Unit 5: Quadratics

Content Area: **Mathematics**
Course(s):
Time Period: **Marking Period 4**
Length: **9 Weeks**
Status: **Published**

Summary of Quadratics

The topic of quadratics is a critical component of the course curriculum. In this unit, quadratics are first shown as algebraic expressions, presented as the product of two binomials. Quadratic expressions are then studied as quadratic equations, and students learn how to find solutions through factoring and the zero-product principle. Quadratic equations may also be solved using the quadratic formula, and the method of "completing the square." Quadratics are important because they can be used to model many real-life situations, including the motion of projectiles.

Revision Date: July 2024

NJ Standards for Quadratics Unit

ELA.K-12.1	Developing Responsibility for Learning: Cultivating independence, self-reflection, and responsibility for one's own learning.
MATH.9-12.A.APR.A	Perform arithmetic operations on polynomials
MATH.9-12.A.APR.B	Understand the relationship between zeros and factors of polynomials
	For example, the difference of two squares; the sum and difference of two cubes; the polynomial identity $(x^2 + y^2)^2 = (x^2 - y^2)^2 + (2xy)^2$ can be used to generate Pythagorean triples.
MATH.9-12.A.CED.A	Create equations that describe numbers or relationships
MATH.9-12.A.REI.A	Understand solving equations as a process of reasoning and explain the reasoning
MATH.9-12.A.REI.A.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.
MATH.9-12.A.REI.B.4	Solve quadratic equations in one variable.
MATH.9-12.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.
MATH.9-12.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.
MATH.9-12.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.
MATH.9-12.F.IF.C.7.a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MATH.9-12.F.IF.C.7.b	Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions.
MATH.9-12.F.IF.C.8.a	Use the process of factoring and completing the square in a quadratic function to show

	zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context.
MATH.9-12.A.SSE.A	Interpret the structure of expressions
MATH.9-12.F.IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
MATH.9-12.A.SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MATH.9-12.A.SSE.A.2	Use the structure of an expression to identify ways to rewrite it.
MATH.9-12.A.SSE.B	Write expressions in equivalent forms to solve problems
MATH.9-12.A.SSE.B.3.a	Factor a quadratic expression to reveal the zeros of the function it defines.
MATH.9-12.A.SSE.B.3.b	Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
CS.K-12.3.a	Identify complex, interdisciplinary, real-world problems that can be solved computationally.
CS.K-12.3.b	Decompose complex real-world problems into manageable sub-problems that could integrate existing solutions or procedures.
SCI.HS-ESS2-3	Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection.
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.

Essential Questions for Quadratics

- How does one factor a quadratic expression?
- What is the standard form of a quadratic equation?
- What are the various methods used to solve a quadratic equation?
- What is the discriminant of a quadratic equation, and why is it significant?
- What is a quadratic function and how does one identify its domain and range?
- How does one determine the average rate of change for a quadratic function over a stated interval?
- How do transformations of quadratic functions compare to transformations of absolute value functions?
- How can quadratic functions be used to model real-life scenarios?

Enduring Understandings for Quadratics

- Quadratic functions appear in many aspects of secondary and advanced mathematics.
- Quadratic expressions may result from the product of two binomials.
- Quadratic equations may be solved through factoring and quadratic equations may be solved using the quadratic formula.
- The discriminant of a quadratic equation may be used to determine the number and type of solutions for a quadratic equation.
- Quadratic functions may be expressed in standard form, as well as vertex form, using the method of completing the square.

- The vertex of a quadratic function represents either its minimum or maximum value.
- The x-intercepts on the graph of a quadratic function are the same values as the solutions to the corresponding quadratic equation.

Objectives for Quadratics

- How to factor a quadratic expression into the product of two binomials, when possible.
- Multiple methods for solving a quadratic equation.
- How to find and interpret the value of the discriminant for a quadratic equation.
- How to graph a quadratic function, identify the intercepts and the vertex.
- How to calculate the average rate of change for a quadratic function over a stated interval.
- How to factor the difference of squares into two binomials.
- How to rewrite a quadratic function from standard form into vertex form.

Objectives for Quadratics

- Factoring quadratic expressions into the product of two binomials.
- Solving quadratic equations.
- Recognizing the difference of squares.
- Graphing quadratic functions.
- Identifying the domain and range of a quadratic function.
- Using the method of completing the square to write algebraically equivalent expressions for quadratics.
- Using quadratic functions to model real-life scenarios, including projectile motion.

Learning Plan for Quadratics

3 Weeks: Practicing the different types of factoring, including the removal of the GCF, the difference of squares, and rewriting quadratic expressions into the product of two binomials (with and without a coefficient on leading term).

2-3 Weeks: Using the zero-product property to solve quadratic equations and using the quadratic formula to solve equations. Practice finding the discriminant and become skilled at interpreting its significance for the number and type of solutions. Also, include solving by taking the square root. Equations and exercises will frequently be tied to word problems so that students are working with quadratics in context and interpreting the solution as it relates to a real-life scenario.

3 Weeks: Comprehensive exploration with quadratic functions. Class time is used to translate word problems into quadratic functions and draw the corresponding graphs. Students will learn key characteristics of quadratic graphs (standard, intercept, and vertex), including how to identify and interpret the significance of the intercepts and the vertex, and how to calculate the average rate of change of a quadratic function over a stated interval. In this section, students will learn how to rewrite a quadratic expression from standard form into vertex form, by completing the square.

1 Week: Review all topics and assess. Practice test questions, IXL assessment, student portfolio assignment.

Evidence/Performance Tasks for Quadratics

Formative assessments will include classroom activities and discussions, with immediate feedback from the instructor. Short written quizzes will be administered and reviewed during class time to identify any challenges that students may have with their comprehension of these topics. Additionally, students may have the option to verbally articulate their understanding of key concepts or elaborate on their written work. Students will be assessed on their ability to create mathematical models for situations described in word problems, and their ability to successfully express quadratic functions in four different ways – algebraically, in tables, as a graph, and in words. The IXL platform will be used to track student progress with an individualized SmartScore, and IXL will also be used to generate quizzes to assess their levels of understanding.

Materials

Core Instructional materials: Lecture notes and classroom activities designed by instructors.

Core Book List including Algebra 1, Pearson Publishing

Supplemental instructional materials: IXL

Suggested Strategies for Modification

Possible accommodations/modification for Algebra 1