# 06-Quadratic Equations & Functions

Content Area: **Math**
Course(s):
Time Period: **Full Year**
Length: **5 weeks (18-20 blocks)**
Status: **Published**

## General Overview, Course Description or Course Philosophy

In this unit, students will expand their knowledge of functions to investigate quadratic functions. They will be able to identify key characteristics of quadratic functions from a graph, a table, or an equation. Students will combine their knowledge of quadratic functions and factoring polynomials to solve quadratic equations using a variety of methods. They will identify the benefits and drawbacks of each method and when each would be most efficient.

## OBJECTIVES, ESSENTIAL QUESTIONS, ENDURING UNDERSTANDINGS

Students will understand that:

- Quadratic functions can be used to represent real-world situations
- Factoring is one tool used to solve quadratic equations or equations containing rational expressions
- Rules of arithmetic and algebra can be used together with equivalence to transform equations so solutions can be found to problems

Essential Questions:

- What are the key characteristics of a quadratic function? How are these represented on its graph?
- How can you tell which method will be most efficient by looking at the quadratic equation?
- What types of real-world situations can be represented by quadratic functions or equations?
- How are linear and quadratic functions similar? How are they different?

## CONTENT AREA STANDARDS

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

| MA.F-IF.C.9 | Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). |
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| MA.F-IF.C.7a | Graph linear and quadratic functions and show intercepts, maxima, and minima. |
| MA.F-IF.C.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. |
| MA.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). |
| MA.F-LE.A.3 | Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. |
| MA.F-LE.A.1b | Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. |
| MA.S-ID.B.6a | 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. |
| MA.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. |
| MA.A-CED.A.1 | Create equations and inequalities in one variable and use them to solve problems. |
| MA.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. |
| MA.A-CED.A.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. |
| MA.A-CED.A.4 | Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. |
| MA.A-REI.B.4a | 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. |
| MA.A-REI.B.4b | 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 $b$. |
| MA.A-SSE.B.3a | Factor a quadratic expression to reveal the zeros of the function it defines. |
| MA.A-SSE.B.3b | Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. |

## RELATED STANDARDS (Technology, 21st Century Life & Careers, ELA Companion Standards are Required)

| CS.K-12.3.a | Identify complex, interdisciplinary, real-world problems that can be solved computationally. |
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| CS.K-12.3.b | Decompose complex real-world problems into manageable sub-problems that could integrate existing solutions or procedures. |
| CS.K-12.3.c | Evaluate whether it is appropriate and feasible to solve a problem computationally. |
| LA.K-12.NJSLSA.R7 | Integrate and evaluate content presented in diverse media and formats, including visually and quantitatively, as well as in words. |
| TECH.K-12.P.5 | Utilize critical thinking to make sense of problems and persevere in solving them. |

## STUDENT LEARNING TARGETS

### Declarative Knowledge

Students will understand that:

- Quadratic functions can be written in standard and vertex forms
- Key characteristics of a quadratic function are its vertex, axis of symmetry, domain, range, and intercepts
- Zero product property can be used to find solutions to quadratic equations when factoring
- The quadratic formula can be used to solve any quadratic equation

### Procedural Knowledge

Students will be able to:

- Determine the direction of opening, axis of summetry, vertex, y-intercept, and range using a graph, standard form equation, or vertex form equation
- Identify the vertex of a quadratic function and determine if it's a maximum or a minimum
- Apply completing the square to rewrite standard functions in vertex form
- Convert between vertex and standard forms
- Recognize solutions to a quadratic equation on a graph
- Solve quadratic equations using square roots
- Solve quadratic equations using factoring
- Apply completing the square to solve quadratic equations
- Solve quadratic equations using the quadratic formula
- Identify the most efficient method to solve a quadratic equation and justify their reasoning
- Create and solve quadratic equations from real-world situations

## EVIDENCE OF LEARNING

## Formative Assessments

- Class Discussion/Exit Cards
- Homework/practice problems (assigned from textbook or various web resources, such as Khan Academy, Albert, Quizizz, or Desmos)

## Summative Assessments

- Lesson quizzes
- Teacher-generated unit test
- Performance tasks

## RESOURCES (Instructional, Supplemental, Intervention Materials)

- *Algebra 1: Common Core*, Chapter 9
- Illustrative Math Tasks
- Arlington Algebra Project (Quadratic Functions)
- Desmos Activities:
  - Introduction to Parabolas
  - Standard Form Investigation
  - Completing the Square (with Algebra Tiles)
  - Will it hit the hoop?
  - Vertex Form Investigation
  - Match My Parabola
  - Polygraph: Parabolas

## INTERDISCIPLINARY CONNECTIONS

Factoring and quadratic equations/functions have many real-world applications that overlap with physics, such as projectile motion problems (i.e. throwing a ball, diving off a board, etc.).

## ACCOMMODATIONS & MODIFICATIONS FOR SUBGROUPS

See link to Accommodations & Modifications document in course folder.