Algebra I

COURSE OUTLINE		
Unit One	Patterns *Representing Patterns* *Patterns with Integers* *Arithmetic Sequences* *Geometric Sequences* *Patterns with Fractals*	18 Days
Unit Two	Linear Equations and Inequalities *Understanding Algebraic Expressions* *One-Step and Two-Step Linear Equations* *Combining Like Terms to Solve Equations* *Solving Equations Using the Distributive Property* *Formulas and Literal Equations* *Linear Inequalities*	23 Days
Unit Three	Functions *Relations and Functions* *What is a Function?* *Function Notation and Evaluating Functions* *Multiple Representations and Applications of Functions*	17 Days
Unit Four	Linear Functions *What Makes a Function Linear?* *Recognizing Linear Functions from Words, Tables, and Graphs* *Calculating and Interpreting Slope* *Effects of Changing Parameters of an Equation in Slope-Intercept Form* *Forms of Linear Equation* *Point-Slope Form of Linear Equations*	26 Days
Unit Five	Scatter Plots & Trend Lines *One Variable Data* *Introduction to Scatterplots and Trend Lines* *Technology and Linear Regression* *Explorations of Data Sets* *Exploring the Influence of Outliers on Trend Lines* *Piecewise Functions*	21 Days
Unit Six	Systems of Linear Equations *Solving Systems of Linear Equations* *Solving Systems of Linear Equations Using Substitution* *Solving Systems of Linear Equations Using Elimination*	13 Days
Unit Seven	Introduction to Exponential Functions *A New Function Family – World Population Growth* *Exponential Growth and Exponents* *Exploring Parameters of Exponential Functions* *Modeling Exponential Data* *Exponential Patterns and Per Cent Change* *Exponential Functions and Climate Change*	25 Days
Unit Eight	Quadratic Functions and Equations *Another Nonlinear Family: Parabolas Everywhere* *Quadratic Functions in Vertex Form*	27 Days

	Solving Quadratic Equations Using the Square Root Property *Quadratic Functions in Factored Form* *Factoring Quadratic Trinomials* *Solving Quadratic Equations by Completing the Square and the Quadratic Formula*	

School-wide Academic Expectations Taught In This Course

- Communication
- Collaboration
- Analysis
- Literacy

School-wide Social and Civic Expectations Taught in This Course

- Demonstrate Resiliency
- Demonstrate Responsibility
- Demonstrate Respect

Content Standards Taught in This Course

F-IF 3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.

F-BF 1. Write a function that describes a relationship between two quantities.
a. Determine an explicit expression, a recursive process, or steps for calculation from a context.

F-BF 2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

8EE 7. Solve linear equations in one variable.
a. Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

A-SSE 1. Interpret expressions that represent a quantity in terms of its context.
a. Interpret parts of an expression, such as terms, factors, and coefficients.
b. Interpret complicated expressions by viewing one or more of their parts as a single entity...

A-SSE 3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

A-CED 1. Create equations and inequalities in one variable and use them to solve problems.

A-CED 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
A-REI 1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.

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

N-Q 1 Use units as a way to understand problems and to guise the solution of multi-step problems; choose and interpret units consistently in formulas

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

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

8F 1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

8F 2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

8F 5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

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

A-CED 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

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

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

F-IF 4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities and sketch graphs showing key features given a verbal description of the relationship.

F-IF 5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

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

F-IF 9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
F-IF 6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.

F-IF 7. Graph functions expressed symbolically and show key features of the graph, by hand in simple

cases and using technology for more complicated cases.

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

F-LE 1. Distinguish between situations that can be modeled with linear functions [and with exponential functions].

a. Prove that linear functions grow by equal differences over equal intervals...

b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another....

F-LE 2. Construct linear functions, including arithmetic sequences, given a graph, a description of a relationship, or two input-output pairs

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

8-SP 2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

8-SP 3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept.

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

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

S-ID 6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.

a. Fit a function to the data; use functions fitted to data to solve problems in the context of the data.

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

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

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

S-ID 9. Distinguish between correlation and causation.

A-CED 3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

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

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

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

N-RN 1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.

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

A-SSE 1b. Interpret complicated expressions by viewing one or more of their parts as a single entity.

A-SSE 3c. Use the properties of exponents to transform expressions for exponential functions.

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

a. Graph exponential ... functions, showing intercepts and end behavior... F-IF 8b. Use the properties of exponents to interpret expressions for exponential functions.

F-BF 2. Write geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

F-LE 1. Distinguish between situations that can be modeled with linear functions and with exponential functions.a. Prove ... that exponential functions grow by equal factors over equal intervals....

b. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

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

F-LE 3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly.

F-LE 5. Interpret the parameters in an exponential function in terms of a context.

8EE 2. Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational.

A-SSE 3. a Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

A-REI 4. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions. Derive the quadratic formula from this

form. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation.

A-APR 1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

A-CED 1. Create equations and inequalities in one variable and use them to solve problems.

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

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

F-IF 7a. Graph quadratic functions and show intercepts, maxima, and minima.

F-IF 8a. 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.

F-BF 3. Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology...

Unit 1: Patterns

Introduction and Established Goals: This is the introductory unit for the Algebra I course. Students will express their mathematical background, as well as showing their abilities to work cooperatively and to communicate clearly both orally and in writing. At the same time, students will engage in learning mathematical skills within the context of interesting problems that connect to real world issues. Throughout this course, it is hoped that students recognize and appreciate the power of mathematical thinking and how analyzing mathematical models aids in making important decisions. This unit demonstrates how ubiquitous patterns are in nature and in man-made objects.

Desired Outcome(s): Analyzing patterns and writing recursive and explicit algebraic rules provides a powerful way to extend patterns and make predictions.

CT/Common Core State Standard(s):

- F-IF 3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
- F-BF 1. Write a function that describes a relationship between two quantities.
- Determine an explicit expression, a recursive process, or steps for calculation from a context.
- F-BF 2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Math Practice(s):

- MP4) Model with mathematics
- MP8) Look for and express regularity in repeated reasoning

Essential Question(s):

- What is a sequence?
- How can patterns be represented?
- What are the advantages and disadvantages of a recursive rule compared to an explicit rule?

Key Terms/Concepts: Arithmetic Sequence, Atom, Butane, Energy, Ethane, Explicit Rule, Methane, Fossil Fuel, Fractal, Geometric Sequence, Hexagon, Honeycomb, Hydrocarbon, Ion, Integer, Kilojoule, Mole, Molecular Structure, Molecule, N-th Term, Pentagon, Propane, Recursive Rule, Rule of 72, Symbolic Algebraic, Expression, Truss Style Bridge

Unit 1 – LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
8-F 2	1. Identify patterns from real world contexts	○ 1.1.1 Exploring with Hydrocarbons	Exit Slip 1.1

F-BF 1 **F-IF 3** **CCSS.ELA-LITERACY.RST.9-10.4**	2. Represent patterns using tables, graphs, and equations 3. Use patterns to solve problems	○ 1.1.2 Burning Hydrocarbons ○ 1.1.3 Organic Alcohols ○ Using eChem to Model Molecules ○ Titan Video ○ NASA Solar System Exploration ○ Molecular modeling kit (Styrofoam, gum drops, or marshmallows)	Journal Entry
F-IF 3 **F-BF 1** **CCSS.ELA-LITERACY.RST.9-10.4**	4. Add subtract multiply and divide integers 5. Apply order of operations to simplify	○ 1.2.1 Algebra Tiles and Integers ○ 1.2.2 Patterns in Signed Numbers ○ 1.2.3 Bingo with Order of Operations ○ Exploring Krypto ○ 1.2.4 Order of Operations ○ 1.2.5 Lifting Weights ○ 1.2.6 Patterns in Arithmetic ○ 1.2.7 Stack of Cups	Exit Slip 1.2.1 Exit Slip 1.2.2 Journal Entry
F-BF 1 **F-BF 2** **CCSS.ELA-LITERACY.RST.9-10.4**	6. Identify arithmetic sequences 7. Write recursive rules and explicit rules 8. Use patterns to solve problems	○ 1.3.1 Recursive and Explicit Rules for Arithmetic Sequences ○ 1.3.2 Building Bridges ○ 1.3.3 Arithmetic Sequences with Calculators ○ 1.3.4 Mohegan Sun Arena	Exit Slip 1.3 Journal Entry Mid-Unit Test
F-BF 1 **F-BF 2** **CCSS.ELA-LITERACY.RST.9-10.4**	9. Find recursive rules 10. Calculate terms of geometric sequences 11. Explain the difference between an arithmetic and a geometric sequence	○ 1.4.1 Doubling Your Money ○ 1.4.2 Applications of Geometric Sequences ○ 1.4.3 More Geometric Sequences ○ Illuminations' *Devil and Daniel Webster* Activity	Exit Slip 1.4 Journal Entry
F-IF 3 **F-BF 1** **F-BF 2** **CCSS.ELA-LITERACY.RST.9-10.4**	12. Create fractals 13. Identify patterns in fractals 14. Write recursive rules for geometric sequences	○ Fractal Website alicekelley.com ○ 1.5.1 Fractal Geometry ○ 1.5.2 Sierpinski's Triangle ○ 1.5.3 Koch Snowflake	Exit Slip 1.5 Journal Entry
		○ Unit 1 Performance Task (Honeycombs)	End of Unit Test

Suggested Resources and Texts: Titan video, NASA Solar System Exploration, Molecular modeling kit, Krypto game, The story of Devil and Daniel Webster by Illuminations, kokogiak's collection of pennies, The rule of 72 – 114 – 144 by allfinancialmatters, alicekelley.com, splashnology fractal designs, incrediblesnaps fractal desings

Suggested Technology: LCD Projector, Teacher computer with internet access and speakers, Computer lab or student computers for Excel exploration, graphing calculators, TI-SmartView Emulator or other means to project calculator steps

Unit 2: Linear Equations and Inequalities

Introduction and Established Goals: The material in this unit is the heart of algebraic thinking. Students write, simplify, evaluate, and model situations with linear expressions. Students then examine the concept of equality and use linear equations and linear inequalities to model and solve real-world problems. The properties of real numbers play a prominent role in this unit. The commutative, associative, and distributive properties are used when students simplify and evaluate expressions and solve multi-step equations. Opposites, reciprocals, and order of operations are used when students evaluate expressions and solve equations. Students revisit rational numbers when they solve equations and inequalities with rational number coefficients and rational number solutions.

Desired Outcome(s): To obtain a solution to an equation, no matter how complex, always involves the process of undoing the operations.

CT/Common Core State Standard(s):

- 8EE 7. Solve linear equations in one variable.
    - Give examples of linear equations in one variable with one solution, infinitely many solutions, or no solutions. Show which of these possibilities is the case by successively transforming the given equation into simpler forms, until an equivalent equation of the form $x = a$, $a = a$, or $a = b$ results (where a and b are different numbers).
    - Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.

- A-SSE 1. Interpret expressions that represent a quantity in terms of its context.
- Interpret parts of an expression, such as terms, factors, and coefficients.
- Interpret complicated expressions by viewing one or more of their parts as a single entity.

- A-SSE 3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.

- A-CED 1. Create equations and inequalities in one variable and use them to solve problems.

- A-CED 4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.

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

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

- N-Q 1 Use units as a way to understand problems and to guise the solution of multi-step problems; choose and interpret units consistently in formulas

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

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

- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Math Practice(s):

- MP1) Make sense of problems and persevere in solving them
- MP6) Attend to precision
- MP7) Look for and make use of structure

Essential Question(s):

- What is an equation?
- What is an expression?
- What does equality mean?
- What is an inequality?
- How can we use linear equations and linear inequalities to solve real world problems?
- What is a solution set for a linear equation or linear inequality?
- How can models and technology aid in the solving of linear equations and linear inequalities?

Key Terms/Concepts: Algebraic expression, associative property, coefficient, constant, commutative property, distributive property, evaluate, inequality symbol, integers, inverse operations, linear inequalities, literal equations, order of operations, properties of equality, real numbers, simplify, variable

Unit 2 – LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
AA-SSE 1 CCSS.ELA-LITERACY.RST.9-10.4	1. Represent algebraic expressions by verbal descriptions and flowcharts 2. Convert verbal descriptions to algebraic expressions 3. Evaluate algebraic expressions	○ 2.1.1 The Magic of Algebra ○ 2.1.2 Representing Expressions with Stories & Flowcharts ○ 2.1.3 Representing Expressions with Algebra Arrows ○ Fi.uu.nl/wisweb/en Algebra Arrows Applet ○ 2.1.4 Evaluating Algebraic Expressions	Exit Slip 2.1 Journal Entry
8EE 7 A-CED 1 A-REI 1 A-REI 3	4. Write linear equations that model real world scenarios 5. Solve one- and two-step linear equations 6. Justify their steps using algebraic properties	○ 2.2.1 Solving Equations using Flowcharts ○ 2.2.2 Solving Equations with Algebra Tiles ○ 2.2.3 Solving One-Step Linear Equations ○ 2.2.4 Equations in Education ○ 2.2.5 New York City Cab Fares	Exit Slip 2.2 Journal Entry 1 Journal Entry 2

CCSS.ELA-LITERACY.RST.9-10.4		○ 2.2.6 Station Problems Group Activity ○ 2.2.7 Solving Two-Step Linear Equations ○ NVLM Balance Scale Applet	
8EE 7 A-SSE 3 A-CED 1 A-REI 1 A-REI 3 CCSS.ELA-LITERACY.RST.9-10.4	7. Write linear equations that model real world scenarios 8. Solve equations with variables on both sides 9. Justify their steps using the properties of equality 10. Recognize equations for which there is no solution 11. Recognize equations for which there are infinite solutions	○ 2.3.1 Combining Like Terms with Algebra Tiles ○ 2.3.2 Solving Equations that Contain Like Terms ○ 2.3.3 Solving Equations with Variables on Both Sides ○ Writing and solving equations group activity ○ 2.3.4 Practice Solving Equations ○ NVLM Balance Scales ○ 2.3.5 Solving Equations with Balance Scales ○ 2.3.6 How Many Solutions ○ 2.3.7 Comparing Cab Fares	Exit Slip 2.3.1 Exit Slip 2.3.2 Journal Entry 1 Journal Entry 2 Mid-Unit Test
8EE 7 A-SSE 3 A-CED 1 A-REI 1 A-REI 3 CCSS.ELA-LITERACY.RST.9-10.4	12. Solve multi-step equations in a variety of contexts using the distributive property and combining like terms	○ 2.4.1 Solving Problems Using the Distributive Property Group Activity ○ 2.4.2 Distributive Property with Algebra Tiles ○ 2.4.3 Using the Distributive Property ○ 2.4.4 Walk-A-Thon ○ 2.4.5 Epic Win, Epic Fail Group Activity ○ NCTM Illuminations Balance Activity ○ 2.4.6 Pizza Party ○ 2.4.7 Multi-Step Equation Challenge ○ Algebralab.org additional practice ○ 2.4.8 Fraction Busters ○ 2.4.9 Geometry and Sports ○ 2.4.10 Arithmetic Sequences Revisited ○ 2.4.11 Big Brain Contest Competition	Exit Slip 2.4.1 Exit Slip 2.4.2 Exit Slip 2.4.3 Journal Entry
A-CED 4 A-REI 3 CCSS.ELA-LITERACY.RST.9-10.4	13. Change the subject of a formula in a literal equation 14. Explain why one would want to change the subject of a formula	○ 2.5.1 Literal Equations ○ 2.5.2 More Literal Equations ○ 2.5.3 Literal Equations with Flowcharts ○ 2.5.4 Green Problems ○ Comparison Powerpoint ○ Calculator Programming	Exit Slip 2.5 Journal Entry 1 Journal Entry 2

A-CED 1 A-REI 3 CCSS.ELA-LITERACY.RST.9-10.4	15. Write and solve linear inequalities in context 16. Justify why the inequality symbol is reversed when multiplying or dividing by a negative number, 17. Solve multi-step linear inequalities	○ 2.6.1 Representing Inequalities	Exit Slip 2.6.1 Exit Slip 2.6.2 Journal Entry
		○ 2.6.2 Equations and Inequalities	
		○ 2.6.3 When Do We Flip It?	
		○ Optional Graphing Calculator Program	
		○ 2.6.4 Working with Inequalities	
		○ 2.6.5 Practice Solving Inequalities	
		○ 2.6.6 Putting It All Together	
		○ 2.6.7 Passing Linear Inequalities Group Work	
		○ 2.6.8 Inequalities in the Real World	
		○ Prepsportswear.com activity	
		Unit 2 Performance Task (iPods)	End of Unit Test

Suggested Resources and Texts: WisWeb Algebra Arrows, Algebra Balance Scales (Positive and Negative Coefficients; NVLM) Applet, Algebra Tiles, Pan Balance NCT Illuminations Applet, AlgebraLab.org Online Practice, onlinemathlearning.com Multi-Step Equations, yourteacher.com Multi-Step Equations, education.ti.com Programming Tutorials, teachers.henrico.k12.va.us/math/hcpsalgebra1/module3-5.html Comparison Powerpoint, LINEQUA information on TI Website, prepsportswear.com

Suggested Technology: Graphing Calculators

Unit 3: Functions

Introduction and Established Goals: Students are introduced to the concept of a function in the first investigation of this unit. After identifying relationships that are or are not functions, they learn how to define the domain and range of a function.

Desired Outcome(s): Students will understand that functions are a mathematical way to describe relationships between two quantities that vary.

CT/Common Core State Standard(s):

- 8F 1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.

- 8F 2. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

- 8F 5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

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

- A-CED 10. Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).

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

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

- F-IF 4. For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities and sketch graphs showing key features given a verbal description of the relationship.

- F-IF 5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.

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

- F-IF 9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Math Practice(s):

- MP4) Model with mathematics
- MP5) Use appropriate tools strategically

Essential Question(s):

- What is a function?
- What are the different ways in which functions may be represented?
- How can functions be used to model real world situations, make predictions, and solve problems?

Key Terms/Concepts: Dependent Variable, Domain, Equation of a Function, Evaluating a Function, Function, Function Notation, Graph of a Function, Independent Variable, Input, Linear Function, Mapping Diagram, Non-Linear Function, Ordered Pair, Output, Parabola, Range, Relation, Table, Vertical Line Test

Unit 3 – LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
8 F-1 **F-IF1** **CCSS.ELA-LITERACY.RST.9-10.4**	1. Identify whether a given relation is a function 2. Identify domain and range of functions	3.1.1a/b Representing Relations I/II 3.1.2 Is It a Function?	Exit Slip 3.1 Journal Entry
8 F-2 **8 F-5** **A-CED 2** **A-CED 10** **F-IF 9** **CCSS.ELA-LITERACY.RST.9-10.4**	3. Identify functions and non-functions in real world contexts 4. Determine the input variable and the output variable 5. Represent function by tables and graphs and words	Tap Water vs. Bottle Water Video 3.2.1 Bottled Water 3.2.2 Hartford Precipitation 3.2.3 Functions Everywhere 3.2.4 Celsius and Fahrenheit 3.2.5 The Raven and the Jug	Exit Slip 3.2 Journal Entry
F-IF 2 **CCSS.ELA-LITERACY.RST.9-10.4**	6. Use function notation to solve problems 7. Evaluate functions using function notation	3.3.1 Function Machines 3.3.2 Introduction to Function Notation 3.3.3 Exchange Rates 3.3.4 Hot Air Balloon Group Activity 3.3.5 Piecewise Functions	Exit Slip 3.3.1 Exit Slip 3.3.2 Journal Entry
A-CED 2 **F-IF 4**	8. Evaluate linear and non-linear functions in context	Parent Functions Reference Sheet 3.4.1 Highway Driving 3.4.2 Travel Time 3.4.3 Free Throws	Exit Slip 3.4 Journal Entry

F-IF 5 CCSS.ELA-LITERACY.RST.9-10.4	9. Identify the domain and range of linear and non-linear functions	3.4.4 Height of a Ball	
		3.4.5 Volume of a Cube	
		3.4.6 Phone Tree	
		3.4.7 Handshakes Group Activity	
		3.4.8 Geoboard Squares	
		Thefutureschannel.com Video (*The Wind Business*)	
		Powermills Activity	
		3.4.9 U.S. Postal Service Rates	
		Unit 3 Performance Task (Functions in the Real World)	End of Unit Test

Suggested Resources and Texts: bottledwater.org, weather.com, bofunk.com video on consumer preference for bottled water, environmental video on thefutureschannel, powermills activity sheet

Suggested Technology: Projector

Unit 4: Linear Functions

Introduction and Established Goals: Students start Unit 4 by exploring the distinction between linear and nonlinear behavior, and then focus on learning about linear functions. Throughout Unit 4, students derive linear models of real-world situations in order to analyze situations, make predictions or solve problems. Analyzing situations often takes the form of identifying the real world meaning of the slope and the *x*- and *y*-intercepts of a linear model. Making predictions involves evaluating models for a given independent variable (given *x* find *y*), and solving equations for the independent variable given the dependent variable (given *y* find *x*). Problem solving occurs through the use of various representations: algebraic, tabular, graphic and numeric.

Desired Outcome(s): Students will understand linear functions are characterized by a constant average rate of change (or constant additive change).

CT/Common Core State Standard(s):

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

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

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

- F-LE 1. Distinguish between situations that can be modeled with linear functions [and with exponential functions].
    - Prove that linear functions grow by equal differences over equal intervals...
    - Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.

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

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

- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Math Practice(s):

- MP4) Model with mathematics
- MP5) Use appropriate tools strategically

Essential Question(s):

- What is a linear function?
- What are the different ways that linear functions may be represented?
- What is the significance of a linear function's slope and y-intercept?
- How many linear functions model real world situations?

- How may linear functions help us analyze real world situations and solve practical problems?

Key Terms/Concepts: Constant Additive Change, Convex Polygon, Dependent Variable, Direct Variation, Independent Variable, Initial Value, Linear Function, Linear Models, Magnitude, Nonlinear Function, Parameters, Piecewise Function, Point-Slope Form, Rate of Change, Slope, Slope-Intercept Form, Standard Form, Unit Rate, Velocity, x-intercept, y-intercept

Unit 4 – LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
FLE-1 **FIF-7A** **CCSS.ELA-LITERACY.RST.9-10.4**	1. Interpret distance-time graphs and tables in terms of the motion of an object 2. Write a verbal description of a distance-time function, sketch its graph, and construct a table of values 3. Distinguish between linear and non-linear functions by recognizing that linear functions have a constant rate of change whether the function is given verbally, graphically, or in table form. 4. Identify distance-time functions with slopes of different magnitudes from the verbal description, the graph, and the table 5. Distinguish between distance-time functions with positive slopes and functions with negative slopes given a verbal, graphical, or tabular representation of the function	○ "Do the Locomotion" Intro Video ○ Sheila Patek TED Talk ○ Aimee Mullens TED Talk ○ Maglev Train Video ○ 4.1.1 What Makes a Function Linear ○ 4.1.2 Motion Graph Scenarios ○ 4.1.3 More Motion Graphs ○ 4.1.4 Stories and Graphs ○ 4.1.5 Motion Graph Challenge Problems	Exit Slip 4.1.1 Exit Slip 4.1.2 Journal Entry
F-IF6 **F-LE1**	6. Distinguish between a linear and non-linear	○ 4.2.1 Pizza Problems ○ 4.2.2 Recognizing Linear Functions	Exit Slip 4.2 Journal Entry

F-LE1A **CCSS.ELA-LITERACY.RST.9-10.4**	function from a table of values and from a graph 7. Transform a function from one representation to another 8. Identify a linear function's constant average rate of change and y-intercept and interpret them in a non-contextual setting 9. Use an equation or a graph of a function that models a real-world situation to produce a particular ordered pair and give an appropriate interpretation of its meaning in context 10. Choose appropriate increments and scales to construct tables and four-quadrant graphs and select the appropriate table set up and windows when using technology and use the trace feature to demonstrate the relationship between an ordered pair and a point on the graph	○ 4.2.3 Using Tables to Determine if a Function is Linear Group Work ○ 4.2.4 Draining a Swimming Pool Group Work ○ 4.2.5 Ordering DVDs ○ 4.2.6 Linear Functions in Geometry ○ 4.2.7 Teddy Bear Sales	
	11.	○	Quiz on Investigations 4.1 and 4.2
F-IF6 **F-LE1A** **F-LE1B** **CCSS.ELA-LITERACY.RST.9-10.4**	12. Determine run, rise, and slope given two points in the coordinate plane 13. Identify the slope given the verbal description, graphic, or tabular model of a linear function 14. Graph a line given a point and the average rate of change or slope 15. Graph a linear function by creating a table of	○ 4.3.1 What is Slope ○ 4.3.2 Calculating and Interpreting Slope ○ 4.3.3 Positive and Negative Slope ○ 4.3.4 Magnitude of Slope	Exit Slip 4.3.1 Exit Slip 4.3.2 Journal Entry

	values when given an equation for the linear function 16. Recognize rates in the form of units of the dependent variable per units of independent variable 17. Interpret the rate of change of the linear function in a real-world context 18. Identify and graph horizontal and vertical lines 19. Determine whether lines are parallel or perpendicular		
F-LE2 **F-LE5** **F-IF7** **F-IF7A** **G-GPE 5** **CCSS.ELA-LITERACY.RST.9-10.4**	20. 21. Describe the changes in a line that occur when the y-intercept increases or decreases 22. Describe the changes in a line that occur when the slope increases or decreases 23. Graph a line given the slope intercept form of a line by first plotting the y-intercept then using slope to find a second point on the line 24. Explain the meaning of a change in slope or a change in y-intercept in the context of a real world problem 25. Identify the slope and y-intercept of a line from the graph of a linear function 26. Find the slope intercept form of the equation of a line given its graph with	○ 4.4.1 Effects of Changing Parameters ○ 4.4.2 Slope-Intercept Form ○ 4.4.3 Practice with Slope-Intercept Form ○ 4.4.4 Making a Profit ○ 4.4.5 Applications of Slope-Intercept Form ○ 4.4.6 Parallel and Perpendicular Lines ○ 4.4.7 More Parallel and Perpendicular Lines	Exit Slip 4.4.1 Exit Slip 4.4.2 Journal Entry

	the y-intercept and an indicated point 27. Identify parallel lines as having the same slope, but distinct y-intercepts 28. Identify perpendicular lines as having slopes that are opposite reciprocals (product of -1)		
	29.	○	Mid-Unit Test
F-LE5 **F-LE2** **F-LE1** **CCSS.ELA-LITERACY.RST.9-10.4**	30. Recognize two forms of a linear equation 31. Recognize direct variation problems as a special case of slope-intercept form 32. Model a real world situation with an appropriate form of a linear equation 33. Find x and y intercepts and slope of a linear function given any form of the equation 34. Draw the graph given the x and y intercepts, slope and y-intercept 35. Explain what the x and y intercepts represent in the context of a real world problem 36. Transform linear equations from standard form to slope-intercept form	○ 4.5.1 Direct Variation ○ 4.5.2 More Direct Variation ○ 4.5.3 Standard Form of a Linear Equation ○ 4.5.4 More Standard Form ○ 4.5.5 Practice with Standard Form and Slope-Intercept Form ○ Slope Intercept Online Game ○ Video on Roof Trusses	Exit Slip 4.5 Journal Entry 1 Journal Entry 2 Journal Entry 3
			Unit 4 Investigation 5 Quiz
F-LE 5 **F-LE2** **F-IF8** **F-LE1**	37. Write an equation of a line in the context of a real world of a real world problem 38. Write the equation of a line in slope-intercept	○ 4.6.1 Trends in Bottled Water Consumption ○ 4.6.2 Point-Slope Form of an Equation ○ 4.6.3 Practice with Point-Slope Form ○ 4.6.4 Can We Both Be Right	Exit Slip 4.6.1 Journal Entry 1 Exit Slip 4.6.2 Journal Entry 2

CCSS.ELA-LITERACY.RST.9-10.4	form, point-slope form, or standard form 39. Transform an equation from slope-intercept form or point-slope form to standard form 40. Transform an equation from point-slope form or standard form to slope-intercept form 41. Make predictions based on the meaning of the function 42. Use slope and intercepts to analyze real world problems	○ 4.6.5 Transforming Linear Forms ○ 4.6.6 Finding and Using Linear Functions ○ 4.6.7 You Choose ○ Forest Elementray Link ○ NY Times Bottled Water Archive Activity	
		Unit 4 Performance Task (Linear Models)	End of Unit Test

Suggested Resources and Texts: NCTM Illuminations lesson "Movement with Functions," Time-Distance lessons under "classroom activities" on the Texas instruments website, Workbooks from Texas Instruments such as *Real World Math Made Easy* by Chris Brueningsen, *CBR Explorations: Math and Science in Motion* by Brueningsen, Forest Elementary Article hometownlife.com, NY Times bottled water archive topics.nytimes.com, slope intercept game links at hotmath.com, video on roof trusses on youtube

Suggested Technology: Motion detector such as those by Vernier, Projector, graphing calculators

Unit 5: Scatter Plots and Trend Lines

Introduction and Established Goals: Students will begin the unit by exploring measures of central tendency and spread and displays of one-variable data including, dot plots, histograms, and box-and-whisker plots. They will use the five number summary to create box-and-whisker plots and identify outliers with the 1.5 X IQR rule. They will be introduced to using the STAT menu on the graphing calculator.

Desired Outcome(s): Although scatter plots and trend lines may reveal a pattern, the relationship of the variables may indicate a correlation, but not causation**.**

CT/Common Core State Standard(s):

- 8-SP 1. Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

- 8-SP 2. Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

- 8-SP 3. Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept.

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

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

- S-ID 6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related.
    - Fit a function to the data; use functions fitted to data to solve problems in the context of the data.
    - Fit a linear function for a scatter plot that suggests a linear association.

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

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

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

- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Essential Question(s):

- How do we make predictions and informed decisions based on current numerical information?
- What are the advantages and disadvantages of analyzing data by hand versus by using technology?
- What is the potential impact of making a decision from data that contains one or more outliers?

Key Terms/Concepts:

Boxplot, causation, correlation, correlation coefficient, data, data set, dependent variable, distribution, domain, extrapolation, graphical representation, histogram, independent variable, interpolation, interquartile range (IQR), line of best fit, linear regression, linear relationship/model, mean (average), median, measures of central tendency, mode, nonlinear relationship/model, ordered pair, outlier, piecewise function, prediction, regression equation, scale, scatter plot, skewed distribution, slope, trend line, variable, x intercept, y intercept.

LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
S-ID 1 **S-ID 2** **S-ID 3** **CCSS.ELA-LITERACY.RST.9-10.4**	1. Find and understand measures of center 2. Find and understand measures of spread 3. Create and interpret a dot plot, histogram, and box-and-whisker plot	○ "The Power of Hurricanes" Video ○ 5.1.1 Hurricanes ○ 5.1.2 Home Run Hitters ○ 5.1.3 More Histograms ○ 5.1.4 The Five-Number Summary ○ 5.1.5 Outliers and the 1.5xIQR Rule ○ 5.1.6 Box-and-Whisker Plots ○ 5.1.7 Test Grades	Exit Slip 5.1.1 Exit Slip 5.1.2 Journal Entry
8-SP 1 **8-SP 2** **8-SP 3** **S-ID 6 a, c** **S-ID 7** **CCSS.ELA-LITERACY.RST.9-10.4**	4. Be able to fit a trend line to data. 5. Write an equation for a trend line 6. Use the equation to interpolate or extrapolate 7. Be understand the contextual meaning of the parameters of the trend line equation	○ Sea Level Rise Powerpoint ○ 5.2.1 Sea Level Rise ○ 5.2.2 Scatter Plots and Trend Lines ○ 5.2.3 Television, Homework, and Test Scores ○ 5.2.4 Height and Shoe Size	Exit Slip 5.2.1 Exit Slip 5.2.2 Journal Entry
8-SP 1 **8-SP 2** **8-SP 3**	8. Be able to find the equation for the line of best fit using technology 9. Identify the strength and direction of a trend line	○ 5.3.1 Fitting Lines with Technology ○ 5.3.2 Evolution of the Telephone ○ Evolution of the Telephone Video	Exit Slip 5.3 Journal entry

S-ID 6 a, c **S-ID 7** **S-ID 8** **S-ID 9** **CCSS.ELA-LITERACY.RST.9-10.4**	using the correlation coefficient 10. Explain the difference between one variable being correlated to the other and one variable causing the other to occur	○ 5.3.3 Correlation and Causation ○ 5.3.4 Shark Attacks ○ 5.3.5 Regression Equation Practice	
8-SP 1 **S-ID 6** **S-ID 8** **CCSS.ELA-LITERACY.RST.9-10.4**	11. Answer a question about the world that can be analyzed with bivariate data 12. Be able to use technology to calculate the regression equation and correlation coefficient 13. Solve an equation for y given x and x given y 14. They will be able to explain the meaning of slope and intercepts in context 15. Distinguish between data that is correlated compared to causal	○ 5.4.1 Forensic Anthropology ○ Forensic Anthropology Powerpoint ○ 5.4.2 Rubber Bands ○ 5.4.3 Stadium Wave ○ 5.4.4 Balloons ○ 5.4.5 Walking Away ○ 5.4.6 Population and Representation ○ 5.4.7 Conducting an Experiment	Exit Slip 5.4 Journal Entry
S-ID 6 **S-ID 8** **CCSS.ELA-LITERACY.RST.9-10.4**	16. Define an outlier 17. Identify whether a potential outlier is present on a scatter plot and name the coordinates of the outlier 18. Draw regression lines and provide a general description of the influence that outliers have on the slope as well as the direction and strength of the relationship between two variables	○ 5.5.1 Outliers ○ 5.5.2 Barry Bonds' Home Runs ○ 5.5.3 Home Prices ○ 5.5.4 Chicago Bulls ○ 5.5.5 Crickets Chirping ○ The Outlier Game	Exit Slip 5.5 Journal Entry

	19. Describe the impact that outliers have on linear regression equations, their related components, and the conclusions drawn from an analysis of a data set in which they are included			
8-SP 1 **8-SP 2** **8-SP 3** **S-ID 6 a, c** **S-ID 7** **F-IF 7b** **CCSS.ELA-LITERACY.RST.9-10.4**	20. Identify two points on each line segment and use them to calculate the equation of the line that contains that segment 21. Identify the domain for which the line segment fits the data 22. Write the piecewise function given the graph 23. Create a story that describes a piecewise graph	○ 5.6.1 Swimming Records ○ 5.6.2 Paychecks & Triathlons ○ 5.6.3 Dog Food ○ 5.6.4 Feeding the Birds ○ 5.6.5 Bike Tours ○ 5.6.6 Creating Stories	Exit Slip 5.6 Journal Entry 1 Journal Entry 2	
		Unit 5 Performance Task (Linearity is in the Air – Can You Find It?)	End of Unit Test	

Suggested Resources and Texts: Raw Spaghetti, Measuring Tapes, Yard Sticks, Rulers, Rubber Bands, Youtube.com, Masking Tape, Balloons, Small Aerobic Exercise Equipment

Suggested Technology: Graphing Calculators, Computer, Projector, Stopwatch

Unit 6: Systems of Equations

Introduction and Established Goals: Through the three investigations in this unit, students will understand how to solve equations involving two unknowns, both algebraically and graphically. Students will identify the point of intersection of the two lines as the solution of the system of equations and then interpret the solution in the context of the problem. Students will recognize when one method of solving a system of linear equations is more advantageous than another.

Desired Outcome(s): Students will understand that a system of linear equations is an algebraic way to compare two equations that model a situation and find the breakeven point or choose the most efficient or economical plan.

CT/Common Core State Standard(s):

- A-CED 3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.

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

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

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

Math Practice(s):

- MP4 Model with Mathematics
- MP5 Use appropriate tools strategically

Essential Question(s):

- What does the number of solutions (none, one or infinite) of a system of linear equations represent?
- What are the advantages and disadvantages of solving a system of linear equations graphically versus algebraically?

Key Terms/Concepts: Addition Property of Equality, Breakeven Point, Elimination Method for Solving Systems of Equations, Fixed Cost, Multiplication Property of Equality, Profit, Revenue, Solution of Linear Equations, Substitution Method for Solving Systems, Substitution Property of Equality, System of Linear Equations, Total Cost, Transitive Property of Equality, Variable Cost

LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
A-REI #6 **A-REI #11**	1. Write equations to model a situation, graph equations, find the point of intersection, and interpret the solution in the context of the problem 2. Solve a system of linear equations that represents a real-world situation graphically and numerically 3. Students will explain what the solution to a system of linear equations means in the context of the problem.	○ 6.1.1 Will Women Catch the Men? ○ 6.1.2 Choosing a Gym ○ 6.1.3 Solving Systems of Equations by Graphing ○ 6.1.4 Systems with Equations in Different Forms	Exit Slip 6.1 Journal Entry
A-REI #5 **A-REI #6**	4. Solve a system of linear equations using the substitution method 5. Explain what the solution to a system of linear equations means in the context of a real-world problem	○ 6.2.1 Passing on the Gift ○ 6.2.2 Solving Systems by the Substitution Method ○ 6.2.3 More Practice with the Substitution Method ○ 6.2.4 Drag Racing ○ Drag Racing Video ○ Drag Racing Applet ○ 6.2.5 Break-Even Analysis ○ 6.2.6 Systems of Equations in Slope-Intercept Form ○ 6.2.7 One for All	Exit Slip 6.2.1 Exit Slip 6.2.2 Journal Entry 1 Journal Entry 2
A-REI #5	6. Use the elimination method to solve a system of equations 7. Explain the algebraic properties upon which the elimination method is based 8. Explain the relationship between the number of solutions to a system of equations and the relationship between the slopes and y-intercepts of the equations within a system 9. Identify the characteristics of systems of equations that lend themselves to the substitution and elimination methods	○ 6.3.1 Introduction to the Elimination Method ○ 6.3.2 Exploring the Number of Solutions ○ 6.3.3 Applications of the Elimination Method ○ 6.3.4 Mechanics of the Elimination Method ○ 6.3.5 Selecting an Algebraic Method	Exit Slip 6.3.1 Journal Entry 1 Journal Entry 2 Exit Slip 6.3.2

		Unit 6 Performance Task (Park)	End of Unit Test

Suggested Resources and Texts: Heifereducation.org, dragtimes.com, uhaweb.hartford.edu/rdecker, thefutureschannel.com/hands-on_math/computer_problems.php

Suggested Technology: Graphing Calculators, Computers, Projectors

Unit 7: Scatter Plots and Trend Lines

Introduction and Established Goals: Unit 7 builds on the concepts of a function and patterns of change. Students work with interesting and significant relationships that are exponential in nature. Many of the contexts explored affect their daily lives.

Desired Outcome(s): When comparing an exponential model with a linear model, the question is not *if* the exponential model will generate very large or very small inputs, but rather *when*. With real data, sometimes deciding whether data is linear or non-linear is more complex than just looking at a graph, differences ($y_n - y_{n-1}$), or an r-value; it is important to examine differences that are approximately the same more carefully to see if there is a pattern of increasing or decreasing values that, because the pattern is exponential, soon begins to produce outputs of remarkable values.

CT/Common Core State Standard(s):

- N-RN 1. Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.*

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

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

- A-SSE 3c. Use the properties of exponents to transform expressions for exponential functions. For example, the expression 1.15^t can be rewritten as $[1.15^{(1/12)}]^{(12t)} \approx 1.012^{(12t)}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.

- F-IF 7. Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- e. Graph exponential functions, showing intercepts and end behavior.

- F-IF 8b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{12t}$, $y = (1.2)^{(t/10)}$, and classify them as representing exponential functions.

- F-BF 2. Write ... geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.

- F-LE 1. Distinguish between situations that can be modeled with linear functions and with exponential functions.

    - Prove that exponential functions grow by equal factors over equal intervals.
    - Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.

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

- F-LE 3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly.

- F-LE 5. Interpret the parameters in an exponential function in terms of a context.

- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Math Practice(s):

- MP1) Make sense of problems and persevere in solving them
- MP4) Model with mathematics
- MP6) Attend to precision

Essential Question(s):

- What characterizes exponential growth and decay?
- What are real world models of exponential growth and decay?
- What are the limitations of exponential growth models?
- How can one differentiate an exponential model from a linear model given a real world data set?

Key Terms/Concepts: Exponential Function, Exponential Growth, Exponential Decay, Growth Factor, Decay Factor, Per Cent rate of change, Doubling Time, Half Life, Compound Interest, Asymptote, Laws of Exponents

LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
F-IF 7e **F-BF 2** **F-LE 1a** **F-LE 3** **CCSS.ELA-LITERACY.RST.9-10.4**	1. Distinguish between linear and nonlinear growth in tables or in graphs 2. Recognize that nonlinear growth leads to average rates of change that are not constant 3. Use a recursive feature of a graphing calculator to model exponential growth	○ Fao.org/hunger/en ○ Wfp.org/hunger/map ○ Stopthehunger.com ○ Youtube.com ○ 7.1.1 Is Population Growth Linear ○ 7.1.2 Is it a Good Deal? ○ 7.1.3 A Closer Look at World Population Data ○ 7.1.4 World Agriculture Production ○ 7.1.5 Population and Food Production	Exit Slip 7.1.1 Exit Slip 7.1.2 Journal Entry 1 Journal Entry 2

	4. Recognize that exponential growth occurs when there is a constant multiplicative pattern among function values		
N-RN 1 **N-RN 2** **F-IF 7e** **F-LE 1** **F-LE 3** **CCSS.ELA-LITERACY.RST.9-10.4**	5. Recognize that whereas linear growth patterns can be modeled by y=mx+b, exponential growth patterns can be modeled by $y = ab^x$ 6. Explore patterns with positive integer exponents to justify the rules: 7. $a^m a^n = a^{m+n}$, $\frac{a^m}{a^n} = a^{m-n}$, and $(a^m)^n = a^{mn}$. 8. Extend the meaning of exponents to include zero and negative integer exponents 9. Extend the meaning of exponents to include rational exponents 10. Contrast linear and exponential growth	○ 7.2.1 Exploring Growth Patterns ○ 7.2.2 The Meaning of Integer Exponents ○ 7.2.3 Exploring the Meaning of Rational Exponents ○ 7.2.4 Roots and Exponents ○ 7.2.5 Exploring an Exponential Function ○ 7.2.6 How Many Grains? ○ Mathforum.org King and Chess Story	Exit Slip 7.2.1 Journal Entry 1 Exit Slip 7.2.2 Journal Entry 2
F LE-1 **F LE-2** **F LE-3** **F LE-5** **CCSS.ELA-LITERACY.RST.9-10.4**	11. Describe the effects of the parameters a and b in the exponential function $f(x) = ab^x$ 12. Distinguish between exponential growth and decay in real-world contexts 13. Fit an exponential function to a set of data	○ Whc.unesco.org/en/list/438 ○ 7.3.1 Building Walls ○ 7.3.2 Exploring the Exponential Graph ○ 7.3.3 Effects of Parameters ○ 7.3.4 Modeling Exponential Growth and Decay Using Parameters ○ 7.3.5 Growth and Decay Situations ○ 7.3.6 Identifying Exponential Functions	Journal Entry Exit Slip 7.3
F-LE 2 **F-LE 5**	14. Collect data from an experiment, make a table and a graph, and	○ 7.4.1 Tossing M and Ms ○ 7.4.2 Bouncing Balls ○ 7.4.3 Facebook Users	Exit Slip 7.4 Journal Entry

CCSS.ELA-LITERACY.RST.9-10.4	then fit an exponential function to the data 15. Reflect on the accuracy of the exponential model given the nature of the experiments		
A-SSE 1b **A-SSE 3c** **F-IF 8b** **F-LE 1c** **F-LE 5** **CCSS.ELA-LITERACY.RST.9-10.4**	16. Given a percent rate of change students will be able to determine the growth or decay factor and write an explicit equation for an exponential function 17. Given an exponential function students will be able to determine the percent rate of change and the growth or decay factor 18. Students will apply their understanding of exponential functions to the computation of compound interest	○ Thefutureschannel.com Video ○ 7.5.1 Percents and Percent Change ○ 7.5.2 Percent Change and Exponential Functions ○ 7.5.3 Percent Change Situations ○ 7.5.4 Modeling Exponential Functions: What Is the Percent Change? ○ 7.5.5 Compound Interest ○ 7.5.6 Doubling Time and Half-Life ○ Rule of 72 Supplemental Activities	Exit Slip 7.5.1 Journal Entry Exit Slip 7.5.2
F-LE 1 **F-LE 1c** **F-LE 2** **F-LE 5** **CCSS.ELA-LITERACY.RST.9-10.4**	19. Represent climate data with tables, graphs, and equations 20. Explore graphs of data and determine which type of function (linear, exponential, or piecewise) to use a model 21. Interpret the parameters of functions in terms of context 22. Use linear and exponential models to predict future values	○ 7.6.1 The Mathematics of Global Warming ○ 7.6.2 Countering Global Warming ○ Climatecrisis.com ○ Takepart.com/an-inconvenient-truth ○ Co2now.org	Exit Slip 7.6 Journal Entry
		Unit 7 Performance Task (The Consequences of Global Warming)	End of Unit Test

Suggested Resources and Texts: foa.org/hunger/en, wfp.org/hunger/map, stopthehunger.com, youtube.com, mathforum.org/sanders/geometry/GP11Fable.html, Square Tiles and Linked Cubes, Bags of M&Ms, Paper Plates and Paper Cups, Bouncing Balls, Yardsticks, Tape Measures, Masking Tape, climatecrisis.com, takepart.com/an-inconvenient-truth, co2now.com

Suggested Technology: Graphing Calculators, Projector, Computer

Unit 8: Quadratic Functions and Equations

Introduction and Established Goals: Students will learn how quadratic functions and solving quadratic equations relate to real-world examples.

Desired Outcome(s): Quadratic functions can be used to model real world relationships and the key points in quadratic functions have meaning in the real-world context. Polynomials are closed under addition, subtraction, and multiplication. Dynamic software, graphic calculators, and other technology can be used to explore and deepen our understanding of mathematics.

CT/Common Core State Standard(s):

- 8EE 2. Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.

- A-SSE 3. a Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

- A-REI 4. a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form (x – p)2 = q that has the same solutions. Derive the quadratic formula from this form. Solve quadratic equations by inspection (e.g., for x2 = 49), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation.

- A-APR 1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.

- A-CED 1. Create equations and inequalities in one variable and use them to solve problems. Include equations arising from ...quadratic functions ...

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

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

- F-IF 7a. Graph ... quadratic functions and show intercepts, maxima, and minima.

- F-IF 8a. 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.

- F-BF 3. Identify the effect on the graph of replacing f(x) by f(x) + k, kf(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs.

Experiment with cases and illustrate an explanation of the effects on the graph using technology.

- CCSS.ELA-LITERACY.RST.9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grade 9 text and topics.

Math Practice(s):

- MP4) Model with mathematics
- MP5) Use appropriate tools strategically

Essential Question(s):

- What can the zeros, intercepts, vertex, maximum, minimum and other features of a quadratic function tell you about real world relationships?
- How is the polynomial system analogous to the system of integers?
- How can technology support investigation and experimentation of the way that parameters effect functions?

Key Terms/Concepts: Algorithm, Binomial, Coefficient, Completing the Square, Constant Term, Decreasing, Delta, Delta-Delta, Expanded Form, Factored Form, First Differences, Increasing, Leading Coefficient, Line of Symmetry, Linear Term Opens Up, Monomial, Opens Down, Quadratic Formula, Quadratic Function, Quadratic Equation, Quadratic, Second Differences, Parabola, Parameter, Quadratic, Square Root Property, Standard Form, Trinomial, Vertex, Vertex Form, Vertex Formula, x-intercepts, y-intercepts, Zero Product Property

LEARNING PLAN

STANDARD	LEARNING OBJECTIVES (Content and Skill)	INSTRUCTIONAL STRATEGIES	ASSESMENT EVIDENCE
A-CED 1 A-CED 2 F-IF4 CCSS.ELA-LITERACY.RST.9-10.4	1. Distinguish, given a table of values, between the nonlinear pattern of exponential and quadratic growth 2. Make a scatter plot by hand or technology with appropriate scaling and labels and recognize a graph that could be modeled by a quadratic function 3. Recognize that for nonlinear growth, the average rates of change will not be constant	○ 8.1.1 Quadratics in the Kitchen ○ 8.1.2 Modeling HIV Data ○ 8.1.3 Rolling Ball & CBR 2 ○ 8.1.4 Quadratic Functions by Table ○ 8.1.5 Social Security Trust Fund ○ 8.1.6 Exploring the Parameters of $y = ax^2 + bx + c$ ○ 8.1.7 Galileo in Dubai	Exit Slip 8.1.1 Journal Entry Exit Slip 8.1.2

	4. Recognize that for quadratic growth, the average rates of change exhibit linear growth or in other words, the second differences are constant		
F-IF 4 F-IF 7a F-BF 3 CCSS.ELA-LITERACY.RST.9-10.4	5. Find the vertex of a quadratic function from its equation given an equation in vertex form of standard form 6. Model a real-world situation by writing the equation of quadratic function given the vertex and one other point 7. Transform a quadratic function in standard form to a function in vertex form by finding $h = \frac{-b}{2a}$ and $k = f\left(\frac{-b}{2a}\right)$ 8. Graph a quadratic function in vertex form	○ 8.2.1 Design a Solar Cooker ○ Falstad.com/ripple/ex-parabola ○ 8.2.2 Graphing Quadratic Functions in Vertex Form ○ 8.2.3 Exploring Parameters with Geometer's Sketchpad ○ 8.2.4 Modeling with Quadratic Functions in Vertex Form ○ 8.2.5 Bouncing Ball ○ 8.2.6 Transforming Quadratic Functions in Standard Form to Vertex Form ○ Solar Cooker Video/Images	Exit Slip 8.2 Journal Entry 1 Journal Entry 2
8-EE 2 A-REI 4 CCSS.ELA-LITERACY.RST.9-10.4	9. Recognize the relationship between squares and square roots 10. Recognize and distinguish quadratic functions in standard form and in vertex form 11. Undo quadratic expressions to find solutions to equations 12. Solve equations of the form $a(x-h)^2 + k$= constant 13. Find the x-intercepts of parabolas given functions in vertex form.	○ 8.3.1 Fenway Park ○ 8.3.2 The Square Root Property ○ 8.3.3 Solving Two Step Equations with the Square Root Property ○ 8.3.4 Multi-Step Equations with Square Roots ○ 8.3.5 Finding x-intercepts of Parabolas ○ 8.3.6 Solving Quadratic Equations in Standard Form	Journal Entry 1 Exit Slip 8.3.1 Exit Slip 8.3.2 Journal Entry 2
			Mid Unit Test
A-APR 1 F-IF 4 F-IF 7a	14. Graph and find the vertex of quadratic functions in factored form 15. Use the zero product property to find the	○ 8.4.1 Functions in Factored Form ○ 8.4.2 Finding the Maximum Profit ○ 8.4.3 Password ○ Youtube Video	Exit Slip 8.4.1 Journal Entry 1 Exit Slip 8.4.2

F-BF 3 CCSS.ELA-LITERACY.RST.9-10.4	intercepts of a quadratic function in factored form 16. Multiply combinations of monomials, binomials, and trinomials 17. Convert quadratic functions in factored form to standard form	○ 8.4.4 Writing Quadratic Equations in Factored Form ○ 8.4.5 Multiplying Polynomials ○ Algebra Tiles ○ 8.4.6 Standard Form for Quadratic Functions	Journal Entry 2
A-SSE 3a CCSS.ELA-LITERACY.RST.9-10.4	18. Factor quadratic trinomials in various forms 19. Check factorizations using multiplication 20. Convert quadratic functions in standard form to factored form 21. Solve a quadratic equation by factoring or determine that a quadratic equation cannot be solved in this way	○ 8.5.1 Finding Common Monomial Factors ○ Factoring methods video ○ Algebra Tiles ○ Wolfram alpha ○ Calculatorsoup.com ○ 8.5.2 Factoring Trinomials ○ 8.5.3 Find Your Match ○ Juggling Video ○ 8.5.4 Solving Quadratic Equations by Factoring ○ 8.5.5 Building Fences	Exit Slips 8.5 Journal Entry 1 Journal Entry 2
A-REI 4 A-SSE 3b F-IF 8a CCSS.ELA-LITERACY.RST.9-10.4	22. Solve a quadratic equation that cannot be factored by completing the square and by using the quadratic formula	○ 8.6.1 Completing the Square ○ 8.6.2 Proving the Quadratic Formula ○ 8.6.3 Using the Quadratic Formula ○ 8.6.4 Golden Rectangles	Exit Slip 8.6 Journal Entry
		Unit 8 Performance Task (Stopping Distance)	End of Unit Test

Suggested Resources and Texts: education.TI.com, math.lsa.umich.edu/courses/105/m105_f05_h4.pdf, wolframalpha.com, Algebra Tiles PowerPoint, illuminations.nctm.org, library.thinkquest.org, phet.colorado.edu, video.pbs.org

Suggested Technology: Graphing Calculators, Computer Access