ALGEBRA - GRADE 9
COMMON CORE STATE STANDARDS
Church Hill Preparatory Academy

CONTENT AREA: ELA - GRAMMAR

Column1

Algebra I - Anchor Standards

Unit 1 - Relationships Between Quantities and Reasoning with Equations

This unit builds on earlier experience with systems of linear equations by asking students to analyze and explain the process of solving an equation. Students develop fluency writing, interpreting, and ranslating between various forms of linear equations and inequalities, and using them to solve prooblems. They master the solution of linear equaitons and apply related solution techniques and the laws of exponents to the creation and solution of simple exponnntial equations. all of this work is grounded on understanding quantities and on relationships between them.

Unit 2: Linear and Exponential Relationships

In this unit, students will learn function notation and develop the concepts of domain and range. They move beyond reviewing functions as processes that take inputs and yield outputs and start viewing functions as objects in their own right. They explore many examples of functions, including sequences; they interpret functions given graphically, numerically, symbolically, and verbally, translate between representations, and understand the limitations of various representations. They work with functions given by graphs and tables, keeping in mind that, depending upon the context, these representations are likely to be approximate and incomplete. Their work includes functions that can be described or approximated by formulas, as well as those that cannot. When functions describe relationshipsbetween quantities arising from a context, students reason with the units in which those quantities are measured. Students explore systems of equations and inequalities, and they find and interpret their solutions. Students build on and informally extend their understanding of integer exponents to consider exponetial functions. They compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change. They interpret arithmetic sequences as linear functions and geometric

Unit 3: Descriptive Statistics

This units builds upon students' prior experience with descriptive statistics, providing students with 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 the context to make judgements about the appropriatemness of linear models. With linear models, they look at residuals to analyze the goodness of fit.

Unit 4: Expressions and Equations

In this unit, students build on their knowledge from unit 2, where they extended the laws of exponents to rational exponents. Students apply this new understanding of number and strengthen their ability to see structure in and create quadratic and exponential expressions. They create and solve equations, inequalities, and sytems of equations involving quadratic expressions.

Unit 5: Quadratic Functions and Modeling

ALGEBRA - GRADE 9
COMMON CORE STATE STANDARDS

In preparation for work with quadratic relationships, students explore distinctions between rational and irrational numbers. They consider quadratic functions, comparing the key characteristics of quadratic functions to those of lijnear and exponential functions. They select from among these functions to model phenomena. Students learn to anticipate the graph of a quadratic function by interpreting various forms of quadratic expressions. In particular, they identify the real solutions of a quadratic equation as the zeros of a related quadratic function. Students learn that when quadratic equations do not have real solutionsthe number system must be extended so that solutions exist, analagous to the way in which extending the whole numbers to the negative numbers allows x+1 = 0 to have a solution. Formal work with complex numbers comes in Algebra II. Students expand their experience with functions to include more specialized functions - absolute value, step, and those that are piece-wise defined.

Indicator

M.9.1 Relationships between Quantities and Reasoing with Equations

M.9.1a Reinforce understanding of the properties of integer exponents.

M.9.1b Reason quantitatively and use units to solve problems.

✓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.

M.9.1c Interpret the structure of expressions.

✓A.SSE.1 Interpret expressions that represent a quantity in tems 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.

M.9.1d Create equations that describe numbers or relationships.

✓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.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.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.

M.9.1e Understand solving equations as a process of reasoning and explain the reasoning.

✓A.REI.1 Explain each step in solving a simple equation as starting 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.

M.9.1f Solve equations and inequalities in one variable.

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

M.9.2 Linear and Exponential Relationships

M.9.2a Extend the properties of exponents to rational exponents.

✓N.RN.1 Explain how the definition of the meaning 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.

✓N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents.

M.9.2b Solve systems of equations.

✓A.REI.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equationand a multiple of the other producesa system with the same solutions.

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

M.9.2c Represent and solve equations and inequalities graphically.

✓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.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 equalities 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 equalities in two variables as the intersection of the corresponding half-planes.

M.9.2d Understand the concept of a function and use function notation,

✓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 of 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 $n \geq 1$.

M9.2e Interpret functions that arise in applications in terms of a context.

✓F.IF.4 For a function that models a relationship between two quantities, interrpret 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.1.F5 Relate the domain of a function to its graph and, where applicable, to the qualitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a fatctory, then the positive integers would be an appropriate domain for the function.

✓F.1F.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.

✓M.9.2f Analyze functions using different representations.

✓F.1F.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 linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions showing period, midline, and amplitude.

✓F.1F.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.

M.9.2g Build a function that models a relationship between two quantities.
Focus on vertical translations of graphs of linear and exponential functions. Relate the vertical translation of a linear function to its y-intercept.

✓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. Limit to linear and exponential functions.

b. Combine standard function types using arithmetic operations. For example, build a functionthat models the temperature of a cooling body by adding constant function toa decaying exponential, and relate these functions to the model. Limit to linear and exponential functions.

M.9.2h Build new functions from existing functions. Focus on veritcal translations of graphs of linear and exponential functions. Relate the vertical translation of a linear function to its y-intercept.

✓F.BF.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 explananation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

M.9.2i Construct and compare linear, quadratic, and exponential models and solve problems.

✓F.LE.1 Distinguish between situations which can be modeled with linear functions and with exponential ones.

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.

✓F.LE.2 Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-putput pairs (include reading these from a table).

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

M.9.2j Interpret expressions for functions in terms of the situation they model.

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

M.9.3 Descriptive Statistics

M.9.3a Summarize represent, and intepret data on a single count or measurement variable.

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 difference in shape, center and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

M.9.3b Summarize , represent and interrpret data on two categorical and quantitative variables.

S.ID.6 Represent data on two quantitative variables on a scatter plot, and describe how 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 ofr choose a function suggested by the context. Emphathize linear and expponential models.

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

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

M.9.3.c Interpret linear models. Introduce the correlation coefficient.

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

S.ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit. Observe the correlation coefficient as a measure of how well the data fit the relationship.

S.ID.9 Distinguish between correlation and causation. Observe the important difference between a statistical relationship and a cause-and-effect relationship.

ALGEBRA - GRADE 9
COMMON CORE STATE STANDARDS
Church Hill Preparatory Academy

M.9.4 Expressions and Equations

M.9.4a Interpret the structure of expressions. Focus on quadratic and exponential expressions.

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.

Exponents are extended from integer exponents to rational exponents focusing on those that represent square or cube roots.

A.SSE.2 Use the structure of an expression to identify ways to rewrite it.

M.9.4b Write expressions in equivalent forms to solve problems. Develop the skill in factoring and completing the square. Understand what different forms of a quadratic expression reveal.

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.

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

c. Use the properties of exponents to transform expressions for exponential functions.

M.9.4c Perform arithmetic operations on polynomials. Focus on polynomial expressions that simplify to forms that are linear or quadratic in a positive integer power of x.

A.APR.1 Understand that polynomials form a system analygous to the integers, namely, add, subtract, and multiply polynomials.

they are claosed under the operations of addition, subtraction, and multiplication;

M.9.4d Create equations that describe numbers or relationships.

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.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 to R.

M.9.4.d Solve equations and inequalities in one variable. Learn of the existence of the complex number system.

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 and 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.

M.9.4e Solve systems of equations.Include systems consisting of one linear and one quadratic equation.

A.REI.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$. Include systems that lead to work with fractions. For exsample, finding the intersections between $x^2 + y^2 = 1$ and $y = (x+1)/2$ leads to the point (3/5, 4/5) on the unit circle, corresponding to the Pythagorean triple $3^2 + 4^2 = 5^2$.

M.9.5 Quadratic Functions and Modeling

M.9.5a Use properties of rational and irrational numbers.

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. Connect with physical situations e.g., finding the perimeter of a square of area 2.

M.9.5b Interpret functions that arise in applications in terms of a context. Focus on quadratic functions; compare with linear and quadratic functions studied in Unit 2.

F.IF.4 For a function that models a realtionship between two quantities, interpret key features of graphsand tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the realtionship. Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity.

F.1F.5c 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.1F.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.

M.9.5c Analyze functions using different representations.

F.1F.7 Graph functions expressed symbolically and show key featuresof the graph, by hand in simple cases and using technology for more complicated cases.

a. Graph linear and quadratic functions and show intercepts, maxima, and minima.

b. Graph square root, cube root, and piece-wise defined functions, including step functions and absolute value functions.

F.1F.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.

b. Use the properties of exponents to interpret expression for exponential functions. For example, identify percent of change in functions and classify them as representing exponential growth or decay.

ALGEBRA - GRADE 9

COMMON CORE STATE STANDARDS

Church Hill Preparatory Academy

F.1F.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.

M.9.5d Build a function that models a relationship between two quantities. Focus on situations that exhibit a quadratic relationship.

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. Focus on situations that exhibit a quadratic relationship.

b. Combine standard function types using arithmetic operations. For example, build a functionthat models the temperature of a cooling body by adding constant function toa decaying exponential, and relate these functions to the model. Focus on situations that exhibit a quadratic relationship.

F.BF.3 Identify the effect on the graph of replacing f(x) by f(x) + k, kf(x), f(kx), ND 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 he graphusing technology. Include recognizing even and odd functions form thier graphs and algebraic expressions for them.

F.BF.4 Find inverse functions.

a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. For example, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.

M.9.5e Construct and compare linear, quadratic, and exponential models and solve problems. Compare linear and exponential growth to quadratic growth.

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

ALGEBRA - GRADE 9

COMMON CORE STATE STANDARDS

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