

Georgia Tutorials are designed specifically for the Georgia Standards of Excellence and the Georgia Performance Standards to prepare students for the Georgia Milestones.

Math Tutorials offer targeted instruction, practice and review designed to develop computational fluency, deepen conceptual understanding, and apply mathematical practices. They automatically identify and address learning gaps down to elementary-level content, using adaptive remediation to bring students to grade-level no matter where they start. Students engage with the content in an interactive, feedback-rich environment as they progress through standards-aligned modules. By constantly honing the ability to apply their knowledge in abstract and real world scenarios, students build the depth of knowledge and higher order skills required to demonstrate their mastery when put to the test.

In each module, the Learn It and Try It make complex ideas accessible to students through focused content, modeled logic and process, multi-modal representations, and personalized feedback as students reason through increasingly challenging problems. The Review It offers a high impact summary of key concepts and relates those concepts to students' lives. The Test It assesses students' mastery of the module's concepts, providing granular performance data to students and teachers after each attempt. To help students focus on the content most relevant to them, unit-level pretests and posttests can quickly identify where students are strong and where they're still learning.

Unit 1: Real Number System

• LAWS OF EXPONENTS

- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
- MGSE9-12.N.RN.2: The Real Number System Extend the properties of exponents to rational exponents. Rewrite expressions involving radicals (i.e., simplify and/or use the operations of addition, subtraction, and multiplication, with radicals within expressions limited to square roots).
- MGSE9-12.A.REI.1: Reasoning with Equations and Inequalities Understand solving equations as a process of reasoning and explain the reasoning Using algebraic properties and the properties of real numbers, justify the steps of a simple, one-solution equation. Students should justify their own steps, or if given two or more steps of an equation, explain the progression from one step to the next using properties.

• OPERATIONS ON RATIONAL AND IRRATIONAL NUMBERS

- MGSE9-12.N.RN.3: The Real Number System Use properties of rational and irrational numbers. Explain why the sum or product of rational numbers is rational; why the sum of a rational number and an irrational number is irrational; and why the product of a nonzero rational number and an irrational number is irrational.

• MONITORING PRECISION AND ACCURACY

- MGSE9-12.N.Q.2: Quantities Reason quantitatively and use units to solve problems. Define appropriate quantities for the purpose of descriptive modeling. Given a situation, context, or problem, students will determine, identify, and use appropriate quantities for representing the situation.
- MGSE9-12.N.Q.3: Quantities Reason quantitatively and use units to solve problems. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- MGSE9-12.N.Q.1c: Quantities Reason quantitatively and use units to solve problems. Use units of measure (linear, area, capacity, rates, and time) as a way to understand problems: Use units within multi-step problems and formulas; interpret units of input and resulting units of output.
- MGSE9-12.N.Q.1a: Quantities Reason quantitatively and use units to solve problems. Use units of measure (linear, area, capacity, rates, and time) as a way to understand problems: Identify, use, and record appropriate units of measure within context, within data displays, and on graphs;

Unit 2: Rates and Unit Rates

• RATES AND UNIT RATES

- MGSE9-12.N.Q.1c: Quantities Reason quantitatively and use units to solve problems. Use units of measure (linear, area, capacity, rates, and time) as a way to understand problems: Use units within multi-step problems and formulas; interpret units of input and resulting units of output.

• UNIT CONVERSIONS

- MGSE9-12.N.Q.1b: Quantities Reason quantitatively and use units to solve problems. Use units of measure (linear, area, capacity, rates, and time) as a way to understand problems: Convert units and rates using dimensional analysis (English-to-English and Metric-to-Metric without conversion factor provided and between English and Metric with conversion factor);

Unit 3: Equations and Inequalities

• ONE-STEP EQUATIONS AND INEQUALITIES

- MGSE9-12.A.CED.1: Creating Equations Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions (integer inputs only).
- MGSE9-12.A.REI.1: Reasoning with Equations and Inequalities Understand solving equations as a process of reasoning and explain the reasoning Using algebraic properties and the properties of real numbers, justify the steps of a simple, one-solution equation. Students should justify their own steps, or if given two or more steps of an equation, explain the progression from one step to the next using properties.
- MGSE9-12.A.REI.3: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve linear equations and inequalities in one variable including equations with coefficients represented by letters.

- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
- MGSE9-12.A.REI.11: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Using graphs, tables, or successive approximations, show that the solution to the equation $f(x) = g(x)$ is the x -value where the y -values of $f(x)$ and $g(x)$ are the same.
- **MULTI-STEP EQUATIONS AND INEQUALITIES**
 - MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
 - MGSE9-12.A.REI.1: Reasoning with Equations and Inequalities Understand solving equations as a process of reasoning and explain the reasoning Using algebraic properties and the properties of real numbers, justify the steps of a simple, one-solution equation. Students should justify their own steps, or if given two or more steps of an equation, explain the progression from one step to the next using properties.
 - MGSE9-12.A.REI.3: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve linear equations and inequalities in one variable including equations with coefficients represented by letters.
 - MGSE9-12.A.CED.1: Creating Equations Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions (integer inputs only).
 - MGSE9-12.A.REI.11: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Using graphs, tables, or successive approximations, show that the solution to the equation $f(x) = g(x)$ is the x -value where the y -values of $f(x)$ and $g(x)$ are the same.

Unit 4: Working with Equations

- **AXIOMS OF EQUALITY**
 - MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
 - MGSE9-12.A.REI.1: Reasoning with Equations and Inequalities Understand solving equations as a process of reasoning and explain the reasoning Using algebraic properties and the properties of real numbers, justify the steps of a simple, one-solution equation. Students should justify their own steps, or if given two or more steps of an equation, explain the progression from one step to the next using properties.
- **LITERAL EQUATIONS**

- MGSE9-12.A.CED.1: Creating Equations Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions (integer inputs only).
- MGSE9-12.A.REI.3: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve linear equations and inequalities in one variable including equations with coefficients represented by letters.
- MGSE9-12.A.CED.4: Creating Equations Create equations that describe numbers or relationships Rearrange formulas to highlight a quantity of interest using the same reasoning as in solving equations.

Unit 5: Writing Expressions and Equations

• FORMULATING AND SIMPLIFYING ALGEBRAIC EXPRESSIONS

- MGSE9-12.N.Q.2: Quantities Reason quantitatively and use units to solve problems. Define appropriate quantities for the purpose of descriptive modeling. Given a situation, context, or problem, students will determine, identify, and use appropriate quantities for representing the situation.
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
- MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.

• FORMULATING AND SOLVING EQUATIONS FROM WORD PROBLEMS

- MGSE9-12.A.CED.1: Creating Equations Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions (integer inputs only).
- MGSE9-12.F.BF.2: Building Functions Build a function that models a relationship between two quantities Write arithmetic and geometric sequences recursively and explicitly, use them to model situations, and translate between the two forms. Connect arithmetic sequences to linear functions and geometric sequences to exponential functions.

- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.LE.1b: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
- **FORMULATING AND SOLVING INEQUALITIES FROM WORD PROBLEMS**
 - MGSE9-12.A.CED.1: Creating Equations Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions (integer inputs only).
 - MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
 - MGSE9-12.A.REI.3: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve linear equations and inequalities in one variable including equations with coefficients represented by letters.

Unit 6: Functions

- **FUNCTIONS AND RELATIONS**
 - MGSE9-12.F.IF.2: Interpreting Functions Understand the concept of a function and use function notation Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
 - MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
 - MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a

function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).

- **DOMAIN AND RANGE**

- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

- **EVALUATING FUNCTIONS**

- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.2: Interpreting Functions Understand the concept of a function and use function notation Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.

Unit 7: Graphs of Linear Equations and Inequalities 1

- **SLOPE**

- MGSE9-12.F.IF.6: Interpreting Functions Interpret functions that arise in applications in terms of the context 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.
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the

input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.

- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

• GRAPHING AND ANALYZING LINEAR FUNCTIONS

- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).

Unit 8: Graphs of Linear Equations and Inequalities 2

• GRAPHING AND MANIPULATING $Y = MX + B$

- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to

represent relationships between quantities; graph equations on coordinate axes with labels and scales.

- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.6: Interpreting Functions Interpret functions that arise in applications in terms of the context 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.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.S.ID.7: Interpreting Categorical and Quantitative Data Interpret linear models Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.LE.1b: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
- MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.

- **GRAPHS OF LINEAR INEQUALITIES**

- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
- MGSE9-12.A.REI.3: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve linear equations and inequalities in one variable including equations with coefficients represented by letters.
- MGSE9-12.A.REI.12: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Graph the solution set to a linear inequality in two variables.

Unit 9: Linear Equations

• SLOPE-INTERCEPT FORM OF A LINEAR EQUATION

- MGSE9-12.S.ID.7: Interpreting Categorical and Quantitative Data Interpret linear models Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- MGSE9-12.A.REI.10: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.IF.6: Interpreting Functions Interpret functions that arise in applications in terms of the context 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.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

- MGSE9-12.F.BF.2: Building Functions Build a function that models a relationship between two quantities Write arithmetic and geometric sequences recursively and explicitly, use them to model situations, and translate between the two forms. Connect arithmetic sequences to linear functions and geometric sequences to exponential functions.

- **POINT-SLOPE FORM OF A LINEAR EQUATION**

- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.A.REI.10: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- MGSE9-12.A.REI.11: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Using graphs, tables, or successive approximations, show that the solution to the equation $f(x) = g(x)$ is the x -value where the y -values of $f(x)$ and $g(x)$ are the same.
- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Unit 10: Two-Variable Linear Systems

- **SOLVING SYSTEMS OF LINEAR EQUATIONS: GUESS AND CHECK**

- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations

and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.

- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
- MGSE9-12.A.REI.6: Reasoning with Equations and Inequalities Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

• SOLVING SYSTEMS OF LINEAR EQUATIONS: GRAPHING

- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
- MGSE9-12.A.REI.6: Reasoning with Equations and Inequalities Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

Unit 11: Solving Two-Variable Linear Systems Algebraically

• SOLVING SYSTEMS OF LINEAR EQUATIONS: SUBSTITUTION

- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
- MGSE9-12.A.REI.6: Reasoning with Equations and Inequalities Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
- MGSE9-12.A.REI.5: Reasoning with Equations and Inequalities Solve systems of equations Show and explain why the elimination method works to solve a system of two-variable equations.

• SOLVING SYSTEMS OF LINEAR EQUATIONS: ELIMINATION

- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
- MGSE9-12.A.REI.6: Reasoning with Equations and Inequalities Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
- MGSE9-12.A.REI.5: Reasoning with Equations and Inequalities Solve systems of equations Show and explain why the elimination method works to solve a system of two-variable equations.

Unit 12: Linear Systems

• SOLVING SYSTEMS OF LINEAR INEQUALITIES

- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
- MGSE9-12.A.REI.12: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Graph the solution set to a linear inequality in two variables.

• SOLVING THREE-VARIABLE SYSTEMS OF LINEAR EQUATIONS

- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.A.CED.3: Creating Equations Create equations that describe numbers or relationships Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret data points as possible (i.e. a solution) or not possible (i.e. a non-solution) under the established constraints.
- MGSE9-12.A.REI.5: Reasoning with Equations and Inequalities Solve systems of equations Show and explain why the elimination method works to solve a system of two-variable equations.

Unit 13: Exponential Functions, Equations, and Inequalities

• EXPONENTIAL FUNCTIONS

- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an

expression, such as terms, factors, and coefficients, in context.

- MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
- MGSE9-12.A.REI.10: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- MGSE9-12.F.LE.1a: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. (This can be shown by algebraic proof, with a table showing differences, or by calculating average rates of change over equal intervals).
- MGSE9-12.F.IF.6: Interpreting Functions Interpret functions that arise in applications in terms of the context 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.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.LE.3: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

- MGSE9-12.F.IF.7e: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph exponential functions, showing intercepts and end behavior.
 - MGSE9-12.A.CED.1: Creating Equations Create equations that describe numbers or relationships Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear, quadratic, and exponential functions (integer inputs only).
 - MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
 - MGSE9-12.F.LE.1c: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
 - MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.
- **EXPONENTIAL GROWTH AND DECAY**
- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
 - MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
 - MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
 - MGSE9-12.F.LE.1a: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. (This can be shown by algebraic proof, with a table showing differences, or by calculating average rates of change over equal intervals).

- MGSE9-12.F.LE.1c: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
- MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.
- MGSE9-12.F.LE.3: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
- MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.
- MGSE9-12.S.ID.6a: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Decide which type of function is most appropriate by observing graphed data, charted data, or by analysis of context to generate a viable (rough) function of best fit. Use this function to solve problems in context. Emphasize linear, quadratic and exponential models.
- MGSE9-12.F.LE.1b: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.
- MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.
- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

- MGSE9-12.A.REI.10: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.
- MGSE9-12.F.LE.5: Linear, Quadratic, and Exponential Models Interpret expressions for functions in terms of the situation they model Interpret the parameters in a linear ($f(x) = mx + b$) and exponential ($f(x) = a \times dx$) function in terms of context. (In the functions above, m and b are the parameters of the linear function, and a and d are the parameters of the exponential function.) In context, students should describe what these parameters mean in terms of change and starting value.
- **SOLVING EXPONENTIAL INEQUALITIES**
 - MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
 - MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
 - MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
 - MGSE9-12.F.LE.1c: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

Unit 14: Sequences

- **SEQUENCES**
 - MGSE9-12.F.IF.3: Interpreting Functions Understand the concept of a function and use function notation Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (Generally, the scope of high school math defines this subset as the set of natural numbers 1,2,3,4...) By graphing or calculating terms, students should be able to show how the recursive sequence $a=7$, $a_n=a_{n-1}+2$; the sequence $s = 2(n-1) + 7$; and the function $f(x) = 2x + 5$ (when x is a natural number) all define the same sequence.

- MGSE9-12.F.BF.2: Building Functions Build a function that models a relationship between two quantities Write arithmetic and geometric sequences recursively and explicitly, use them to model situations, and translate between the two forms. Connect arithmetic sequences to linear functions and geometric sequences to exponential functions.
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
- MGSE9-12.F.IF.3: Interpreting Functions Understand the concept of a function and use function notation Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (Generally, the scope of high school math defines this subset as the set of natural numbers 1,2,3,4...) By graphing or calculating terms, students should be able to show how the recursive sequence $a=7$, $a=a +2$; the sequence $s = 2(n -1) + 7$; and the function $f(x) = 2x + 5$ (when x is a natural number) all define the same sequence.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.IF.3: Interpreting Functions Understand the concept of a function and use function notation Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (Generally, the scope of high school math defines this subset as the set of natural numbers 1,2,3,4...) By graphing or calculating terms, students should be able to show how the recursive sequence $a=7$, $a=a +2$; the sequence $s = 2(n -1) + 7$; and the function $f(x) = 2x + 5$ (when x is a natural number) all define the same sequence.
- **ARITHMETIC AND GEOMETRIC SEQUENCES**
 - MGSE9-12.F.BF.2: Building Functions Build a function that models a relationship between two quantities Write arithmetic and geometric sequences recursively and explicitly, use them to model situations, and translate between the two forms. Connect arithmetic sequences to linear functions and geometric sequences to exponential functions.
 - MGSE9-12.F.IF.3: Interpreting Functions Understand the concept of a function and use function notation Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (Generally, the scope of high school math defines this subset as the set of natural numbers 1,2,3,4...) By graphing or calculating terms, students should be able to show how the recursive sequence $a=7$, $a=a +2$; the sequence $s = 2(n -1) + 7$; and the function $f(x) = 2x + 5$ (when x is a natural number) all define the same sequence.
 - MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
 - MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).

- MGSE9-12.F.IF.3: Interpreting Functions Understand the concept of a function and use function notation Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. (Generally, the scope of high school math defines this subset as the set of natural numbers 1,2,3,4...) By graphing or calculating terms, students should be able to show how the recursive sequence $a=7$, $a=a +2$; the sequence $s = 2(n -1) + 7$; and the function $f(x) = 2x + 5$ (when x is a natural number) all define the same sequence.

Unit 15: Polynomials

• ADDITION AND SUBTRACTION OF POLYNOMIALS

- MGSE9-12.A.APR.1: Arithmetic with Polynomials and Rational Expressions Perform arithmetic operations on polynomials Add, subtract, and multiply polynomials; understand that polynomials form a system analogous to the integers in that they are closed under these operations.

• MULTIPLICATION OF POLYNOMIALS

- MGSE9-12.A.APR.1: Arithmetic with Polynomials and Rational Expressions Perform arithmetic operations on polynomials Add, subtract, and multiply polynomials; understand that polynomials form a system analogous to the integers in that they are closed under these operations.

Unit 16: Factoring

• FACTORING QUADRATIC TRINOMIALS

- MGSE9-12.A.SSE.3a: Seeing Structure in Expressions Write expressions in equivalent forms to solve problems Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor any quadratic expression to reveal the zeros of the function defined by the expression.
- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
- MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).

- **FACTORING SPECIAL CASES**

- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
- MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.

Unit 17: Graphs of Quadratic Functions

- **QUADRATIC FUNCTIONS**

- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
- MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
- MGSE9-12.A.SSE.3b: Seeing Structure in Expressions Write expressions in equivalent forms to solve problems Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function defined by the expression.
- MGSE9-12.F.IF.8a: Interpreting Functions Analyze functions using different representations Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. 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.
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.

- **ANALYZING GRAPHS OF QUADRATIC FUNCTIONS**

- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
- MGSE9-12.F.IF.9: Interpreting Functions Analyze functions using different representations Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- MGSE9-12.A.REI.11: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Using graphs, tables, or successive approximations, show that the solution to the equation $f(x) = g(x)$ is the x -value where the y -values of $f(x)$ and $g(x)$ are the same.
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.F.IF.8a: Interpreting Functions Analyze functions using different representations Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. 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.

- **REPRESENTATIONS OF QUADRATIC FUNCTIONS**

- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
- MGSE9-12.A.REI.4a: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p) = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx + c = 0$.
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.IF.9: Interpreting Functions Analyze functions using different representations Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.
- MGSE9-12.F.IF.8a: Interpreting Functions Analyze functions using different representations Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. 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.

Unit 18: Solving Quadratic Functions

• SOLVING QUADRATIC EQUATIONS BY FACTORING

- MGSE9-12.A.SSE.3a: Seeing Structure in Expressions Write expressions in equivalent forms to solve problems Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Factor any quadratic expression to reveal the zeros of the function defined by the expression.

- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.F.IF.8a: Interpreting Functions Analyze functions using different representations Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. 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.
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.A.REI.11: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Using graphs, tables, or successive approximations, show that the solution to the equation $f(x) = g(x)$ is the x -value where the y -values of $f(x)$ and $g(x)$ are the same.
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.

- **COMPLETING THE SQUARE**

- MGSE9-12.A.SSE.3b: Seeing Structure in Expressions Write expressions in equivalent forms to solve problems Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function defined by the expression.
- MGSE9-12.A.REI.4a: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x + p) = q$ that has the same solutions. Derive the quadratic formula from $ax + bx + c = 0$.
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.F.IF.8a: Interpreting Functions Analyze functions using different representations Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. 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.
- MGSE9-12.A.SSE.2: Seeing Structure in Expressions Interpret the structure of expressions Use the structure of an expression to rewrite it in different equivalent forms.
- MGSE9-12.A.REI.4a: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x + p) = q$ that has the same solutions. Derive the quadratic formula from $ax + bx + c = 0$.
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).

- MGSE9-12.A.REI.4a: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x + p) = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx + c = 0$.
- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- **QUADRATIC FORMULA**
 - MGSE9-12.A.SSE.1a: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Interpret parts of an expression, such as terms, factors, and coefficients, in context.
 - MGSE9-12.A.SSE.1b: Seeing Structure in Expressions Interpret the structure of expressions Interpret expressions that represent a quantity in terms of its context. Given situations which utilize formulas or expressions with multiple terms and/or factors, interpret the meaning (in context) of individual terms or factors.
 - MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
 - MGSE9-12.A.REI.4a: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x + p) = q$ that has the same solutions. Derive the quadratic formula from $ax^2 + bx + c = 0$.
 - MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).

- MGSE9-12.A.REI.4b: Reasoning with Equations and Inequalities Solve equations and inequalities in one variable Solve quadratic equations in one variable. Solve quadratic equations by inspection (e.g., for $x = 49$), taking square roots, factoring, completing the square, and the quadratic formula, as appropriate to the initial form of the equation (limit to real number solutions).
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.BF.1a: Building Functions Build a function that models a relationship between two quantities Write a function that describes a relationship between two quantities. Determine an explicit expression and the recursive process (steps for calculation) from context.

Unit 19: Parent Functions

• LINEAR AND EXPONENTIAL PARENT FUNCTIONS

- MGSE9-12.A.REI.10: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key

features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

- MGSE9-12.F.IF.7e: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph exponential functions, showing intercepts and end behavior.
- MGSE9-12.F.LE.1c: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

• **QUADRATIC PARENT FUNCTION**

- MGSE9-12.A.REI.10: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane.
- MGSE9-12.F.IF.7a: Interpreting Functions Analyze functions using different representations Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context).
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

Unit 20: Transformations of Parent Functions

• **TRANSFORMATIONS OF THE LINEAR AND EXPONENTIAL PARENT FUNCTIONS**

- MGSE9-12.F.BF.3: Building Functions Build new functions from existing functions 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.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

• **TRANSFORMATIONS OF THE QUADRATIC PARENT FUNCTION**

- MGSE9-12.F.BF.3: Building Functions Build new functions from existing functions 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.
- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

Unit 21: Working with Functions

• LINEAR VERSUS NONLINEAR FUNCTIONS

- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.
- MGSE9-12.F.IF.6: Interpreting Functions Interpret functions that arise in applications in terms of the context 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.
- MGSE9-12.F.IF.9: Interpreting Functions Analyze functions using different representations Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.F.LE.1a: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. (This can be shown by algebraic proof, with a table showing differences, or by calculating average rates of change over equal intervals).
- MGSE9-12.F.LE.1b: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can

be modeled with linear functions and with exponential functions. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

- MGSE9-12.F.LE.1c: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

• **MULTIPLE REPRESENTATIONS OF FUNCTIONS**

- MGSE9-12.F.IF.9: Interpreting Functions Analyze functions using different representations Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).
- MGSE9-12.A.CED.2: Creating Equations Create equations that describe numbers or relationships Create linear, quadratic, and exponential equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- MGSE9-12.F.LE.1a: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. (This can be shown by algebraic proof, with a table showing differences, or by calculating average rates of change over equal intervals).

Unit 22: Nonlinear Functions

• **ABSOLUTE VALUE FUNCTIONS**

- MGSE9-12.F.IF.1: Interpreting Functions Understand the concept of a function and use function notation Understand that a function from one set (the input, called the domain) to another set (the output, called the range) assigns to each element of the domain exactly one element of the range, i.e. each input value maps to exactly one output value. If f is a function, x is the input (an element of the domain), and $f(x)$ is the output (an element of the range). Graphically, the graph is $y = f(x)$.
- MGSE9-12.F.IF.5: Interpreting Functions Interpret functions that arise in applications in terms of the context Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
- MGSE9-12.F.IF.4: Interpreting Functions Interpret functions that arise in applications in terms of the context Using tables, graphs, and verbal descriptions, interpret the key characteristics of a function which models the relationship between two quantities. Sketch a graph showing key

features including: intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; and end behavior.

- MGSE9-12.F.BF.3: Building Functions Build new functions from existing functions 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.

- **SYSTEMS OF NONLINEAR EQUATIONS**

- MGSE9-12.A.REI.6: Reasoning with Equations and Inequalities Solve systems of equations Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
- MGSE9-12.A.REI.5: Reasoning with Equations and Inequalities Solve systems of equations Show and explain why the elimination method works to solve a system of two-variable equations.
- MGSE9-12.A.REI.11: Reasoning with Equations and Inequalities Represent and solve equations and inequalities graphically Using graphs, tables, or successive approximations, show that the solution to the equation $f(x) = g(x)$ is the x -value where the y -values of $f(x)$ and $g(x)$ are the same.
- MGSE9-12.F.LE.2: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems 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).

Unit 23: Statistics

- **DATA ANALYSIS**

- MGSE9-12.S.ID.1: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on a single count or measurement variable Represent data with plots on the real number line (dot plots, histograms, and box plots).
- MGSE9-12.S.ID.2: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on a single count or measurement variable Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, mean absolute deviation) of two or more different data sets.
- MGSE9-12.S.ID.3: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on a single count or measurement variable Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

- **FREQUENCY TABLES**

- MGSE9-12.S.ID.5: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on two categorical and quantitative variables 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.

- MGSE9-12.S.ID.3: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on a single count or measurement variable Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

Unit 24: Two-Variable Data

• SCATTERPLOTS

- MGSE9-12.S.ID.6a: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Decide which type of function is most appropriate by observing graphed data, charted data, or by analysis of context to generate a viable (rough) function of best fit. Use this function to solve problems in context. Emphasize linear, quadratic and exponential models.
- MGSE9-12.S.ID.6c: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Using given or collected bivariate data, fit a linear function for a scatter plot that suggests a linear association.
- MGSE9-12.S.ID.9: Interpreting Categorical and Quantitative Data Interpret linear models Distinguish between correlation and causation.
- MGSE9-12.F.IF.6: Interpreting Functions Interpret functions that arise in applications in terms of the context 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.
- MGSE9-12.S.ID.7: Interpreting Categorical and Quantitative Data Interpret linear models Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.

• SCATTERPLOTS AND MODELING

- MGSE9-12.S.ID.6a: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Decide which type of function is most appropriate by observing graphed data, charted data, or by analysis of context to generate a viable (rough) function of best fit. Use this function to solve problems in context. Emphasize linear, quadratic and exponential models.
- MGSE9-12.S.ID.6c: Interpreting Categorical and Quantitative Data Summarize, represent, and interpret data on two categorical and quantitative variables Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. Using

given or collected bivariate data, fit a linear function for a scatter plot that suggests a linear association.

- MGSE9-12.S.ID.8: Interpreting Categorical and Quantitative Data Interpret linear models Compute (using technology) and interpret the correlation coefficient r of a linear fit. (For instance, by looking at a scatterplot, students should be able to tell if the correlation coefficient is positive or negative and give a reasonable estimate of the r value.) After calculating the line of best fit using technology, students should be able to describe how strong the goodness of fit of the regression is, using r .
- MGSE9-12.S.ID.8: Interpreting Categorical and Quantitative Data Interpret linear models Compute (using technology) and interpret the correlation coefficient r of a linear fit. (For instance, by looking at a scatterplot, students should be able to tell if the correlation coefficient is positive or negative and give a reasonable estimate of the r value.) After calculating the line of best fit using technology, students should be able to describe how strong the goodness of fit of the regression is, using r .
- MGSE9-12.S.ID.7: Interpreting Categorical and Quantitative Data Interpret linear models Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.
- MGSE9-12.F.LE.1a: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Show that linear functions grow by equal differences over equal intervals and that exponential functions grow by equal factors over equal intervals. (This can be shown by algebraic proof, with a table showing differences, or by calculating average rates of change over equal intervals).
- MGSE9-12.F.LE.1c: Linear, Quadratic, and Exponential Models Construct and compare linear, quadratic, and exponential models and solve problems Distinguish between situations that can be modeled with linear functions and with exponential functions. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.