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# NOTES: Section 4.1 – Graph Quadratic Functions in Standard Form

Goals: #1 - I can identify the $y$-intercept, vertex, axis of symmetry, opening direction, and maximum or minimum value from standard form of a quadratic.

#2 - I can graph a quadratic function from standard form.

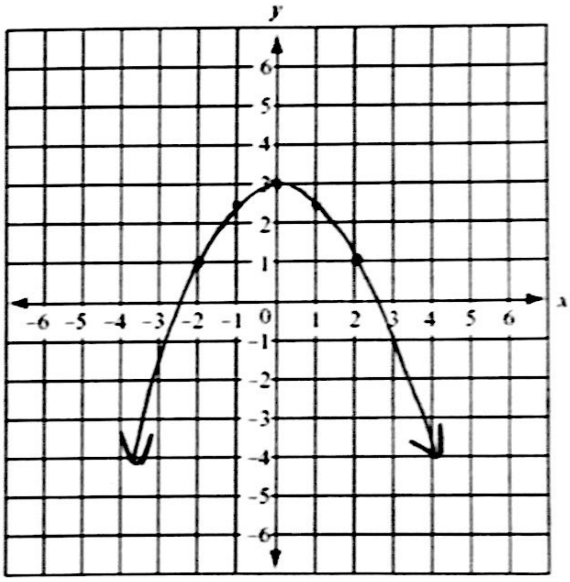
#3 - I can create a quadratic equation from a word problem and change it into standard form.

*Homework: Lesson 4.1 Worksheet*

**Exploration #1:** Graph the following function using a table of values.

1. $y = -\frac{1}{2}x^2 + 3$

| $x$ | $y$ |
|---|---|
| -2 | 1 |
| -1 | 2.5 |
| 0 | 3 |
| 1 | 2.5 |
| 2 | 1 |




a. Make some observations about your graph:

symmetrical vertex face down

b. Do you know what this shape is called?

parabola

c. Do you know what type of function this is?

quadratic

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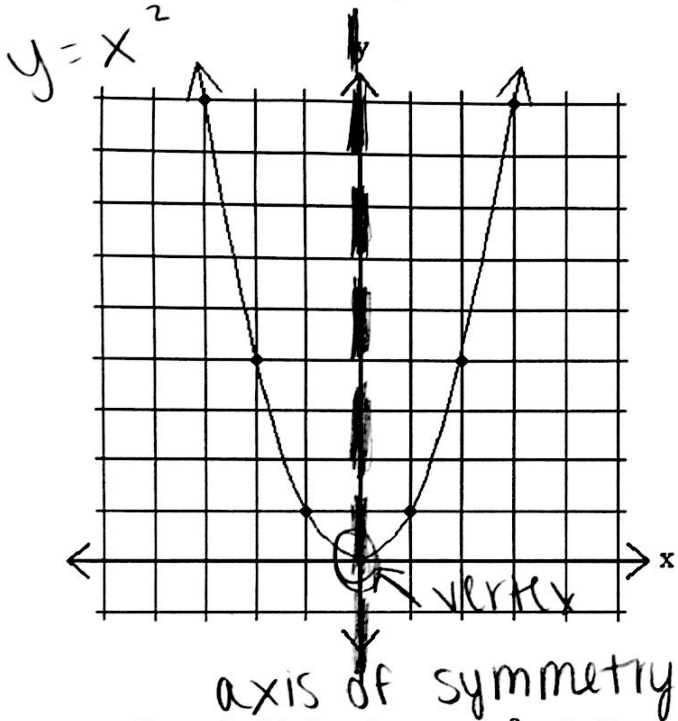
**Notes:**

A <u>quadratic function</u> is a function that can be written in the <u>standard form</u>: <u>$y = ax^2 + bx + c$</u>.

The graph of a <u>quadratic</u> function is a <u>parabola</u>.




**Characteristics of Quadratic Functions:**

- Parabolas can open <u>up</u> or <u>down</u>.
- The lowest or highest point (min/max value) on a parabola is called the <u>vertex</u>.
- The <u>axis of symmetry</u> divides the parabola into mirror images and passes through the <u>vertex</u>.

**Example #1:** Graph $y = -2x^2 + 2$. Compare the graph with the graph of $y = x^2$.

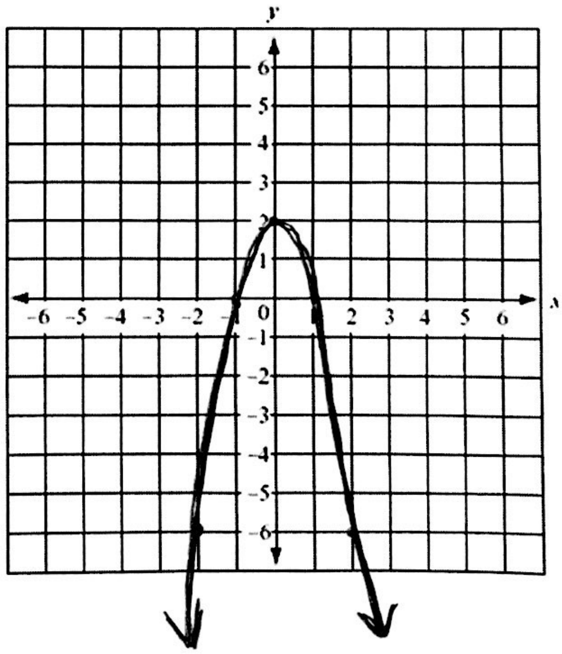
AOS: <u>y-axis or x=0</u>

Vertex: <u>(2, 0)</u>

Opens: <u>down</u>

Max./Min. Value: <u>y = 2</u>

| $x$ | -2 | -1 | 0 | 1 | 2 |
|---|---|---|---|---|---|
| $y$ | -6 | 0 | 2 | 0 | -6 |




Comparison to $y = x^2$:

- reflection over x-axis
- vertical stretch
- shift up 2

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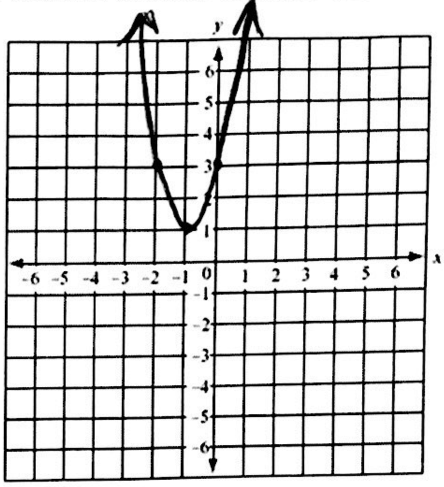
**Exploration #2:** Graph $y = 2x^2 + 4x + 3$ using a table of values. Answer the following questions.

| $x$ | $y$ |
|---|---|
| -2 | 3 |
| -1 | 1 |
| 0 | 3 |
| 1 | 9 |
| 2 | 19 |




a. What is the $x$-value of the vertex?

$-1$

b. What is the axis of symmetry?

$x = -1$ $\qquad x = \frac{-(4)}{2(2)} = \frac{-4}{4} = -1$

c. What is the $y$-intercept?

3

**CHALLENGE:** How could we answer questions a-c by looking at the equation only?

**Notes:**

We can use the following properties to graph *any* quadratic function in standard form.

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

- The graph opens up if $a>0$ and opens down if $a<0$.
- The graph gets narrower if $|a|>1$ and wider if $|a|<1$
- The axis of symmetry is $x = \frac{-b}{2a}$. This is the same as the x-coodinate of the vertex.
- The y-interupt is c.

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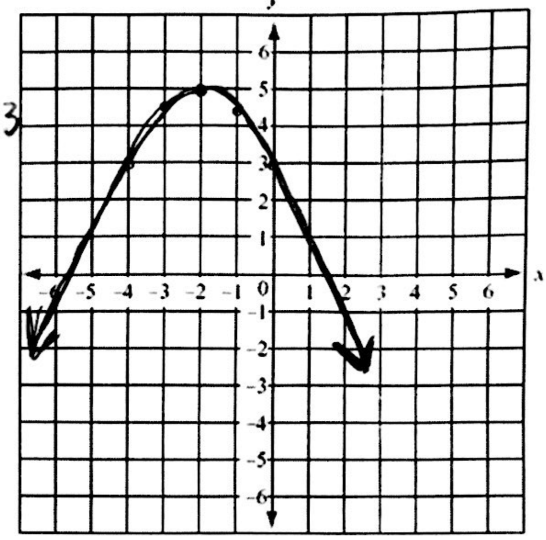
**Example #2:** Graph $y = -\frac{1}{2}x^2 - 2x + 3$ Compare the graph with the graph of $y = x^2$.

AOS: $x = \frac{-(-2)}{2(-\frac{1}{2})} = \frac{2}{-1} = -2$ $\boxed{x = -2}$

Vertex: $(-2, 5)$ $\quad y = -\frac{1}{2}(-2)^2 - 2(-2) + 3$, $y = 5$

Opens: down (a is −)

Max./Min. Value: $y = 5$



| $x$ | −4 | −3 | −2 | −1 | 0 |
|---|---|---|---|---|---|
| $y$ | 3 | 4.5 | 5 | 4.5 | 3 |

Comparison to $y = x^2$:
- reflection in x-axis
- shift up 5 left 2
- vertical shrink

**Example #3:** Tell whether the function $y = 3x^2 - 18x + 20$ has a *minimum value* or a *maximum value*. Then find the minimum or maximum value.

a = 3 which 3 > 1, so $\boxed{\text{minimum}}$

(3, min)

$x = \frac{-b}{2a} = \frac{-(-18)}{2(3)} = \frac{18}{6} = 3$

$y = 3(3)^2 - 18(3) + 20 = -7$

$\boxed{\text{minimum value: } -7}$

**Example #4:** A video store sells about 150 DVDs a week at the price of $20 each. The owner estimates that for each $1 decrease in price, about 25 more DVDs will be sold each week. Create a function that models the store's weekly revenue, $R$, as a function of the DVD price reduction, $x$. Then determine the price that the owner should sell DVDs for to maximize revenue.

Revenue = price · DVDs

$(20-1)(150+25)$
$(20-2)(150+25(2))$
$(20-3)(150+25(3))$
⋮

$R(x) = (20 - x)(150 + 25x)$ FOIL

$= 3000 + 500x - 150x - 25x^2$

$\boxed{R(x) = -25x^2 + 350x + 3000}$

(x, max)

vertex: $x = \frac{-b}{2(-25)} = \frac{-350}{2(-25)} = \frac{-350}{-50} = 7$

$R(7) = -25(7)^2 + 350(7) + 3000 = \boxed{\$4225}$

Sell DVDs at $13 to max revenue of $4225