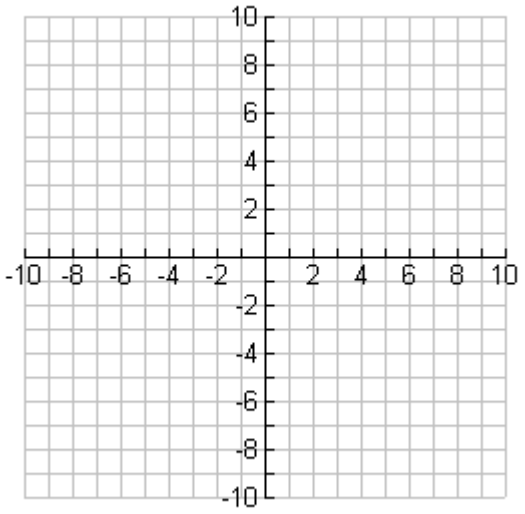
M117 Activity Section 11.4a Graphing Parabolas

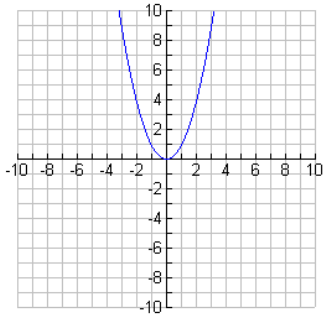
The graph of $y = ax^2 + bx + c$ is called a parabola. In this activity, we will find a systematic way of graphing parabolas that are in the form $y = a(x - h)^2 + k$.

Let's first graph $y = x^2$ by using the points from the table on the left.

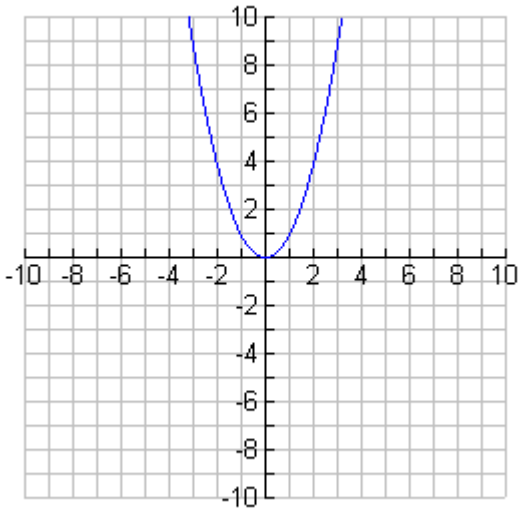


x	x^2
-5	25
-4	16
-3	9
-2	4
-1	1
0	0
1	1
2	4
3	9
4	16
5	25
6	36
7	49
8	64

Your graph should look like this:

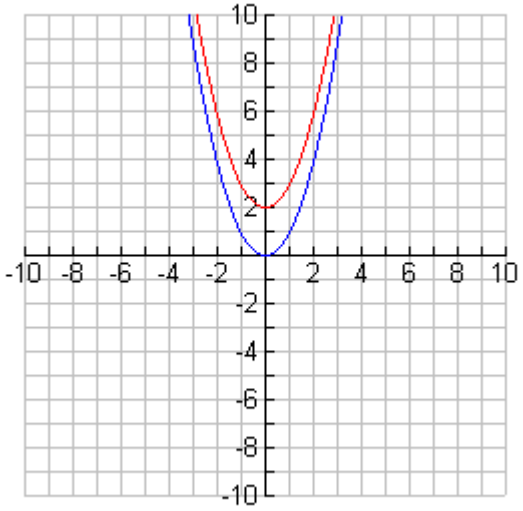


Let's graph $y = x^2 + 2$ on the graph below and compare the graph of $y = x^2$ and $y = x^2 + 2$. The table for $y = x^2 + 2$ is on the right.



x	x^2 +
-5	27
-4	18
-3	11
-2	6
-1	3
0	2
1	3
2	6
3	11
4	18
5	27
6	38
7	51
8	66

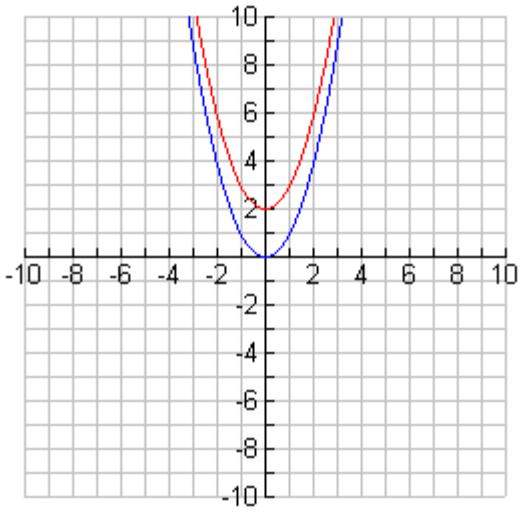
Your graph should look like this:



Describe how the two graphs are the same and how they are different._____

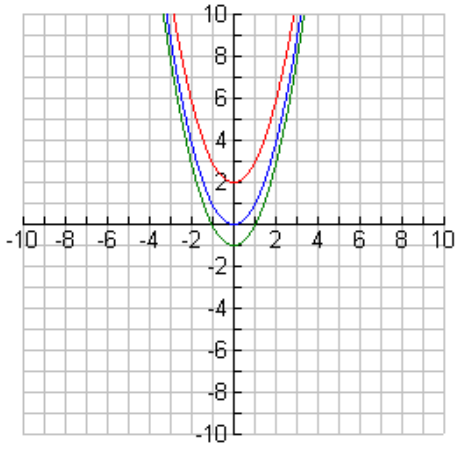
_____

Now graph $y = x^2 - 1$. The graphs of $y = x^2$ and $y = x^2 + 2$ are already on the graph.



x	x^2 -
-5	24
-4	15
-3	8
-2	3
-1	0
0	-1
1	0
2	3
3	8
4	15
5	24
6	35
7	48
8	63

Your new graph should look like this:



Describe how the three graphs are the same and how they are different._____

Describe how the graph of $y = x^2 - 6$ will look._____

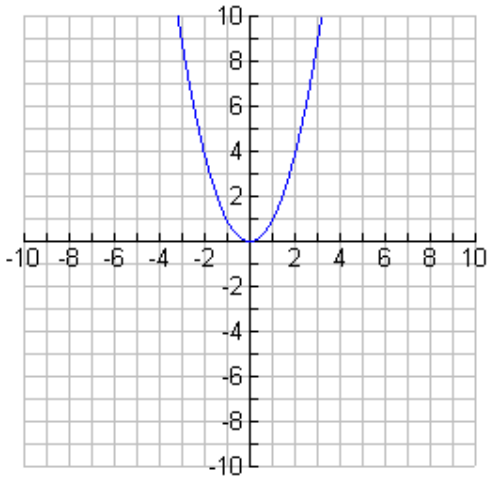
_____

The **vertex** of a parabola is the **lowest** or **highest** point on the graph. Find the vertex of the three parabolas that you just graphed.

$y = x^2$ _____ $y = x^2 + 2$_____ $y = x^2 - 1$_____

In general the graph of a quadratic function of the form $y = ax^2 + k$ is the same as the graph of $y = ax^2$ but moved up or down $|k|$ units, depending on whether k is positive or negative.

Let's determine the role of **a** in the graph of $y = a(x - h)^2 + k$. Graph $y = 2x^2$ on the graph below. $y = x^2$ is already on the graph. Use the table of values on the right.



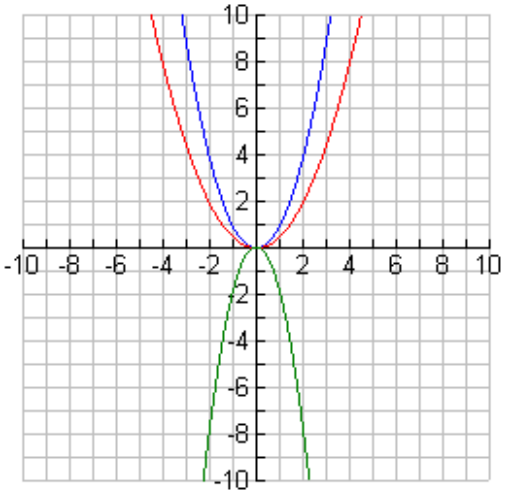
x	2x^2
-5	50
-4	32
-3	18
-2	8
-1	2
0	0
1	2
2	8
3	18
4	32
5	50
6	72
7	98
8	128

x	(1/2)x
-6	18
-4	8
-2	2
0	0
2	2
4	8
6	18
8	32
10	50
12	72
14	98
16	128
18	162
20	200

x	-2x^2
-5	-50
-4	-32
-3	-18
-2	-8
-1	-2
0	0
1	-2
2	-8
3	-18
4	-32
5	-50
6	-72
7	-98
8	-128

On graph above, graph the equations graph $y = \frac{1}{2}x^2$ and $y = -2x^2$. Note the tables on the right.

Your graph should now look like this:



Describe how your graphs are different from $y = x^2$.____

_____

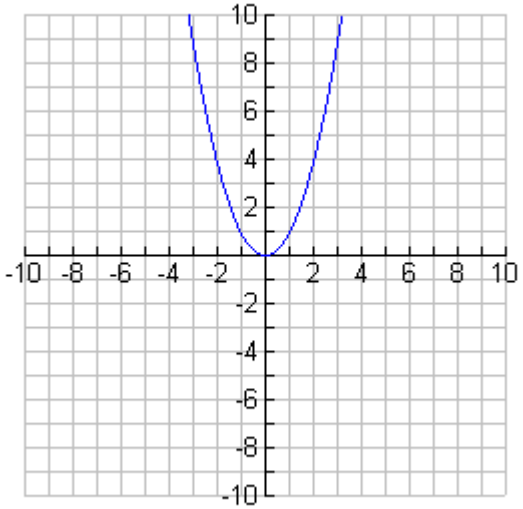
How are they the same?_____

_____

In general, the graph of a quadratic function of the form $y = ax^2$ has its vertex at the origin and opens upward if a is positive and downward if a is negative. The parabola is narrower than the $y = x^2$ if $|a| > 1$ and wider if $|a| > 1$.

Every parabola has a **line of symmetry** (a line that divides the graph in half). This line is called the **axis of symmetry**. The **axis of symmetry** for all of the parabolas above is the y axis or the line x = 0. The axis is always a vertical line having the form **x = h**.

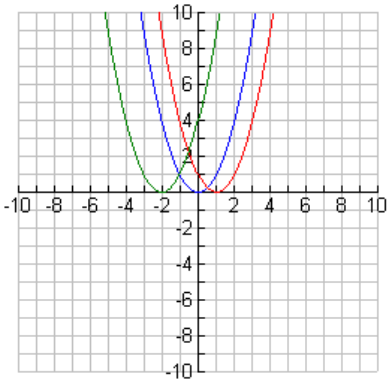
Let's look at the role of h in the equation $y = a(x - h)^2 + k$.
Graph $y = (x - 1)^2$ (first table), the graph of $y = x^2$ is on the graph and the table for this equation is on the right.
Repeat for $y = (x + 2)^2$ (table on the far right)



x	(x -
-5	36
-4	25
-3	16
-2	9
-1	4
0	1
1	0
2	1
3	4
4	9
5	16
6	25
7	36
8	49

x	(x +
-5	9
-4	4
-3	1
-2	0
-1	1
0	4
1	9
2	16
3	25
4	36
5	49
6	64
7	81
8	100

Your graph should look like this:



Find the vertex of each parabola:

$y = x^2$ _____ $y = (x - 1)^2$_____ $y = (x + 2)^2$_____

Find the axis of symmetry for each parabola.

$y = x^2$ _____ $y = (x - 1)^2$_____ $y = (x + 2)^2$_____

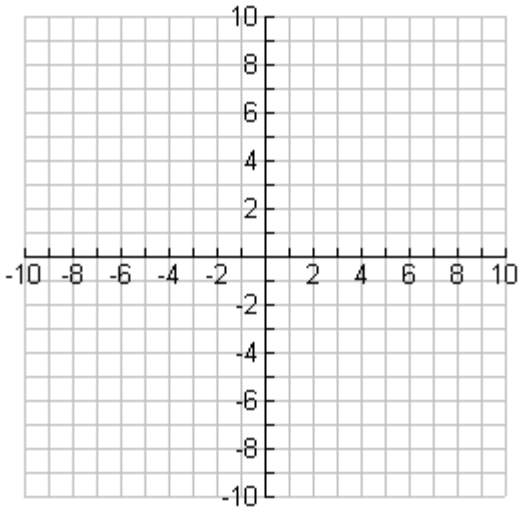
In general, the graph of a quadratic function of the form $y = (x - h)^2$ is the same as the graph of $y = x^2$ but moved to the right h units if $|h|$ is positive or moved to the left $|h|$ if h is negative.

Now put this all together.

Graph $y = (x + 2)^2 - 2$

How is the graph shifted?_____

Compare the size and shape to $y = x^2$. _____

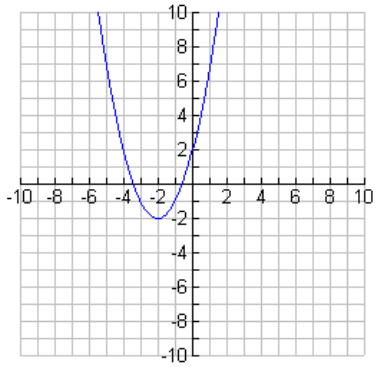


x	(x +
-5	7
-4	2
-3	-1
-2	-2
-1	-1
0	2
1	7
2	14
3	23
4	34
5	47
6	62
7	79
8	98

Name the vertex and the axis of symmetry. Remember the axis of symmetry is a line in the form **x = h** (constant)

Vertex_____ Axis_____

Your graph should look like this:

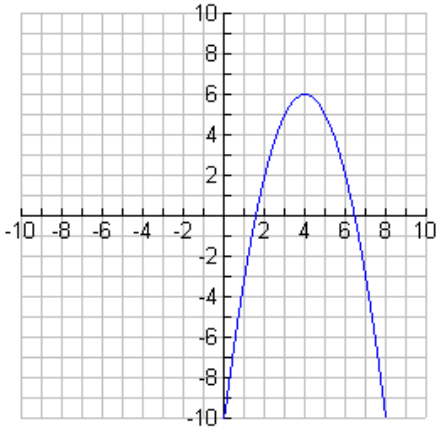


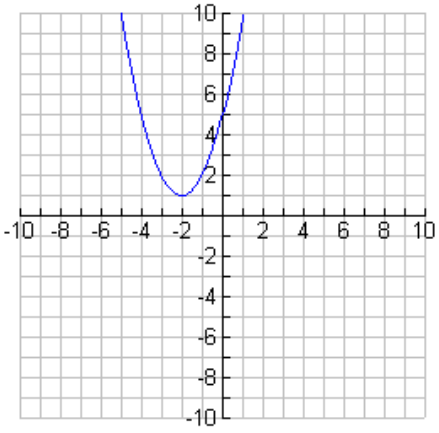
Determine if the following graphs open up or down.
Find the vertex of the graphs of

$y = -(x - 4)^2 + 6$ _____ _____

$y = (x + 2)^2 + 1$ _____ _____

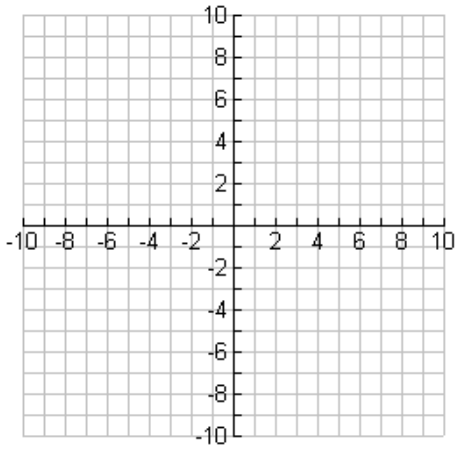
The graphs are shown below. Check your vertex and the direction of opening.





Graph the following parabolas on the axes. Name the vertex and the axis of symmetry. Put these answers in the space below each problem.

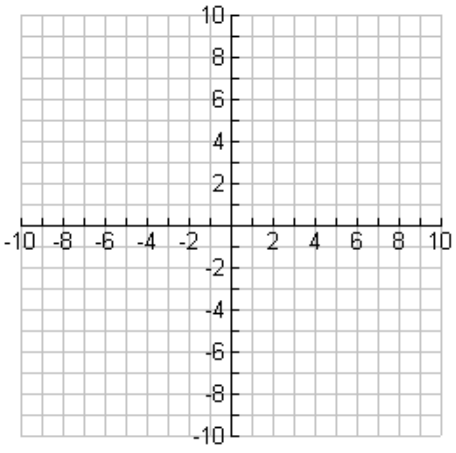
1. $y = -(x+3)^2 - 1$



Vertex_____

Axis of symmetry_____

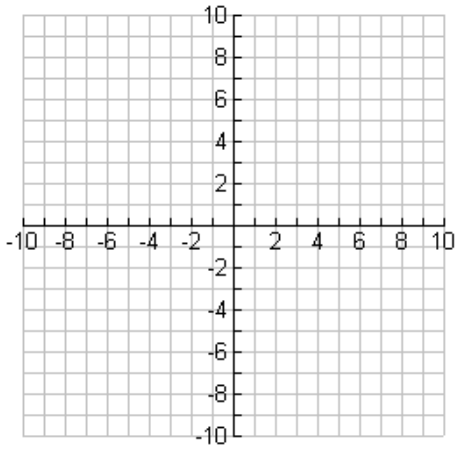
2. $y = (x - 2)^2 + 3$



Vertex_____

Axis of symmetry_____

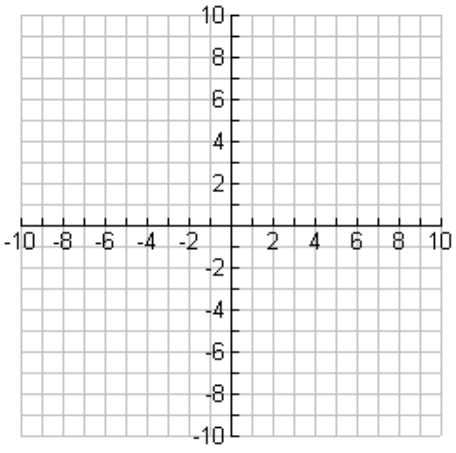
3. $y = 2(x = 3)^2 - 1$



Vertex_____

Axis of symmetry_____

4. $y = (x + 3)^2$



Vertex_____

Axis of symmetry_____