Lesson 4.1 Quadratic Functions & Transformations (Marker Boards)

**Essential Understanding:** The graph of any quadratic function is a transformation of the graph of the parent quadratic function, $y = x^2$.

A parabola is the graph of a quadratic function, which you can write in the form of $f(x) = ax^2 + bx + c$, where $a \neq 0$.

The vertex form of a quadratic function is $f(x) = a(x-h)^2 b + c$. The axis of symmetry is aline that divides the parabola into two mirror images. The equation of the axis of symmetry is $x = h$. The vertex of the parabola is $(h, k)$, the intersection of the parabola and its axis of symmetry.
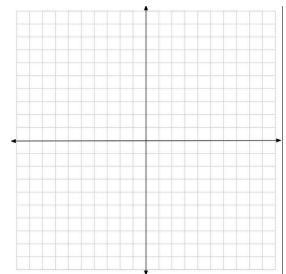
**Key Concept   The Parent Quadratic Function**

The parent quadratic function is $f(x) = x^2$. Its graph is the parabola shown. The axis of symmetry is $x = 0$. The vertex is $(0, 0)$.

Vertex $(0, 0)$
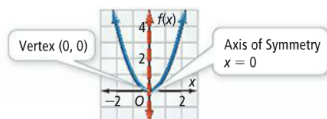
Axis of Symmetry $x = 0$
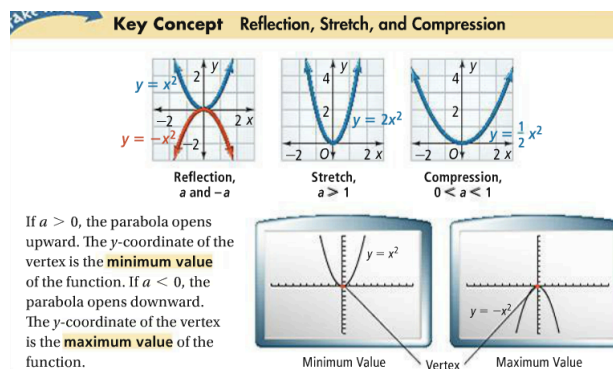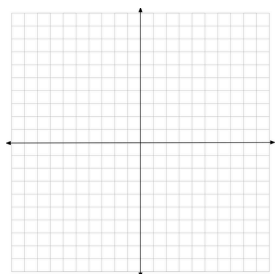
Ex. What is the graph of $f(x) = 1/2\ x^2$?

vertex:

axis of symmetry:

Ex. What is the graph of $f(x) = -1/3\ x^2$?

vertex:

axis of symmetry:

**Key Concept** Reflection, Stretch, and Compression

$y = x^2$

$y = -x^2$

$y = 2x^2$

$y = \frac{1}{2}x^2$

| Reflection, | Stretch, | Compression, |
|---|---|---|
| $a$ and $-a$ | $a > 1$ | $0 < a < 1$ |

If $a > 0$, the parabola opens upward. The $y$-coordinate of the vertex is the **minimum value** of the function. If $a < 0$, the parabola opens downward. The $y$-coordinate of the vertex is the **maximum value** of the function.

$y = x^2$

$y = -x^2$

Minimum Value    Vertex    Maximum Value
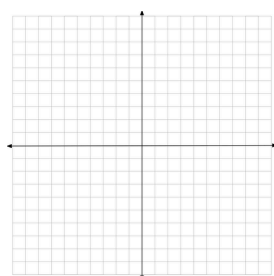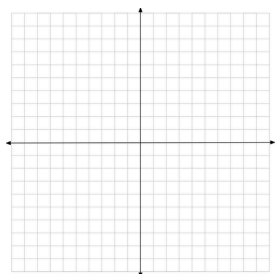
Ex. Graph $f(x) = x^2 - 5$.

Ex. Graph $f(x) = (x - 4)^2$

Ex. Graph $f(x) = (x + 1)^2$

Ex. For $f(x) = 3(x - 4)^2 - 2$, find the following:

    vertex:

    axis of symmetry:

    maximum/minimum value:

    domain:

    range:
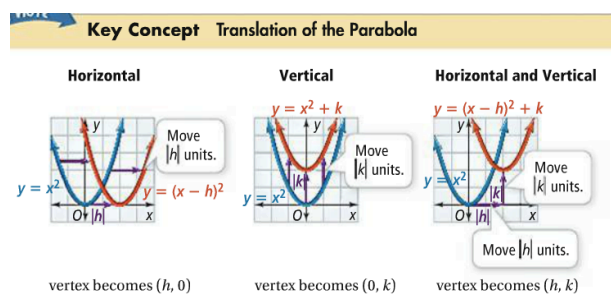
Ex. For $f(x) = -2(x + 1)^2 + 4$, find the following:

    vertex:

    axis of symmetry:

    maximum/minimum value:

    domain:

    range:

**Key Concept**   *Translation of the Parabola*

| Horizontal | Vertical | Horizontal and Vertical |
|---|---|---|
| Move $|h|$ units. $y = x^2$ $y = (x - h)^2$ | $y = x^2 + k$ Move $|k|$ units. $y = x^2$ | $y = (x - h)^2 + k$ $y = x^2$ Move $|k|$ units. Move $|h|$ units. |
| vertex becomes $(h, 0)$ | vertex becomes $(0, k)$ | vertex becomes $(h, k)$ |

Ex. Describe what the graph of $f(x) = -2(x - 1)^2 + 3$ will look like.

Ex. What steps transform the graph of $f(x) = x^2$ to

$f(x) = 2(x + 2)^2 - 5$?

Ex. The pictures shows the jump of a dolphin. What quadratic function models the path of the dolphin's jump?
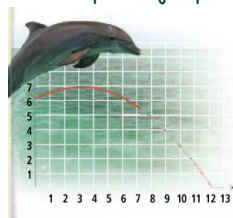


Ex. What quadratic function models a path that has a vertex at (2, 7) and goes through the point (5, 5)?