4.2 * Quadratic Functions In Form $y = ax^2$ *

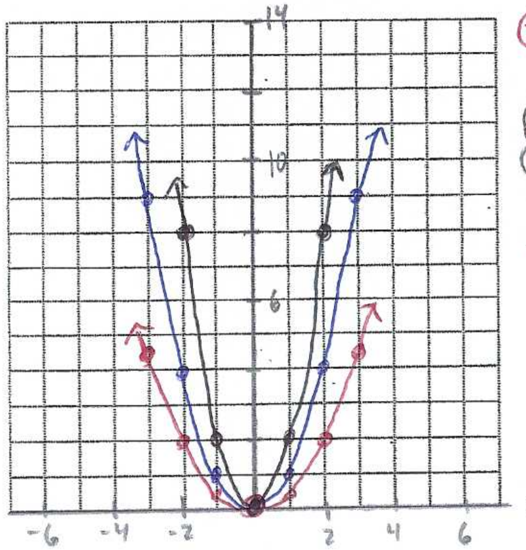
In function notation: $y = a \times f(x)$ ← f is the squaring operation.

↑ a number multiplier aka factor.

Sketch the graph of each of the functions on the grid below. Label each graph with its equation.

① $y = 2x^2$

x	$y = 2x^2$
$x = -2$	$y = 2(-2)^2 = 2(4) = 8$
-1	$y = 2(-1)^2 = 2(1) = 2$
0	$= 2(0)^2 = 2(0) = 0$
1	$= 2$
2	$= 8$
~~3~~	~~= 18~~, too big for our scale.



② $y = \frac{1}{2}x^2$

x	$y = \frac{1}{2}x^2$
-3	$= \frac{1}{2}(-3)^2 = \frac{1}{2}(9) = 4.5$
-2	$= \frac{1}{2}(-2)^2 = \frac{1}{2}(4) = 2$
-1	$= 0.5$
0	$= 0$
1	$= 0.5$
2	$= 2$
3	$= 4.5$

③ Parent $y = x^2$. From memory of the squaring action. "Input 4, $4^2 = 16$ output"

How are the graphs different? How are they the same?

✓ Different Slopes. ($y = 2x^2$ is narrower than parent $y = x^2$. And, $y = \frac{1}{2}x^2$ is wider than basic graph $y = x^2$.)

✓ Open Upwards
✓ Vertex (0,0)
✓ Axis of symmetry line $x = 0$.

✓ X-intercept $x = 0$
✓ Domain = {x is Real}
✓ Range = {y is Real and equal to or greater than zero}

Now we will investigate what happens when the value of **a** negative.

From Page Top Table of Values

1(a) $y = x^2$
(b) $y = -x^2$

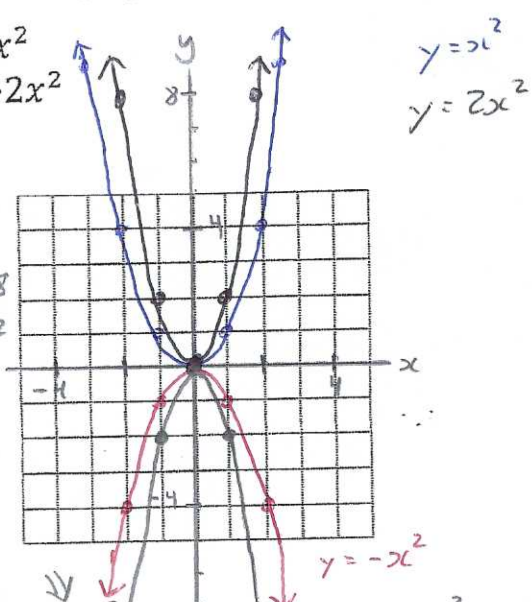
2(a) $y = 2x^2$
(b) $y = -2x^2$

Sketch the graphs;

☆ Careful. Use brackets when subbing to control signage.

x	$y = -x^2$
-2	$y = -(-2)^2 = -(4) = -4$
-1	$= -(-1)^2 = -(1) = -1$
0	$= -(0)^2 = 0$
1	$= -(1)^2 = -1$
2	$= -(2)^2 = -4$

x	$y = -2x^2$
-2	$y = -2(-2)^2 = -2(4) = -8$
-1	$= -2(-1)^2 = -2(1) = -2$
0	$= -2(0)^2 = -2(0) = 0$
1	$= -2(1)^2 = -2(1) = -2$
2	$= -2(2)^2 = -2(4) = -8$



What is the effect of multiplying by a value of a to get $y = ax^2$?

$y = -2x^2$

If factor $a > 0$ aka "a" greater than zero, then parabola opens up and vertex is a minimum point.

If factor $a < 0$ aka "a" less than zero, then parabola opens down and vertex is a maximum point.

If factore a is a fraction btwn 0 and 1, aka $0 < a < 1$, then the parabola is wider by vertical stretch of factor a.

If factor a is an integer greater than 1, aka $a > 1$, then the resulting image parabola is taller by vertical stretch factor a.

f is the squaring function

Putting it all together (functions in the form $y = ax^2 + k$)... aka $y = a\,f(x) + k$

1. Consider the functions $y = x^2$ and $y = -2x^2 + 3$.

a) Write a sentence to compare the graphs of the two functions.

Sol'n: The graph of $y = -2x^2 + 3$ has been vertically stretched by factor "2" so it is twice as tall aka narrow as parent $y = x^2$, has been vertically reflected across the x-axis, and been vertically translated up 3 units.

b) Sketch the graphs.

Sol'n: Tip: Use efficient 3 step mini-table of values approach.

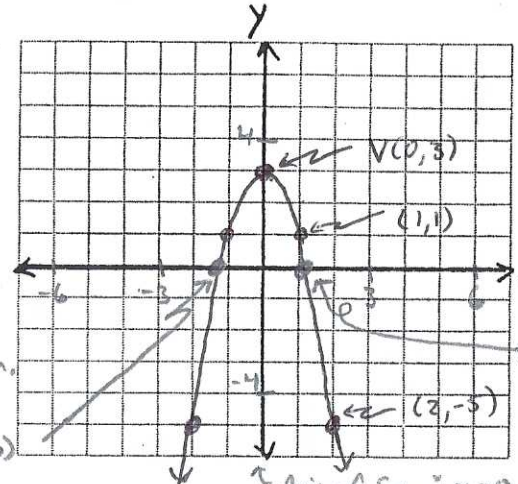
Step 1: Plot the vertex

Step 2: Make a mini-table of easy points with domain values chosen close to one side of the x coordinate of the vertex.

Step 3: Use symmetry to graph the other arm.

x	$y = -2x^2 + 3$
1. V(0,	3)
2. 1	$y = -2(1)^2 + 3 = 1$
2	$y = -2(2)^2 + 3 = -5$

3. Use Symmetry; Reflect horizontally across the axis of symmetry.



c) State the

vertex: $(0,3)$

direction of opening: Down

axis of symmetry: $x = 0$ aka y-axis

max./min. value: $y = 3$

x-intercepts: → Set $y=0$; Solve for x

$\because y = -2x^2 + 3$

$\therefore 0 = -2x^2 + 3$

$-3 \qquad -3$

$\frac{-3}{-2} = \frac{-2x^2}{-2}$

$\frac{3}{2} = x^2$

$\pm\sqrt{\frac{3}{2}} = \sqrt{x^2}$

$\therefore x = \pm\sqrt{1.5}$

$x \doteq \pm 1.22$

domain: {x is Real}

range: {y is Real, y is also less than or equal to 3} ✓ aka {y is Real, $y \le 3$} ✓

2. For each of the following functions:

- Draw a graph (each graph should be done on a separate set of axes)
- Write a sentence to compare the graph to the base function $y = x^2$
- Identify each of the following: vertex, direction of opening, axis of symmetry, max./min. value, x-intercepts, domain and range

Your Turn ☺

Complete just #2c)

\+

P213 #1efik

#2be

#4ac

#6ef

a) $y = x^2 - 6$ ×

b) $y = -x^2 + 1$ ×

c) $y = 2x^2 - 2$ ✓

d) $y = -\frac{1}{2}x^2 + 4$ ×

e) $y = 3x^2$ ×

f) $y = -2x^2 + 5$ ×