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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.

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Using Transformations to Graph Quadratic Functions

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.

k indicates a vertical 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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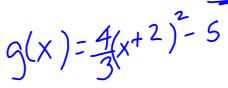
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Using Transformations to Graph Quadratic Functions

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.



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Using Transformations to Graph Quadratic Functions

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.

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

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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.

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

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H.
$$f(x) = \sqrt{x^2 + 5}$$

horizontal $4(\frac{1}{2}x) + 5$
Stretch by $2 + 4(\frac{1}{4}x^2) + 5$
 $x^2 + 5$
UP $2 + 5 + 2$
 $x^2 + 5 + 2$
 $x^2 + 7$
reflection $-(x^2 + 7)$
 $x - axi$

New
$$f(x) = 4x^2 + 5$$

horizontal $4(2x)^2 + 5$
compression $4(4x^2) + 5$
 $16x^2 + 5$
reflection $-(16x^2 + 5)$
in x -axis $-(16x^2 - 5 + 2)$
 $-16x^2 - 5 + 2$
 2
 $4x^2 - 16x^2 - 3$

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