what they notice and communicate observations with precision. While solving problems, students maintain oversight of the process and continually evaluate the reasonableness of their results. This informs and strengthens their understanding of the structure of mathematics which leads to fluency.

Core Content Connectors

Algebra 2

ARIZONA DEPARTMENT OF EDUCATION
HIGH ACADEMIC STANDARDS FOR STUDENTS
December, 2016

Arizona Mathematics Standards Algebra 2

Algebra 2 Overview

NUMBER AND QUANTITY -N

The Real Number System (N-RN)

- Extend the properties of exponents to rational exponents.

Quantities (N-Q)

- Reason quantitatively and use units to solve problems.

The Complex Number System (N-CN)

- Perform arithmetic operations with complex numbers.
- Use complex numbers in polynomial identities and equations.

ALGEBRA - A

Seeing Structure in Expressions (A-SSE)

- Interpret the structure of expressions.
- Write expressions in equivalent forms to solve problems.

Arithmetic with Polynomials and Rational Expressions (A-APR)

- Understand the relationship between zeros and factors of polynomials.
- Use polynomial identities to solve problems.
- Rewrite rational expressions.

Creating Equations (A-CED)

- Create equations that describe numbers or relationships.

Reasoning with Equations and Inequalities (A-REI)

- Understand solving equations as a process of reasoning and explain the reasoning.
- Solve equations and inequalities in one variable.
- Solve systems of equations.
- Represent and solve equations and inequalities graphically.

FUNCTIONS - F

Interpreting Functions (F-IF)

- Interpret functions that arise in applications in terms of context.
- Analyze functions using different representations.

Building Functions (F-BF)

- Build a function that models a relationship between two quantities.
- Build new functions from existing functions.

Linear, Quadratic, and Exponential Models (F-LE)

- Construct and compare linear, quadratic, and exponential models and solve problems.

Linear, Quadratic, and Exponential Models (F-LE) (cont.)

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

Trigonometric Functions (F-TF)

- Extend the domain of trigonometric functions using the unit circle.
- Model periodic phenomena with trigonometric functions.
- Apply trigonometric identities.

STATISTICS AND PROBABILITY - S

Interpreting Categorical and Quantitative Data (S-ID)

- Summarize, represent, and interpret data on a single count or measurement variable.
- Summarize, represent, and interpret data on two categorical and quantitative variables.
- Interpret models.

Making Inferences and Justifying Conclusions (S-IC)

- Understand and evaluate random processes underlying statistical experiments.
- Make inferences and justify conclusions from experiments, and observational studies.

Conditional Probability and the Rules of Probability (S-CP)

- Understand independence and conditional probability and use them to interpret data.
- Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Standards for Mathematical Practices (MP)

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Algebra 2: Critical Areas

For the high school Algebra 2 course, instructional time should focus on four critical areas:

1. Extending the real number system to the complex number system, representing radicals with rational exponents.
2. Solving and interpreting solutions to a variety of equations, inequalities, and systems of equations.
3. Demonstrate competency graphing and interpreting functions extending from linear, quadratic, and exponential with integer exponents to polynomial, radical, rational, exponential with real exponents, logarithmic, trigonometric functions, and piece-wise defined functions.
4. Extend simple and compound probability calculations to conditional probability.

(1) Algebra 2 students extend their knowledge of the real number system by working with complex solutions and factors of polynomials. Students expand their experience with polynomial functions, finding complex zeros and interpreting solutions. Students extend properties of exponents to using rational exponents when factoring, solving, and evaluating.

(2) Connections are made between multiplication of polynomials with multiplication of multi-digit integers and division of polynomials with long division of integers. Students identify zeros of polynomials, including complex zeros of quadratic polynomials, and make connections between zeros of polynomials and solutions of polynomial equations. The Fundamental Theorem of Algebra is examined. Students extend their understanding of solving linear equations, inequalities, and systems to include all the different function types mentioned in the standards.

(3) Students synthesize and generalize what they have learned about a variety of function families. They extend their work with exponential functions to include solving exponential equations with logarithms. They explore the effects of transformations on graphs of diverse functions, including functions arising in an application, in order to abstract the general principle that transformations on a graph always have the same effect regardless of the type of the underlying function. They identify appropriate types of functions to model a situation, they adjust parameters to improve the model, and they compare models by analyzing appropriateness of fit and making judgments about the domain over which a model is a good fit. Building on their previous work with functions and on knowledge of trigonometric ratios and circles, students now use the coordinate plane to extend trigonometry to model periodic phenomena. Students examine data on two quantitative variables to choose functions and make conclusions in context of the data.

(4) Algebra 2 students build on their foundational probability skills from middle school extending to conditional probability. Students determine independence of events and are able to apply conditional probability to everyday situations.

The Standards for Mathematical Practice complement the content standards so that students increasingly engage with the subject matter as they grow in mathematical maturity and expertise throughout the elementary, middle, and high school years. Mathematical modeling is integrated throughout Algebra 2 course by utilizing real world context.

Arizona Mathematics Standards Algebra 2

Number and Quantity - N		
The Real Number System (N-RN)		
A2.N-RN.A **Extend the properties of exponents to rational exponents.**	**A2.N-RN.A.1**	Explain how the definition of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. **No CCC developed for this standard.**
	A2.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents. **H.NO.1a1 Simplify expressions that include exponents.** **H.NO.1a2 Explain the influence of an exponent on the location of a decimal point in a given number.** **H.NO.1a3 Convert a number expressed in scientific notation.** **HS.NO.2c2 Rewrite expressions that include rational exponents.**
Quantities (N-Q)		
A2.N-Q.A **Reason quantitatively and use units to solve problems.**	**A2-N-Q.A.1**	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays, include utilizing real-world context. **H.ME.1a1 Determine the necessary unit(s) to use to solve real world problems.** **H.ME.1a2 Solve real world problems involving units of measurement.**
	A2.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling. Include problem-solving opportunities utilizing real-world context. **No CCC developed for this standard.**
	A2.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities utilizing real-world context. **H.ME.2a1 Describe the accuracy of measurement when reporting quantity (you can lessen your limitations by measuring precisely)**
The Complex Number System (N –CN)		
A2.N-CN.A **Perform arithmetic operations with complex numbers.**	**A2.N-CN.A.1**	Apply the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. Write complex numbers in the form ($a+bi$) with a and b real. **No CCC developed for this standard.**
A2.N-CN.C **Use complex numbers in polynomial identities and**	**A2.N-CN.C.7**	Solve quadratic equations with real coefficients that have complex solutions. **No CCC developed for this standard.**

equations.		
Algebra - A		
Seeing Structure in Expressions (A-SSE)		
A2.A-SSE.A **Interpret the structure of expressions.**	**A2.A-SSE.A.2**	Use structure to identify ways to rewrite polynomial and rational expressions. Focus on polynomial operations and factoring patterns. **H.NO.2c1 Simplify expressions that include exponents.** **H.NO.2c2 Rewrite expressions that include rational exponents.**

A2.A-SSE.B **Write expressions in equivalent forms to solve problems.**	**A2.A-SSE.B.3**	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Include problem-solving opportunities utilizing real-world context and focus on expressions with rational exponents. c. Use the properties of exponents to transform expressions for exponential functions. **H.NO.1a1 Simplify expressions that include exponents.**
	A2.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.* **No CCC developed for this standard.**
Arithmetic with Polynomials and Rational Expressions (A-APR)		
A2.A-APR.B **Understand the relationship between zeros and factors of polynomials.**	**A2.A-APR.B.2**	Know and apply the Remainder and Factor 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 $p(x)$. **No CCC developed for this standard.**
	A2.A-APR.B.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. Focus on quadratic, cubic, and quartic polynomials including polynomials for which factors are not provided **No CCC developed for this standard.**
A2.A-APR.C **Use polynomial identities to solve problems.**	**A2.A-APR.C.4**	Prove polynomial identities and use them to describe numerical relationships. **No CCC developed for this standard.**
A2.A-APR.D **Rewrite rational expressions.**	**A2.A-APR.D.6**	Rewrite rational expressions in different forms; write $a(x)/b(x)$ in the form $q(x) + r(x)/b(x)$, where $a(x)$, $b(x)$, $q(x)$, and $r(x)$ are polynomials with the degree of $r(x)$ less than the degree of $b(x)$, using inspection, long division, or for the more complicated examples, a computer algebra system. **No CCC developed for this standard.**
Creating Equations (A-CED)		
A2.A-CED.A **Create equations that describe numbers or relationships.**	**A2.A-CED.A.1**	Create equations and inequalities in one variable and use them to solve problems. Include problem-solving opportunities utilizing real-world context. Focus on equations and inequalities arising from linear, quadratic, rational, and exponential functions. **H.PRF.2b1 Translate a real-world problem into a one variable linear equation.**
Reasoning with Equations and Inequalities (A-REI)		
A2.A-REI.A **Understand solving equations as a process of reasoning and**	**A2.A-REI.A.1**	Explain each step in solving an equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

explain the reasoning.		Extend from quadratic equations to rational and radical equations. **H.PRF.2b2 Solve equations with one or two variables using equations or graphs**
	A2.A-REI.A.2	Solve rational and radical equations in one variable, and give examples showing how extraneous solutions may arise. **H.NO.2a1 Solve simple equations using rational numbers with one or more variable.**
A2.A-REI.B **Solve equations and inequalities in one variable.**	**A2.A-REI.B.4**	Fluently solve quadratic equations in one variable. 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. **No CCC developed for this standard.**
A2.A-REI.C **Solve systems of equations.**	**A2.A-REI.C.7**	Solve a 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* $x^2 + y^2 = 3$. **No CCC developed for this standard.**
A2.A-REI.D **Represent and solve equations and inequalities graphically.**	**A2.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 problems in real-world context. Extend from linear, quadratic, and exponential functions to cases where $f(x)$ and/or $g(x)$ are polynomial, rational, exponential, and logarithmic functions. **No CCC developed for this standard.**
Functions - F		
Interpreting Functions (F-IF)		
A2.F-IF.B **Interpret functions that arise in applications in terms of the context.**	**A2.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. Include problem-solving opportunities utilizing a real-world context. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root and piecewise-defined functions. **No CCC developed for this standard.**
	A2.F-IF.B.6	Calculate and interpret the average rate of change of a continuous function (presented symbolically or as a table) on a closed interval. Estimate the rate of change from a graph. Include problem-solving opportunities utilizing real-world context. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square

		root, cube root and piecewise-defined functions. **No CCC developed for this standard.**
A2.F-IF.C **Analyze functions using different representations.**	**A2.F-IF.C.7**	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root and piecewise-defined functions. **No CCC developed for this standard.**
	A2.F-IF.C.8	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 and classify those functions as exponential growth or decay. **No CCC developed for this standard.**
A2.F-IF.C (cont.)	**A2.F-IF.C.9**	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions.). Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root and piecewise-defined functions. **No CCC developed for this standard.**
Building Functions (F-BF)		
A2.F-BF.A **Build a function that models a relationship between two quantities.**	**A2.F-BF.A.1**	Write a function that describes a relationship between two quantities. Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root and piecewise-defined functions. Include problem-solving opportunities utilizing real-world context. a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. Combine function types using arithmetic operations and function composition. **No CCC developed for this standard.**
	A2.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. **No CCC developed for this standard.**
A2.F-BF.B **Build new functions from existing functions.**	**A2.F-BF.B.3**	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, 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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

		Functions include linear, quadratic, exponential, polynomial, logarithmic, rational, sine, cosine, tangent, square root, cube root and piecewise-defined functions. **No CCC developed for this standard.**
	A2.F-BF.B.4	Find inverse functions. a. Understand that an inverse function can be obtained by expressing the dependent variable of one function as the independent variable of another, recognizing that functions *f* and g are inverse functions if and only if *f(x)* = *y* and *g(y)* = *x* for all values of *x* in the domain of *f* and all values of *y* in the domain of *g*. b. Understand that if a function contains a point (*a,b*), then the graph of the inverse relation of the function contains the point (b,*a*). c. Interpret the meaning of and relationship between a function and its inverse utilizing real-world context. **No CCC developed for this standard**

Linear, Quadratic, and Exponential Models (F-LE)		
A2.F-LE.A **Construct and compare linear, quadratic, and exponential models and solve problems.**	**A2.F-LE.A.4**	For exponential models, express as a logarithm the solution to $ab^{ct} = d$ where *a*, *c*, and *d* are numbers and the base *b* is 2, 10, or *e*; evaluate the logarithms that are not readily found by hand or observation using technology. **No CCC developed for this standard.**
A2.F-LE.B **Interpret expressions for functions in terms of the situation they model.**	**A2.F-LE.B.5**	Interpret the parameters in an exponential function with rational exponents utilizing real-world context. **No CCC developed for this standard.**
Trigonometric Functions (F-TF)		
A2.F-TF.A **Extend the domain of trigonometric functions using the unit circle.**	**A2.F-TF.A.1**	Understand radian measure of an angle as the length of the arc on any circle subtended by the angle, measured in units of the circle's radius. **No CCC developed for this standard.**
	A2.F-TF.A.2	Explain how the unit circle in the coordinate plane enables the extension of sine and cosine functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. **No CCC developed for this standard.**
A2.F-TF.B **Model periodic phenomena with trigonometric functions.**	**A2.F-TF.B.5**	Create and interpret sine, cosine and tangent functions that model periodic phenomena with specified amplitude, frequency, and midline. **No CCC developed for this standard.**
A2.F-TF.C **Apply trigonometric identities.**	**A2.F-TF.C.8**	Use the Pythagorean identity $\sin2(\theta) + \cos2(\theta) = 1$ and the quadrant of the angle θ to find $\sin(\theta)$, $\cos(\theta)$, or $\tan(\theta)$ given $\sin(\theta)$ or $\cos(\theta)$. **No CCC developed for this standard.**
Statistics and Probability - S		
Interpreting Categorical and Quantitative Data (S-ID)		
A2.S-ID.A **Summarize, represent, and interpret data on a single count or measurement variable.**	**A2.S-ID.A.4**	Use the mean and standard deviation of a data set to fit it to a normal curve, and use properties of the normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, or tables to estimate areas under the normal curve. **H.DPS.1c1 Use descriptive stats; range, median, mode, mean, outliers/gaps to describe the data set.**
A2.S-ID.B **Summarize, represent, and**	**A2.S-ID.B.6**	Represent data of two quantitative variables on a scatter plot, and describe how the quantities are related. Extend to polynomial and exponential models.

interpret data on two categorical and quantitative variables.		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 chooses a function suggested by the context. **H.DPS.1d1 Represent data on a scatter plot to describe and predict** **H.DPS.1d2 Select an appropriate statement that describes the relationship between variables**

A2.S-ID.C **Interpret models.**	**A2.S-ID.C.10**	Interpret parameters of exponential models. **No CCC developed for this standard.**
Making Inferences and Justifying Conclusions (S-IC)		
A2.S-IC.A **Understand and evaluate random processes underlying statistical experiments.**	**A2.S-IC.A.1**	Understand statistics as a process for making inferences about population parameters based on a random sample from that population. **H.DPS.1c3 Determine what inferences can be made from statistics**
	A2.S-IC.A.2	Explain whether a specified model is consistent with results from a given data-generating process. **No CCC developed for this standard.**
A2.S-IC.B **Make inferences and justify conclusions from experiments, and observational studies.**	**A2.S-IC.B.3**	Recognize the purposes of and differences between designed experiments, sample surveys and observational studies. **No CCC developed for this standard.**
	A2.S-IC.B.4	Use data from a sample survey to estimate a population mean or proportion; recognize that estimates are unlikely to be correct and the estimates will be more precise with larger sample sizes. **No CCC developed for this standard.**
Conditional Probability and the Rules of Probability (S-CP)		
A2.S-CP.A **Understand independence and conditional probability and use them to interpret data.**	**A2.S-CP.A.3**	Understand the conditional probability of *A* given *B* as $P(A \text{ and } B)/P(B)$, and interpret independence of *A* and *B* as saying that the conditional probability of *A* given *B* is the same as the probability of A, and the conditional probability of *B* given *A* is the same as the probability of *B*. **No CCC developed for this standard.**
	A2.S-CP.A.4	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. **H.DSP.2d Select or make an appropriate statement based on a two-way frequency table.**
	A2.S-CP.A.5	Recognize and explain the concepts of conditional probability and independence utilizing real-world context. **H.DSP.2e Select or make an appropriate statement based on real world examples of conditional probability.**
A2.S-CP.B **Use the rules of probability to compute probabilities of compound events in a uniform probability model.**	**A2.S-CP.B.6**	Use Bayes Rule to 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. **No CCC developed for this standard.**
	A2.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. **No CCC developed for this standard.**
	A2.S-CP.B.8	Apply the general Multiplication Rule in a uniform probability model, $P(A \text{ and } B) = P(A)P(B\|A) = P(B)P(A\|B)$, and

		interpret the answer in terms of the model. **No CCC developed for this standard.**

Standards for Mathematical Practice	
A2.MP.1	**Make sense of problems and persevere in solving them.** Mathematically proficient students explain to themselves the meaning of a problem, look for entry points to begin work on the problem, and plan and choose a solution pathway. While engaging in productive struggle to solve a problem, they continually ask themselves, "Does this make sense?" to monitor and evaluate their progress and change course if necessary. Once they have a solution, they look back at the problem to determine if the solution is reasonable and accurate. Mathematically proficient students check their solutions to problems using different methods, approaches, or representations. They also compare and understand different representations of problems and different solution pathways, both their own and those of others.
A2.MP.2	**Reason abstractly and quantitatively.** Mathematically proficient students make sense of quantities and their relationships in problem situations. Students can contextualize and decontextualize problems involving quantitative relationships. They contextualize quantities, operations, and expressions by describing a corresponding situation. They decontextualize a situation by representing it symbolically. As they manipulate the symbols, they can pause as needed to access the meaning of the numbers, the units, and the operations that the symbols represent. Mathematically proficient students know and flexibly use different properties of operations, numbers, and geometric objects and when appropriate they interpret their solution in terms of the context.
A2.MP.3	**Construct viable arguments and critique the reasoning of others.** Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents. Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.
A2.MP.4	**Model with mathematics.** Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. When given a problem in a contextual situation, they identify the mathematical elements of a situation and create a mathematical model that represents those mathematical elements and the relationships among them. Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

A2.MP.5	**Use appropriate tools strategically.** Mathematically proficient students consider available tools when solving a mathematical problem. They choose tools that are relevant and useful to the problem at hand. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful; recognizing both the insight to be gained and their limitations. Students deepen their understanding of mathematical concepts when using tools to visualize, explore, compare, communicate, make and test predictions, and understand the thinking of others.
A2.MP.6	**Attend to precision.** Mathematically proficient students clearly communicate to others using appropriate mathematical terminology, and craft explanations that convey their reasoning. When making mathematical arguments about a solution, strategy, or conjecture, they describe mathematical relationships and connect their words clearly to their representations. Mathematically proficient students understand meanings of symbols used in mathematics, calculate accurately and efficiently, label quantities appropriately, and record their work clearly and concisely.
A2.MP.7	**Look for and make use of structure.** Mathematically proficient students use structure and patterns to assist in making connections among mathematical ideas or concepts when making sense of mathematics. Students recognize and apply general mathematical rules to complex situations. They are able to compose and decompose mathematical ideas and notations into familiar relationships. Mathematically proficient students manage their own progress, stepping back for an overview and shifting perspective when needed.
A2.MP.8	**Look for and express regularity in repeated reasoning.** Mathematically proficient students look for and describe regularities as they solve multiple related problems. They formulate conjectures about what they notice and communicate observations with precision. While solving problems, students maintain oversight of the process and continually evaluate the reasonableness of their results. This informs and strengthens their understanding of the structure of mathematics which leads to fluency.