High School Algebra I
Scope and Sequence

by Timothy D. Kanold

First Semester – 77 Instructional days

Unit 1: Understanding Quantities and Expressions (10 Instructional days)

N-Q Quantities

Reason quantitatively and use units to solve problems. (*Supporting Cluster*)

N-Q.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.*

N-Q.2 Define appropriate quantities for the purpose of descriptive modeling.*

N-Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*

A-SSE Seeing Structure in Expressions

Interpret the structure of expressions (*Major Cluster)*

A-SSE.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 complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret $P(1+r)^n$ as the product of P and a factor not depending on P.*

N-RN The Real Number System

Use properties of rational and irrational numbers. (*Additional Cluster)*

N-RN.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.

Note: N-RN 1 and 2 are in the **Algebra 2** curriculum.

Unit 1 Notes:
This initial unit starts with a treatment of quantities (numbers with units) as preparation for work with computation, modeling and functions. Throughout the course emphasis should be placed on reasoning and sense making rather than calculation and symbolic manipulation. Linear and non-linear examples should be explored in this unit as well as Mathematical Modeling (as a conceptual Category theme) is introduced to create context to the problems of the unit.

A short treatment of the CCSS general notion of a "quantity" thought of as *a number with a specific unit of measure,* should unfold.

Include unit analysis – (such as Factor-Label or Unit-Factor Methods) with connections to simple science examples too. Examples should include simple quantities with standard units of measure; and the fundamental dimensions of quantities such as length, time, weight, and temperature.

Division of quantities – Examples of quantities with quotient units such as speed, flow rate, frequency, price, density, pressure; and Flow rates such as a river moving at 3000ft/sec. Thus quotient units as "rates"; quotient units and unit conversion; and unit analysis is included here.

Multiplication of quantities and products of units such as area and volume as examples of quantities with product units; person-days and kilowatt hours as other examples of product units.

Note, in this initial unit there is *very limited* equation solving: Mental Math only. The primary focus is on further development and understanding of the grades 6-8 structure of expressions as well as an understanding of the properties of rational numbers.

This Unit builds on 8.NS 1 *Know that there are numbers that are not rational, and approximate them by rational numbers* and 7.EE1-2 *Use properties of operations to generate equivalent expressions.*

Unit 2: Understanding Functions (15 Instructional days)

F-IF Interpreting Functions

Understand the concept of function and use function notation (*Major Cluster*)

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

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.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 ≥ 1

Interpret functions that arise in applications in terms of the context (*Major Cluster*)

F-IF.5 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.*[*]

F-IF.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: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.*[*]

Analyze functions using different representations (*Supporting Cluster*)

F-IF.9 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 one [quadratic] function and an algebraic expression for another, say which has the larger maximum. Note: comparison of simple functions only — In this unit you would compare the graph of one function with the table of another, and compare values of the function for given points

Unit 2 Notes:
In this unit there should be a general treatment of the function concept with minimal use of symbolic expressions at this stage. Instead you should place emphasis on the idea of a function as a mapping represented in tables or graphs and possibly simple algebraic expressions.

The functions used in this unit, should be mostly simple linear and simple exponential. In Unit 3 and Unit 7 students will more extensively study linear and exponential functions; respectively. They are introduced here in order to compare two different types of functions. Simple quadratic functions could also be used to illustrate the properties of functions as well, if desired.

Properties should include: Domain and range; functions defined by graphs and their interpretation; functions defined by tables and their interpretation; properties of particular functions (rate of change, zeros) and their meaning in an application; sums and differences of two functions; product of a function and a constant; simple equations defined in terms of functions and their solution – such as finding the domain value or values for a given range value; sequences and functions defined recursively.

This unit builds on the Grade 8 CCSS Domain for Functions, 8.F 1, 8.F 2, 8.F 3 *Functions: Define, evaluate, and compare functions.*
and 8.F 4 and 8.F 5 *Functions: Use functions to model relationships between quantities.*

This unit should also provide a continued student experience with the Mathematical Modeling aspects of the course – using real life data to describe or generate the functions.

Unit 3: Linear Functions (17 Instructional days)

F-IF Interpreting

Interpret functions that arise in applications in terms of the context (*Major Cluster*)

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. (Linear only)

Analyze functions using different representations *(Supporting Cluster)*

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated (Linear and absolute Value only) functions

a. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.9 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.

Note: Linear only — (In this unit you would compare the graph of one linear function with the table of another, and compare values of the function for given points)

F-BF Building Functions

Build a function that models a relationship between two quantities (*Supporting Cluster*)

F-BF.1 Write a function that describes a linear relationship between two quantities.*

a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

*F-LE Linear, Quadratic, and Exponential Models**

Construct and compare linear, [quadratic], and exponential models and solve problems (*Supporting Cluster)* (Note: Linear aspect only)

F-LE.2 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).

F-LE.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.

Unit 3 Notes:

A thorough treatment of linear functions of one variable in the general form $f(x) = mx + b$ *with* representation of linear functions using expressions, graphs, and tables.

Students identify and interpret the three parameters of x-intercept, y-intercept and rate of change or slope m from any of the three representations.

Students Build and create expressions for linear functions using the expressions or parameters of $f(x) = mx+b$ *and* $f(x) = m(x-x0)$

Students demonstrate understanding and can explain geometrically why the graph is a line;

Understanding ***constant*** rate of change is the unique feature of linear functions.

Thus students should model a variety of situations using linear functions; look at the special properties of linear functions such as $y = mx$ and their role in representing proportional relationships; and connect to the idea of linear sequences ("arithmetic" sequences) as a linear function model. Students should conclude this Chapter working with the absolute value function $f(x) = |mx + b|$.

Note: This unit builds on 8.EE 5 and 8.EE 6 *Expressions and Equations: Understand the connections between proportional relationships, lines, and linear equations* and 8.F 2 and 8.F 3 *Functions: Define, evaluate, and compare functions. Use functions to model relationships between quantities.*

Unit 4: Modeling Linear Data (18 Instructional days)

*S-ID Interpreting Categorical and Quantitative Data**

Interpret linear models (*Major Cluster*)

S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.*

S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.*

S-ID.9 Distinguish between correlation and causation.*

Summarize represent and interpret data on two categorical and quantitative variables (*Supporting Cluster)*

S-ID.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.*

S-ID.6 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, models.*

b. Informally assess the fit of a function by plotting and analyzing residuals.

c. Fit a linear function for a scatter plot that suggests a linear association.

Note: SD 1, 2, and 3 below are considered additional clusters and not tested and could go into this unit as a combined standard or as supporting material…. SD.4 is now an Algebra II only Standard.

Summarize, represent, and interpret data on a single count or measurement variable (*Additional Cluster)*

S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).*

S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).*

S-ID.4 Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages. Recognize that there are data sets for which such a procedure is not appropriate. Use calculators, spreadsheets, and tables to estimate areas under the normal curve.*

Unit 4 Notes:
This unit is the statistical connection within Algebra 1. It can be placed here as Unit 4 or it could be exchanged with Unit 5 if desired. However, applications n Unit 5 and 6 can be more rich if this unit is

done here.

The unit builds upon statistics from grades 6 and 8 and includes understanding the single variable categorical and quantitative data sets using plots, graphs, measures of center and spread if you choose to address S-ID. 1-4 which although considered part of an additional cluster may good as part of a review form grades 6-8.

The unit is really about the connections to Linear Functions from Unit 3 using two variable data sets. The unit introduces statistical tools to investigate bi-variate data that include frequency tables, scatterplots, and lines that fit the data.

Students interpret, describe and summarize the data to make determinations regarding linear and non-linear associations, clustering, outliers, positive, negative and no correlations. The treatment continues by using linear functions and correlation coefficients (using technology such as a TI-84+, etc.) to make inferences and solve various modeling problems in the context of the data sets.

The students learn to distinguish between correlation and causation, and will do similar statistical work for exponential functions (Unit 7) and Quadratic function (Unit 8) later.

Unit 5: Linear Equations and Inequalities in ONE Variable
(17 instructional days – End of first Semester)

*A-CED Creating Equations**

Create equations that describe numbers or relationships (*Major Cluster*)

A-CED.1 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.]**

A-CED.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. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.**

A-CED.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.**

A-REI Reasoning with Equations and Inequalities

Understand solving equations as a process of reasoning and explain the reasoning (*Major Cluster*)

A-REI.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.

Solve equations and inequalities in one variable *(Major Cluster)*

A-REI.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Represent and solve equations and inequalities graphically

A-REI.11 Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are **linear,** [polynomial, rational,] **absolute value,** [exponential, and logarithmic functions.]*

A-REI.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.]

Unit 5 Notes:
Based on the established understanding of linear functions in a plane from Unit 2 and3, this Unit provides various methods for finding the solution of linear equations in **one unknown** such as $ax + b = cx + d$, with an extension to solution of linear inequalities such as $ax + b < c$

Connecting linear equations to linear functions is a shift in teaching algebra 1 and *signals a priority* that provides and allows for visual and data representations to an understanding of equations.

This unit also develops student understanding that the solution of a linear equation $ax + b = cx + d$ involves the intersection of the graphs of two linear functions – as solving linear equations both through manipulation of expressions and graphically is of critical importance. Thus, students can now consider equations as an ***equivalence of two functions*.**

Understanding the conditions under which a linear equation has no solution, one solution, or an infinite number of solutions can now be understood graphically as well.

In this unit students understand the solution x to a linear equation as the number where two linear functions have the same value and learn how to solve a linear equation step by step analytically.

This unit also expects students to solve linear inequalities such as $ax + b < c$ and $|ax + b| < c$, and represent the solution on a number line. One solution method (perhaps using technology) could include the comparison of the graphs of the functions represented by each side of the inequality.

This unit includes writing (or creating) Linear Equations to solve a wide variety of problems in context **(See Cluster with A-CED 1 and 3).**

This unit builds on 8.EE 7
Expressions and Equations: Analyze and solve linear equations [and pairs of simultaneous linear equations.]

This Unit signifies the end of First Semester.

Second Semester – 77 Instructional days

Unit 6: Linear Equations and Inequalities in Two Variables (15 Instructional days)

*A-CED Creating Equations**

Create equations that describe numbers or relationships (*Major Cluster*)

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

A-CED.3 Represent constraints [by equations or inequalities, and] by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods*.*

A-REI Reasoning with Equations and Inequalities

Solve systems of equations (*Additional Cluster*)

A-REI.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.

A-REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Represent and solve equations and inequalities graphically (*Major Cluster*)

A-REI.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).

A-REI.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.

***Unit 6 notes**:*
This unit presents a thorough treatment of linear equations in two unknowns such as $ax + by + c = 0$. This includes simultaneous solution of two such equations.

Students demonstrate an understanding of the differences among the solutions to a single equation in one unknown, solutions to a single equation in two unknowns, and "simultaneous" solutions to two equations in two unknowns.

Students demonstrate understanding of the solution to an equation $ax + by + c = 0$ in two unknowns as the intersection of the graph of this function with the x-y plane and make the analogy with functions and equations of one variable/unknown. Consider exploration of the symmetric form $(x/x0) + (y/y0) = 1$ of a linear equation in two unknowns.

Students also solve problems (and do additional mathematical modeling) set in an applied context using systems of equations and their solutions. This unit "feels" like a current unit for system of equations, but as an emphasis on modeling and building the systems as well.

Unit 7: Understanding Exponential functions, Models and Equations
(20 Instructional days)

*F-LE Linear, Quadratic, and Exponential Models**

Construct and compare linear, [quadratic,] and exponential models and solve problems (*Supporting Cluster)*

F-LE.2 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).*

F-LE.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 unity interval relative to another.

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, [quadratically,] or (more generally) as polynomial function.

Interpret expressions for functions in terms of the situation they model (*Supporting Cluster*)

F-LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*

F-BF Building Functions

Build a function that models a relationship between two quantities (*Supporting Cluster*)

F-BF.1 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.

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. (Note: This standard is not assessed in PARCC grade 9).

Build new functions from existing functions (*Additional Cluster*)

F-BF.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of 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.*

F-IF Interpreting Functions

Analyze functions using different representations (*Supporting Cluster*)

F-IF.7 Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated (exponential only).

F-IF.8a Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of a function.

F-IF.9 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.

Interpret functions that arise in applications in terms of the context (*Major Cluster*)

F-IF.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: intercepts; intervals where the function is increasing, decreasing, positive, or negative; [relative maximums and minimums; symmetries; end behavior; and periodicity.]* *

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph. (*Percent rate of change)*

A-SSE Seeing Structure in Expressions

Write expressions in equivalent forms to solve problems (*Supporting Cluster*)

A-SSE.3 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 expression 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%.

S-ID Interpreting Categorical and Quantitative Data *

Summarize represent and interpret data on two categorical and quantitative variables (*Supporting Cluster)*

S-ID.6 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 and exponential** models.*

b. Informally assess the fit of a function by plotting and analyzing residuals

Unit 7 Notes:
This Unit connects to Expressions and Equations 8.EE *Work with radicals and integer exponents.*1. *Know and apply the properties of integer exponents to generate equivalent numerical expressions.* This unit is PACKED with content, and thus needs the 20 days to unfold the clusters of comparing, building and interpreting exponential functions.

The unit provides a deep examination of exponential functions, the Laws of exponents: Including definition of exponent notation; sum law for exponents; product law for exponents; definition of negative exponent notation and basic characteristics of exponential functions.

The unit also extends ideas and understandings from Unit 3 on linear functions to the parallel ideas for exponential functions with special emphasis on the notion of ***constant percent*** rate of change (as compared to constant rate of change in Chapter 3) – using repeated multiplication as the big idea, geometric sequences and recursive definitions; the meaning of the dependent variable; the meaning of the independent variable; parameters and their meanings; ways of measuring amount of growth via the constant difference (linear) and constant ratio (exponential).

The unit also features the comparison of linear and exponential functions in a context and from various representations of those types of functions. Statistics is brought back into this unit via fitting an exponential function to data.

Unit 8: Understanding Quadratic Functions (17 Instructional days)

F-IF Interpreting Functions

Analyze functions using different representations (*Supporting Cluster*)

F-IF.7 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 square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.

F-IF.9 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.

F-IF.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 **in a quadratic function** to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.

Interpret functions that arise in applications in terms of the context (*Major Cluster*)

F-IF.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: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; [and periodicity.]**

F-IF.6 Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.*

*F-LE Linear, Quadratic, and Exponential Models**

Construct and compare linear, quadratic, and exponential models and solve problems (*Supporting Cluster)*

F-LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.*

F-BF Building Functions

Build a function that models a relationship between two quantities (*Supporting Cluster*)

F-BF.1 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.

Build new functions from existing functions (*Additional Cluster*)

F-BF.3 Identify the effect on the graph of replacing *f(x)* by *f(x) + k, k f(x), f(kx),* and *f(x + k)* for specific values of *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.*

Unit 8 Notes:

This unit extends the concepts for linear and exponential functions from Units 3 and 7 to Quadratics: A treatment of quadratic functions in one variable $f(x) = ax2 + bx + c$ and their applications.

Students can build quadratics functions and understand the product of two linear expressions ($mx + n$) and ($px + q$) leads to a quadratic function of the form $f(x) = ax2 + bx + c$ and they can represent quadratic functions symbolically, through tables and graphically.

Students also understand that the graph of a quadratic function is a parabola and understand the effect of each of the parameters a, b, and c on the graph of $ax2 + bx + c$. Students can also demonstrate understanding of how to use various forms of a quadratic function such as described in F-IF.8

Students can express the vertex of the parabolic graph in terms of these parameters; see the graph of any quadratic function $ax2 + bx + c$ is a scaled and shifted version of the parabola $y = x$^2 and solve max-min problems involving quadratic functions;

Students continue to explore real life modeling through applications of quadratic functions to problems in a context.

Unit 9: Polynomial Operations (10 Instructional days)

A-APR Arithmetic with Polynomials and Rational Expressions

Perform arithmetic operations on polynomials (*Major Cluster*)

A-APR.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.

Understand the relationship between zeros and factors of polynomials (*Supporting Cluster*)

A-APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.

A-SSE Seeing Structure in Expressions

Interpret the structure of expressions (*Major Cluster*)

A-SSE.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* $(x^2 - y^2)(x^2 + y^2)$.

Unit 9 Notes:
Revisit N-RN 3 from Unit 1 and develop student ability to perform all operations on polynomial expressions – including simplifying them. This short unit is needed as a bridge from the work in Unit 9 to the quadratic equation work in Unit 10. The unit provides the terminology and language for understanding Polynomials and provides various methods for connecting solution methods and solutions to the graphs of the polynomial equations.

Note: This unit could be collapsed into Unit 10, as a module within that final unit on quadratic *equations*

Unit 10: Understanding Quadratic Equations (15 Instructional days)

A-REI Reasoning with Equations and Inequalities

Solve equations and inequalities in one variable (*Major Cluster)*

A-REI.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 $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

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 ± bi for real numbers a and b]

Represent and solve equations and inequalities graphically (*Major Cluster*)

A-REI.11 Explain why the *x*-coordinates of the points where the graphs of the equations *y = f(x)* and *y = g(x)* intersect are the solutions of the equation *f(x) = g(x);* find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where *f(x)* and/or *g(x)* are linear, [polynomial, rational,] absolute value, exponential, [and logarithmic functions.]*

A-SSE Seeing Structure in Expressions

Write expressions in equivalent forms to solve problems. (*Supporting Cluster*)

A-SSE.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.

Unit 10 Notes:
This final unit of algebra 1 provides a treatment of solution methods for quadratic equations in one unknown such as *ax*2 + *bx* + *c* = 0 and its applications. Students explore the solution of the special cases *ax*2 + *c* = 0 and *ax*2 + *bx* = 0 of quadratic equations both graphically and through symbol manipulation.

Students explore the square root functions and understand that the *product of two linear expressions* (*mx* + *n*) and (*px* + *q*) leads to a quadratic function of the form *f*(*x*) = *ax*2 + *bx* + *c* and that any quadratic expression *ax*2 + *bx* + *c* can be factored into a product of two such linear expressions (with limitations if over the Reals).

Students solve quadratic equations *ax*2 + *bx* + *c* = 0 by completing the square, by factoring, by using the quadratic formula and by using graphs (with technology).

Students also model and solve quadratic equations in applied contexts and understand and once again use the idea of an equation as an equivalence of two functions, providing multiple solution pathways.