Unit 08 - Quadratic Functions and Equations

Content Area: **Mathematics**
Course(s): **Algebra I**
Time Period: **April**
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Enduring Understandings

- In the quadratic function y = ax^2+bx+c, the value of b translates the position of the axis of symmetry.
- Linear, quadratic, or exponential functions can be used to model various sets of data.
- Quadratic equations can be solved by a variety of methods, including graphing and finding the square root, using the Zero-Product Property, writing the equation in the form m^2 = n, or using the Quadratic Formula.
- Systems of linear and quadratic equations can be solved graphically and algebraically. This type of system can have two solutions, one solution, or no solutions.
- The family of quadratic functions models certain situations where the rate of change is not constant. These functions are graphed by a symmetric curve with a highest or lowest point corresponding to a maximum or minimum value.

Essential Questions

- How can you solve a quadratic equation?
- How can you use functions to model real-world situations?
- How many possible solutions can you have when using the quadratic formula?
- What are the characteristics of quadratic functions?

Lesson Titles

- Completing the Square
- Factoring to Solve Quadratic Equations
- Linear, Quadratic, and Exponential Models
- Quadratic Functions
- Quadratic Graphs and Their Properties
- Solving Quadratic Equations
- Systems of Linear and Quadratic Equations
- The Quadratic Formula and the Discriminant

Standards/Indicators

CCSS.Math.Practice.MP1	Make sense of problems and persevere in solving them. Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints,

	relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.
CCSS.Math.Practice.MP2	Reason abstractly and quantitatively.
CCSS.Math.Content.HSA-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
CCSS.Math.Content.HSA-SSE.A.1.a	Interpret parts of an expression, such as terms, factors, and coefficients.
	Mathematically proficient students make sense of quantities and their relationships in problem situations. They bring two complementary abilities to bear on problems involving quantitative relationships: the ability to decontextualize-to abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents-and the ability to contextualize, to pause as needed during the manipulation process in order to probe into the referents for the symbols involved. Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; considering the units involved; attending to the meaning of quantities, not just how to compute them; and knowing and flexibly using different properties of operations and objects.
CCSS.Math.Content.HSA-SSE.A.1.b	Interpret complicated expressions by viewing one or more of their parts as a single entity.
CCSS.Math.Practice.MP3	Construct viable arguments and critique the reasoning of others.
	Mathematically proficient students understand and use stated assumptions, definitions, and previously established results in constructing arguments. They make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. They justify their conclusions, communicate them to others, and respond to the arguments of others. They reason inductively about data, making plausible arguments that take into account the context from which the data arose. Mathematically proficient students are also able to compare the effectiveness of two plausible arguments, distinguish correct logic or reasoning from that which is flawed, and-if there is a flaw in an argument-explain what it is. Elementary students can construct arguments using concrete referents such as objects, drawings, diagrams, and actions. Such arguments can make sense and be correct, even though they are not generalized or made formal until later grades. Later, students learn to determine domains to which an argument applies. Students at all grades can listen or read the arguments of others, decide whether they make sense, and ask useful questions to clarify or improve the arguments.
CCSS.Math.Practice.MP4	Model with mathematics.
	Mathematically proficient students can apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community. By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another. Mathematically proficient students who can apply what they know are comfortable making assumptions and approximations to simplify a complicated situation, realizing that these may need revision later. They are able to identify important quantities in a practical

	situation and map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas. They can analyze those relationships mathematically to draw conclusions. They routinely interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.
CCSS.Math.Content.HSF-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.
CCSS.Math.Content.HSS-ID.B.6.a	Fit a function to the data; use functions fitted to data to solve problems in the context of the data.
CCSS.Math.Content.HSA-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
CCSS.Math.Content.HSF-IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes.
CCSS.Math.Practice.MP6	Attend to precision.
CCSS.Math.Content.HSA-SSE.B.3.a	Factor a quadratic expression to reveal the zeros of the function it defines.
	Mathematically proficient students try to communicate precisely to others. They try to use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure, and labeling axes to clarify the correspondence with quantities in a problem. They calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the problem context. In the elementary grades, students give carefully formulated explanations to each other. By the time they reach high school they have learned to examine claims and make explicit use of definitions.
CCSS.Math.Content.HSN-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
CCSS.Math.Content.HSA-SSE.B.3.b	Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines.
CCSS.Math.Practice.MP7	Look for and make use of structure.
	Mathematically proficient students look closely to discern a pattern or structure. Young students, for example, might notice that three and seven more is the same amount as seven and three more, or they may sort a collection of shapes according to how many sides the shapes have. Later, students will see 7 × 8 equals the well remembered 7 × 5 + 7 × 3, in preparation for learning about the distributive property. In the expression $x^2 + 9x + 14$, older students can see the 14 as 2 × 7 and the 9 as 2 + 7. They recognize the significance of an existing line in a geometric figure and can use the strategy of drawing an auxiliary line for solving problems. They also can step back for an overview and shift perspective. They can see complicated things, such as some algebraic expressions, as single objects or as being composed of several objects. For example, they can see $5 – 3(x – y)^2$ as 5 minus a positive number times a square and use that to realize that its value cannot be more than 5 for any real numbers x and y.
CCSS.Math.Content.HSF-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.
CCSS.Math.Practice.MP8	Look for and express regularity in repeated reasoning.
	Mathematically proficient students notice if calculations are repeated, and look both for general methods and for shortcuts. Upper elementary students might notice when dividing 25 by 11 that they are repeating the same calculations over and over again, and conclude they have a repeating decimal. By paying attention to the calculation of slope as they repeatedly check whether points are on the line through (1, 2) with slope 3, middle school students might abstract the equation $(y – 2)/(x – 1) = 3$. Noticing the regularity in

	the way terms cancel when expanding $(x-1)(x+1)$, $(x-1)(x^2+x+1)$, and $(x-1)(x^3+x^2+x+1)$ might lead them to the general formula for the sum of a geometric series. As they work to solve a problem, mathematically proficient students maintain oversight of the process, while attending to the details. They continually evaluate the reasonableness of their intermediate results.
CCSS.Math.Content.HSF-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.
CCSS.Math.Content.HSA-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.
CCSS.Math.Content.HSF-IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
CCSS.Math.Content.HSF-BF.A.1	Write a function that describes a relationship between two quantities.
CCSS.Math.Content.HSF-BF.A.1.b	Combine standard function types using arithmetic operations.
CCSS.Math.Content.HSA-CED.A.1	Create equations and inequalities in one variable and use them to solve problems.
CCSS.Math.Content.HSA-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
CCSS.Math.Content.HSF-BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x)+k$, $k\,f(x)$, $f(kx)$, and $f(x+k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
CCSS.Math.Content.HSA-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
CCSS.Math.Content.HSA-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.
CCSS.Math.Content.HSA-REI.B.4	Solve quadratic equations in one variable.
CCSS.Math.Content.HSA-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.
CCSS.Math.Content.HSF-LE.A.1	Distinguish between situations that can be modeled with linear functions and with exponential functions.
CCSS.Math.Content.HSF-LE.A.1.a	Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.
CCSS.Math.Content.HSA-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.
CCSS.Math.Content.HSF-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).
CCSS.Math.Content.HSA-REI.C.7	Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.
CCSS.Math.Content.HSF-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.
CCSS.Math.Content.HSA-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.

Inter-Disciplinary Connections

- Business
- Chemistry
- Computers
- Engineering
- English
- Geography
- History
- Physics

Warm-Up

- PARCC type of question
- SAT question of the day
- Skill needed to do lesson
- Use What You Know - type of question

Anticipatory Set

- 5 Minute Activity Based
- connecting previous lessons
- connecting vocabulary with roots words
- Discussion including vocab review/recall
- Video Clip

Instructional Strategies, Learning Activities, and Levels of Blooms/DOK

- Introduction, notes, and examples on solving quadratics by completing the square
- List the methods used for solving quadratic equations
- students will work as a team and explain their work
- #1- Blooms Knowledge - Remember previously learned information
- #2 - Blooms Comprehension - Demonstrate an understanding of facts
- #3 - Blooms Application - Apply Knowledge to actual situations
- #4 - Blooms Analysis - Break down objects or ideas into simpler parts and find evidence to support generalizations

- #5 - Blooms Synthesis - Compile component ideas into a new whole or propose alternative solutions
- #6 - Blooms Evaluation - Make and defend judgments based on internal evidence or external criteria
- Choose the best method for solving a given quadratic
- Introduction, notes, and examples on graphing quadratics
- Introduction, notes, and examples on solving by using the quadratic formula
- Introduction, notes, and examples on the discriminant
- Justify the method used in solving and graphing quadratic equations
- review homework if need - answers posted on Edmodo
- review warm up
- students will work individually

Closure

- evaluate your understanding of the lesson
- Pass out of class
- turn to your partner and discuss

Formative Assessment

- Edmodo assignments
- Guided Review
- homework/classwork
- Mathxlforschool
- Partner Board Presentation
- Pass Out of Class
- Socrative
- teacher observation
- think-pair-share
- Warm up Review
- White Boards

Summative Assessment

- quiz
- unit test
- warm up quiz

Resources & Technology

- Algebra 1 Book
- class dojo.com
- color pencils
- desmos.com
- Edmodo
- edpuzzle.com
- Google Forms
- graphing calculator
- Learn Zillion
- mathway.com
- mathxlforschool.com
- quizlet.com
- Remind
- smartboard
- socrative
- student whiteboards
- Teacher Generated Worksheets
- video clips