2-1 Using Transformations to Graph Quadratic Functions

If a parabola opens upward, it has a lowest point. If a parabola opens downward, it has a highest point. This lowest or highest point is the **vertex of the parabola**.

The parent function $f(x) = x^2$ has its vertex at the origin. You can identify the vertex of other quadratic functions by analyzing the function in *vertex form.* The **vertex form** of a quadratic function is $f(x) = a(x - h)^2 + k$, where a, h, and k are constants.

vertex

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Vertex Form of a Quadratic Function

$$f(x) = a(x-h)^2 + k$$

- a indicates a reflection across the x-axis and/or a vertical stretch or compression.
- h indicates a horizontal translation.
- k indicates a vertical translation.

Because the vertex is translated h horizontal units and k vertical from the origin, the vertex of the parabola is at (h, k).

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Example 8: Writing Transformed Quadratic Functions

Use the description to write the quadratic function in vertex form.

The parent function $f(x) = x^2$ is vertically stretched by a factor of $\frac{4}{3}$ and then translated 2 units left and 5 units down to create g.

$g(x) = \frac{4}{3}(x+2)^2 - 5$

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Check It Out! Example 9

Use the description to write the quadratic function in vertex form.

The parent function $f(x) = x^2$ is vertically compressed by a factor of $\frac{2}{3}$ and then translated 2 units right and 4 units down to create g.

$g(x) = \frac{2}{3}(x-2)^2 - 4$

2-1 Using Transformations to Graph Quadratic Functions

Check It Out! Example 10

Use the description to write the quadratic function in vertex form.

The parent function $f(x) = x^2$ is reflected across the x-axis and translated 5 units left and 1 unit up to create g.

$g(x) = -(x+5)^2 + 1$

14. $f(x) = 4x^2 + 5$

horizontal stretch by 2 $\quad 4\left(\frac{1}{2}x\right)^2 + 5$

$4\left(\frac{1}{4}x^2\right) + 5$

$x^2 + 5$

up 2 $\quad x^2 + 5 + 2$

$x^2 + 7$

reflection x-axis $\quad -(x^2 + 7)$

$g(x) = -x^2 - 7$

New

14. $f(x) = 4x^2 + 5$

horizontal compression by 1/2

$4(2x)^2 + 5$

$4(4x^2) + 5$

$16x^2 + 5$

reflection in X-axis

$-(16x^2 + 5)$

$-16x^2 - 5$

up 2

$-16x^2 - 3$

$g(x) = -16x^2 - 3$

$f(x) = -(x-2)^2 + 3$