Linear and Quadratic Functions

Content Area: **Math**
Course(s):
Time Period: **MP1**
Length: **45**
Status: **Published**

Unit Overview

Unit Summary	Unit Rationale
In this unit students build upon their prior knowledge of linear and quadratic functions. Students identify the key features of functions and understand how to interpret graphs of functions. Students learn methods for solving equations and inequalities and systems of linear equations and inequalities by using graphing and tables. In this unit students also identify different forms of quadratic functions and their key features. Students will explore complex numbers and solve problems with complex numbers. This unit also provides opportunities for students to learn different methods for solving quadratic equations.	In this unit students continue to develop their understanding of functions. Functions help students to analyze the relationships between quantities. Skills related to functions allow students to determine how different aspects of a problem are related and how those relationships can be manipulated to achieve a desired results. The skills developed in this unit are also foundational skills for work in upper level mathematics courses.

NJSLS

A.APR.B.3	Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial.
F.BF.A.2	Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.
S.ID.B.6.a	Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.
F.BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, and $f(x + k)$ for specific values of k(both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
N.CN.A.1	Know there is a complex number i such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real.
N.CN.A.2	Use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers.

N.CN.A.3	Find the conjugate of a complex number; use conjugates to find moduli and quotients of complex numbers.
A.CED.A.1	Create equations and inequalities in one variable and use them to solve problems. Include equations arising from linear and quadratic functions, and simple rational and exponential functions.
A.CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
N.CN.C.7	Solve quadratic equations with real coefficients that have complex solutions.
F.IF.A.3	Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers.
F.IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
F.IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
A.REI.B.4	Solve quadratic equations in one variable.
A.REI.B.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.
A.REI.B.4.b	Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.
F.IF.B.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.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
A.REI.C.7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.
F.IF.C.7.b	Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
A.REI.D.10	Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).
A.REI.D.11	Explain why the x-coordinates of the points where the graphs of the equations $y = f(x)$ and $y = g(x)$ intersect are the solutions of the equation $f(x) = g(x)$; find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where $f(x)$ and/or $g(x)$ are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.
A.SSE.A.2	Use the structure of an expression to identify ways to rewrite it.
F.LE.A.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).
A.SSE.B.3.a	Factor a quadratic expression to reveal the zeros of the function it defines.
A.SSE.B.3.b	Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.

Standards for Mathematical Practice

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

Unit Focus

Enduring Understandings	Essential Questions
• The key features of a graph - including the domain, range, and intercepts - reveal the relationship between two quantities. • A function in the form $f(x) = a \cdot f[b(x-h)]+k$ is transformed by changing the values of *a, b, h,* or *k.* • A piecewise defined function is used to model situations in which there are different rules for different parts of the domain of the function • A arithmetic sequence is a sequence of numbers in which the terms have a common difference. An arithmetic sequence can be found using an explicit definition for the sum. • To solve an equation or inequality by graphing, set each expression equal to y and graph the two equations on the same grid. Their intersection represents the solution. • All quadratic functions are transformations of the parent function $f(x)=x^2$. The vertex form of a quadratic function highlights the key features of the function's graph and shows how the graph of the parent function can be transformed. • A quadratic function in vertex form can be rewritten in standard form to highlight different features of the function's graph. The key features are used to interpret the values in context. • The factored form of a quadratic function is used to find the zeros if the function by identifying the values that make one or both of the factors equal to zero. • A complex number contains both real and	• How do graphs reveal information about a relationship between two quantities? • What do differences between the equation of a function and the equation of its parent function tell you about the differences in the graphs of the two functions? • How do you model a situation in which a function behaves differently over different parts of its domain? • What is an arithmetic sequence, and how do you represent and find its terms and their sums? • How can you solve an equation or inequality by graphing? • How can you find and represent solutions of systems of equations and inequalities? • How does the equation of a quadratic function in vertex form highlight key features of the functions graph? • What key features can you determine about a quadratic function from an equation in standard form? • How is the factored form helpful in solving quadratic equations? • How can you represent and operate on numbers that are not on the real number line? • How can you solve a quadratic equation by completing the square? • How can you use the Quadratic Formula to solve quadratic equations or predict the nature of their solutions?

imaginary parts. The four basic operations can be applied to complex numbers. • A quadratic equation can be solved by completing the square to trans form the equation into an equivalent equation, $(x-p)^2=q$. • The Quadratic Formula can be used to solve and quadratic equation, including those with complex solutions.	

Instructional Focus

Learning Targets

Learners will...

- Identify key features of a graph of a function, including the intercepts, positive and negative intervals, and areas where the function is increasing or decreasing.
- Calculate and interpret the average rate of change of a function over a specified interval.
- Graph a transformed function by identifying the effect of k on the graph of $f(x)$ for $f(x)+k$, $kf(x)$, $f(kx)$, and $f(x+k)$.
- Write an equation of a transformed function.
- Create and graph piece-wise defined functions, including absolute value functions and step functions.
- Identify the common difference in an arithmetic sequence.
- Write arithmetic sequences both recursively and with an explicit formula
- Construct arithmetic sequences, given a graph, a description of a relationship, or two input-output pairs.
- Use graphs, tables, and graphing technology to find or approximate solutions to equations and inequalities.
- Create quadratic functions in vertex form to represent relationships between variables as shown in their graphs
- Graph functions on coordinate axes using their key features
- Interpret key features of the graph of a quadratic function
- Create quadratic equation in factored form and use it to identify the zeros of the function it defines
- Determine the intervals over which a quadratic function is positive or negative
- Add, subtract, and multiply complex numbers using the properties of operations and the relation $i^2=-1$
- Use complex numbers to represent numbers that are not on the real number line
- Transform a quadratic equation into the form $(x-p)^2=q$ by completing the square.
- Complete the square to reveal the minimum or maximum value of a quadratic expression
- Use the Quadratic Formula to solve quadratic equations that have complex solutions

Prerequisite Skills

- Integer exponents (both positive and negative) and radicals.
- Students expand the concept of exponent to include fractional exponents and make a connection to radicals. s, rational exponents will be extended to irrational exponents by means of exponential and logarithmic functions.
- The domain of this class of functions (the x values) is all real numbers (rational and irrational) and the range is the set of all positive real numbers.)

Common Misconceptions

- Some students may believe that both terminating and repeating decimals are rational numbers, without considering non-repeating and non-terminating decimals as irrational numbers.
- Students may also confuse irrational numbers and complex numbers, and therefore mix their properties.

Spiraling For Mastery

Current Unit Content/Skills	Spiral Focus	Activity
• Key features of graphs • Sequences • Solutions to equations and inequalities • Forms of a Quadratic Functions • Solving Quadratic Equations	• Equations with Variables (Algebra I) • Transformations of Functions (Algebra I) • Systems of Equations (Algebra I) • Absolute Value and Piecewise-Defined Functions (Algebra I) • Key Features of Functions (Topic 1) • Linear Systems (Topic 1) • Multiplying Binomials (Algebra I) • Solutions of Quadratic Equations (Algebra I)	• IXL • Khan Academy • Delta Math

Assessment

Formative Assessment	Summative Assessment
• Homework • Lesson Checks • MathXL • Quizzes • Exit Tickets • Lesson Reflections • Performance Tasks	• Topic Tests • Unit Benchmark (Link-It)

Resources

Key Resources	Supplemental Resources
• Savvas EnVision Algebra 2 • Pacing Guide	• IXL • Delta Math • Desmos • Khan Academy

Career Readiness, Life Literacies, and Key Skills

9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).

Interdisciplinary Connections

SL.PE.11–12.1	Initiate and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with peers on grades 11–12 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively.
SL.PE.11–12.1.A	Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.
SL.PE.11–12.1.D	Respond thoughtfully to diverse perspectives; synthesize comments, claims, and evidence made on all sides of an issue; resolve contradictions when possible; and determine what

	additional information or research is required to deepen the investigation or complete the task.
9-12.HS-ETS1-1.1.1	Analyze complex real-world problems by specifying criteria and constraints for successful solutions.
9-12.HS-ETS1-4.5.1	Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.