

Parent Newsletter

Chapter 8: Graphing Quadratic Functions

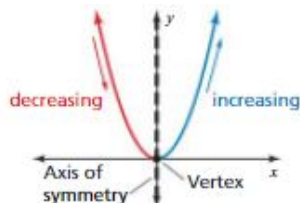
Students will...

- Identify characteristics of quadratic functions.
- Graph quadratic functions.
- Find the foci of parabolas.
- Write equations of parabolas with vertices at the origin given the foci.
- Graph quadratic functions of the form $y = ax^2 + c$ and compare to the graph of $y = x^2$.
- Find the axes of symmetry and the vertices of graphs.
- Graph quadratic functions of the form $y = ax^2 + bx + c$.
- Find maximum and minimum values.
- Graph quadratic functions of the form $y = a(x - h)^2 + k$ and compare to the graph of $y = x^2$.
- Identify linear, quadratic, and exponential functions using graphs or tables.
- Compare graphs of linear, quadratic, and exponential functions.
- Solve real-life problems.

Key Ideas

Characteristics of a Quadratic Function

The most basic quadratic function is $y = x^2$.



Graphing $y = ax^2$ When $a > 0$

- When $0 < a < 1$, the graph of $y = ax^2$ opens up and is wider than the graph of $y = x^2$.
- When $a > 1$, the graph of $y = ax^2$ opens up and is narrower than the graph of $y = x^2$.

Standards

California Common Core:
F.BF.3, F.IF.4,
F.IF.6, F.IF.7a,
F.LE.3

Essential Questions

- What are the characteristics of the graph of the quadratic function $y = ax^2$? How does the value of a affect the graph of $y = ax^2$?
- Why do satellite dishes and spotlight reflectors have parabolic shapes?
- How does the value of c affect the graph of $y = ax^2 + c$?
- How can you find the vertex of the graph of $y = ax^2 + bx + c$?
- How can you compare the growth rates of linear, exponential, and quadratic functions?

Key Terms

A **quadratic function** is a nonlinear function that can be written in the standard form $y = ax^2 + bx + c$, where $a \neq 0$.

The U-shaped graph of a quadratic function is called a **parabola**.

The lowest or highest point on a parabola is the **vertex**.

The vertical line that divides a parabola into two symmetric parts is the **axis of symmetry**.

The **focus** of a parabola is a fixed point on the interior of a parabola that lies on the axis of symmetry.

A **zero** of a function $f(x)$ is an x -value for which $f(x) = 0$.

The y -coordinate of the vertex of the graph $y = ax^2 + bx + c$ is the **maximum value** of the function when $a < 0$ or the **minimum value** when $a > 0$.

The **vertex form** of a quadratic function is $y = a(x - h)^2 + k$, where $a \neq 0$.

Game

- Transform Me

This is available online in the *Game Closet* at www.bigideasmath.com.

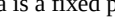


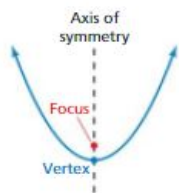
Key Ideas

Graphing $y = ax^2$ When $a < 0$

- When $-1 < a < 0$, the graph of $y = ax^2$ opens down and is wider than the graph of $y = x^2$.
- When $a < -1$, the graph of $y = ax^2$ opens down and is narrower than the graph of $y = x^2$.

The Focus of a Parabola

- The focus of a parabola is a fixed point on the interior of the parabola that lies on the axis of symmetry. A parabola “wraps” around the focus.
 - For functions of the form $y = ax^2$, the focus is $\left(0, \frac{1}{4a}\right)$.
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Graphing $y = x^2 + c$

- When $c > 0$, the graph of $y = x^2 + c$ is a vertical translation c units up of the graph $y = x^2$.
- When $c < 0$, the graph of $y = x^2 + c$ is a vertical translation $|c|$ units down of the graph of $y = x^2$.

Properties of the Graph of $y = ax^2 + bx + c$

- The graph opens up when $a > 0$ and the graph opens down when $a < 0$.
- The y-intercept is c .
- The x-coordinate of the vertex is $-\frac{b}{2a}$.
- The axis of symmetry is $x = -\frac{b}{2a}$.

Maximum and Minimum Values

- The y-coordinate of the vertex of the graph $y = ax^2 + bx + c$ is the maximum value of the function when $a < 0$ or the minimum value of the function when $a > 0$.

Graphing $y = (x - h)^2$

- When $h > 0$, the graph of $y = (x - h)^2$ is a horizontal translation h units to the right of the graph of $y = x^2$.
- When $h < 0$, the graph of $y = (x - h)^2$ is a horizontal translation h units to the left of the graph of $y = x^2$.

Linear Function

- Line
- $y = mx + b$

Exponential Function

- Curve
- $y = ab^x$

Quadratic Function

- Parabola
- $y = ax^2 + bx + c$

Differences and Ratios of Functions

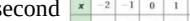
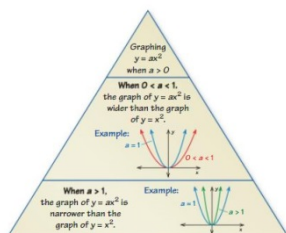
- Linear function: the y -values have a common difference.
 - Exponential function: the y -values have a common ratio.
 - Quadratic function: the second differences are constant.
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- The diagram shows a table with two rows: x and y . The x row contains the values -2, -1, 0, 1, 2. The y row contains the values -1, -2, -1, 2, 7. Above the table, red arrows point from each x value to the next, labeled with $+1$. Below the table, blue arrows point from each y value to the next, labeled with $+1$, $+1$, $+3$, and $+3$. A label 'First differences' is at the bottom right.
- | | | | | | |
|-----|----|----|----|---|---|
| x | -2 | -1 | 0 | 1 | 2 |
| y | -1 | -2 | -1 | 2 | 7 |

Diagram illustrating the calculation of first and second differences for a quadratic sequence. A 2x5 grid shows x values (-2, -1, 0, 1, 2) and y values (-1, -2, -1, 2, 7). First differences (y - x) are shown as +1, +1, +1, +1. Second differences (y - x²) are shown as -1, +1, +3, +5.

Reference Tools

A Summary Triangle can be used to explain a concept. Typically, the summary triangle is divided into 3 or 4 parts. In the top part, students write the concept being explained. In the middle part(s), students write any procedure, explanation, description, definition, theorem, and/or formula(s). In the bottom part, students write an example to illustrate the concept.



What's the Point?

The STEM Videos available online show ways to use mathematics in real-life situations. The Chapter 8: Water Balloons STEM Video is available online at www.bigideasmath.com.



Quick Review

- Graphs of parabolas are U-shaped and symmetric.
- The vertex is the lowest (minimum) or highest (maximum) point on the graph. The axis of symmetry is where the graph could be folded onto itself.
- For a quadratic function, the y -values will increase, then decrease, or the y -values will decrease, then increase.
- If a parabola opens up, it has a minimum value. If a parabola opens down, it has a maximum value.