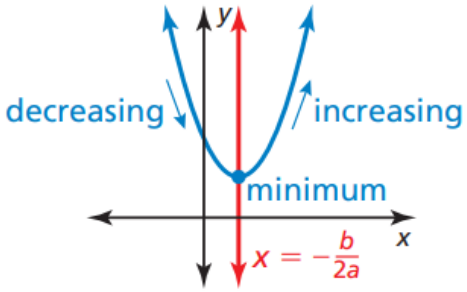
KEY IDEA

Minimum and Maximum Values

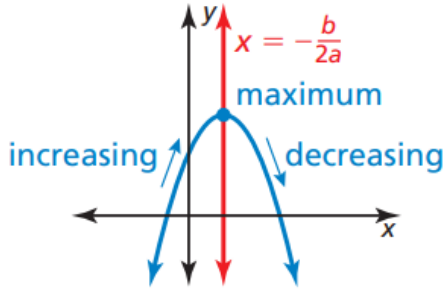
For the quadratic function $f(x) = ax^2 + bx + c$, the y-coordinate of the vertex is the **minimum value** of the function when $a > 0$ and the **maximum value** when $a < 0$. These values can be used to describe other properties of the function, as shown below.

$a > 0$



- Minimum value: $f\left(-\frac{b}{2a}\right)$
- Range: $y \geq f\left(-\frac{b}{2a}\right)$
- Decreasing when $x < -\frac{b}{2a}$
- Increasing when $x > -\frac{b}{2a}$

$a < 0$



- Maximum value: $f\left(-\frac{b}{2a}\right)$
- Range: $y \leq f\left(-\frac{b}{2a}\right)$
- Increasing when $x < -\frac{b}{2a}$
- Decreasing when $x > -\frac{b}{2a}$

Find the minimum value or maximum value of $f(x) = \frac{1}{2}x^2 - 2x - 1$. Find the domain and range of the function, and when the function is increasing and decreasing.

Find the minimum value or maximum value of $f(x) = -x^2 + 5x + 9$. Find the domain and range of the function, and when the function is increasing and decreasing.

Graphing Quadratic Functions Using *x*-Intercepts

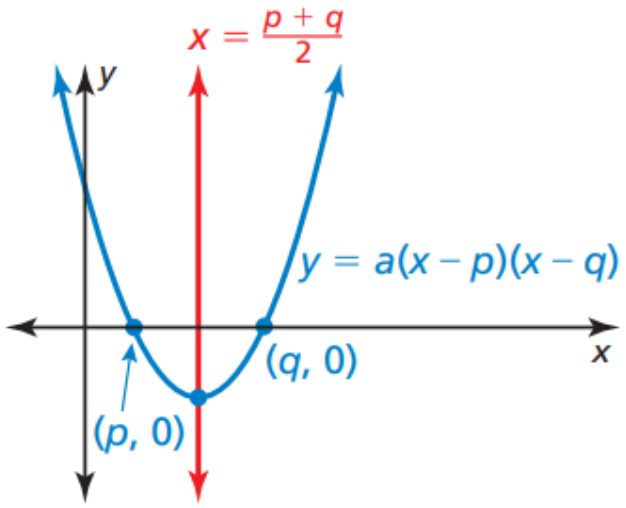
GO DIGITAL

When the graph of a quadratic function has at least one x-intercept, the function can be written in **intercept form**, $f(x) = a(x - p)(x - q)$, where $a \neq 0$.

KEY IDEA

Properties of the Graph of $f(x) = a(x - p)(x - q)$

- Because $f(p) = 0$ and $f(q) = 0$, p and q are the x-intercepts of the graph of the function.
- The axis of symmetry is halfway between $(p, 0)$ and $(q, 0)$. So, the axis of symmetry is $x = \frac{p + q}{2}$.
- The parabola opens up when $a > 0$ and opens down when $a < 0$.



Graph $f(x) = -2(x + 3)(x - 1)$.

Graph $f(x) = -(x+1)(x+5)$.