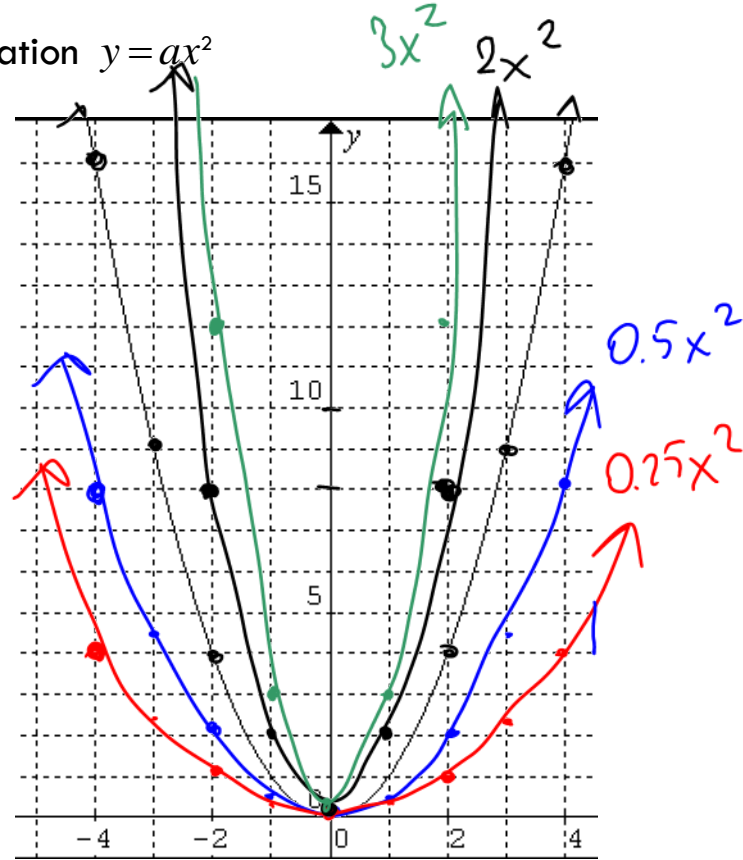


The Quadratic Relation $y = ax^2$

A parabola in standard position.

x	$y = x^2$	(x, y)
-4	$=(-4)^2 = 16$	$(-4, 16)$
-3	$=(-3)^2 = 9$	$(-3, 9)$
-2	$=(-2)^2 = 4$	$(-2, 4)$
-1	$=(-1)^2 = 1$	$(-1, 1)$
0	$=(0)^2 = 0$	$(0, 0)$
1	$=(1)^2 = 1$	$(1, 1)$
2	$=(2)^2 = 4$	$(2, 4)$
3	$=(3)^2 = 9$	$(3, 9)$
4	$=(4)^2 = 16$	$(4, 16)$



INVESTIGATION 1

Graphing $y = ax^2$, when 'a' is positive

Complete each table of values. Use a different colour to sketch a graph of each parabola on the axes above.

$y = \frac{1}{2}x^2 = 0.5x^2$

x	(x, y)
-4	$0.5(-4)^2 = 8$
-3	$0.5(-3)^2 = 4.5$
-2	$0.5(-2)^2 = 2$
-1	$0.5(-1)^2 = 0.5$
0	$0.5(0)^2 = 0$
1	$0.5(1)^2 = 0.5$
2	$0.5(2)^2 = 2$
3	$0.5(3)^2 = 4.5$
4	$0.5(4)^2 = 8$

$y = \frac{1}{4}x^2 = 0.25x^2$

x	(x, y)
-4	$0.25(-4)^2 = 4$
-3	$0.25(-3)^2 = 2.25$
-2	$0.25(-2)^2 = 1$
-1	$0.25(-1)^2 = 0.25$
0	$0.25(0)^2 = 0$
1	$0.25(1)^2 = 0.25$
2	$0.25(2)^2 = 1$
3	$0.25(3)^2 = 2.25$
4	$0.25(4)^2 = 4$

$y = 2x^2$

x	(x, y)
-4	$2(-4)^2 = 32$
-3	$2(-3)^2 = 18$
-2	$2(-2)^2 = 8$
-1	$2(-1)^2 = 2$
0	$2(0)^2 = 0$
1	$2(1)^2 = 2$
2	$2(2)^2 = 8$
3	$2(3)^2 = 18$
4	$2(4)^2 = 32$

$y = 3x^2$

x	(x, y)
-4	$3(-4)^2 = 48$
-3	$3(-3)^2 = 27$
-2	$3(-2)^2 = 12$
-1	$3(-1)^2 = 3$
0	$3(0)^2 = 0$
1	$3(1)^2 = 3$
2	$3(2)^2 = 12$
3	$3(3)^2 = 27$
4	$3(4)^2 = 48$

When 'a' is positive and $|a| < 1$, the parabola opens UP and is vertically compressed

When 'a' is positive and $|a| > 1$, the parabola opens up and is vertically stretched

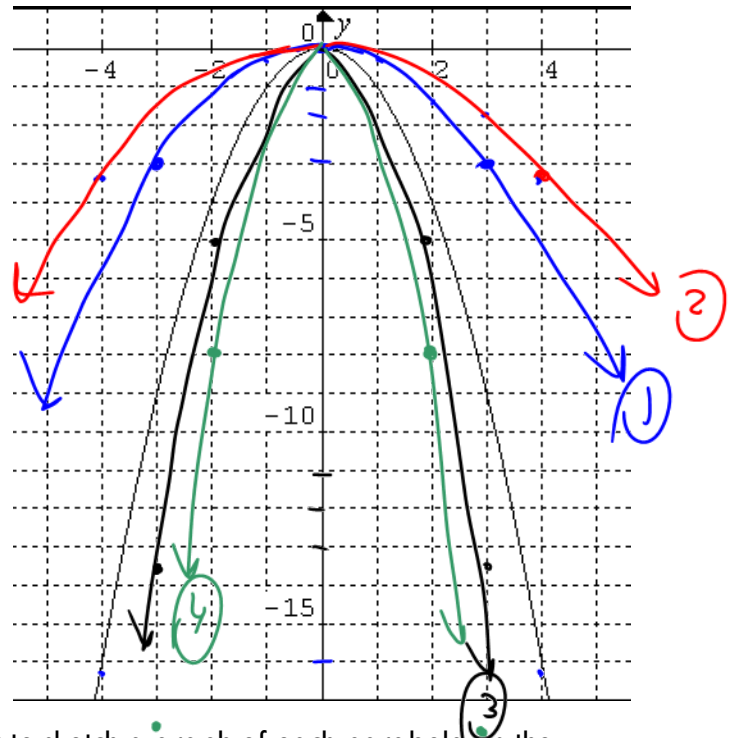
This type of transformation is called a vertical compression/stretch

INVESTIGATION 2

Graphing $y = ax^2$, when 'a' is negative

Complete the table of values for parabola $y = -x^2$

x	$y = -x^2$	(x, y)
-4	$-(-4)^2 = -16$	$(-4, -16)$
-3	$-(-3)^2 = -9$	$(-3, -9)$
-2	$-(-2)^2 = -4$	$(-2, -4)$
-1	$-(-1)^2 = -1$	$(-1, -1)$
0	$-(0)^2 = 0$	$(0, 0)$
1	$-(1)^2 = -1$	$(1, -1)$
2	$-(2)^2 = -4$	$(2, -4)$
3	$-(3)^2 = -9$	$(3, -9)$
4	$-(4)^2 = -16$	$(4, -16)$



Complete each table of values. Use a different colour to sketch a graph of each parabola on the axes above.

① $y = -\frac{1}{3}x^2$

x	(x, y)
-4	$= -\frac{1}{3}(-4)^2 = -\frac{16}{3}$
-3	$= -\frac{1}{3}(-3)^2 = -3$
-2	$= -\frac{1}{3}(-2)^2 = -\frac{4}{3}$
-1	$= -\frac{1}{3}(-1)^2 = -\frac{1}{3}$
0	$= 0$
1	$= -\frac{1}{3}(1)^2 = -\frac{1}{3}$
2	$= -\frac{1}{3}(2)^2 = -\frac{4}{3}$
3	$= -\frac{1}{3}(3)^2 = -3$
4	$= -\frac{1}{3}(4)^2 = -\frac{16}{3}$

② $y = -0.2x^2$

x	(x, y)
-4	$= -0.2(-4)^2 = -3.2$
-3	$= -0.2(-3)^2 = -1.8$
-2	$= -0.2(-2)^2 = -0.8$
-1	$= -0.2(-1)^2 = -0.2$
0	$= 0$
1	$= -0.2(1)^2 = -0.2$
2	$= -0.2(2)^2 = -0.8$
3	$= -0.2(3)^2 = -1.8$
4	$= -0.2(4)^2 = -3.2$

③ $y = -\frac{3}{2}x^2$

x	(x, y)
-4	$= -1.5(-4)^2 = -24$
-3	$= -1.5(-3)^2 = -13.5$
-2	$= -1.5(-2)^2 = -6$
-1	$= -1.5(-1)^2 = -1.5$
0	$= 0$
1	$= -1.5(1)^2 = -1.5$
2	$= -1.5(2)^2 = -6$
3	$= -1.5(3)^2 = -13.5$
4	$= -1.5(4)^2 = -24$

④ $y = -2x^2$

x	(x, y)
-4	$-2(-4)^2 = -32$
-3	$-2(-3)^2 = -18$
-2	$-2(-2)^2 = -8$
-1	$-2(-1)^2 = -2$
0	0
1	$-2(1)^2 = -2$
2	$-2(2)^2 = -8$
3	$-2(3)^2 = -18$
4	$-2(4)^2 = -32$

When 'a' is negative and $|a| < 1$, the parabola opens down and is compressed

When 'a' is negative and $|a| > 1$, the parabola opens down and is stretched

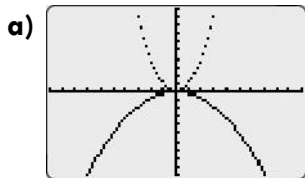
When 'a' is negative, this type of transformation is called a reflection in the x-axis (or flip)

Quadratic $y = ax^2$ Practice

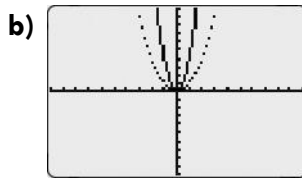
1. In each picture, the graph of $y = x^2$ is shown as a dotted parabola (standard position). The solid parabola is the graph of a quadratic relation of the form $y = ax^2$. For each solid parabola, is the value of a :

- less than -1
- between -1 and 0
- between 0 and 1
- greater than 1 ?

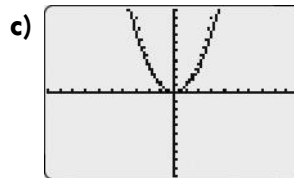
Explain your answer.



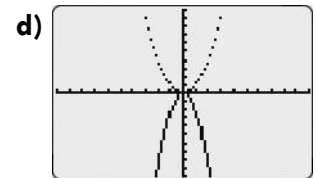
a is between -1 and $-1 \& 0$
 b/c graph is compressed and flipped



a is greater b/c graph is stretched



0 and 1
 b/c graph is compressed

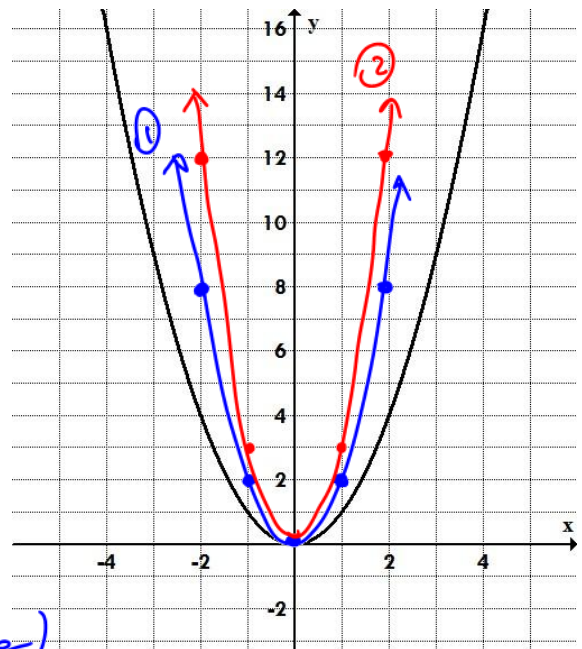


less than -1
 - flipped
 - stretched

2. On the same axis graph the following functions:

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

② $y = 3x^2$	
-2	$3(-2)^2 = 12$
-1	$3(-1)^2 = 3$
0	0
1	$3(1)^2 = 3$
2	$3(2)^2 = 12$



How are the graphs the same?

open up / parabola / stretched

How are the graphs different?

② stretched more than ① (narrower)

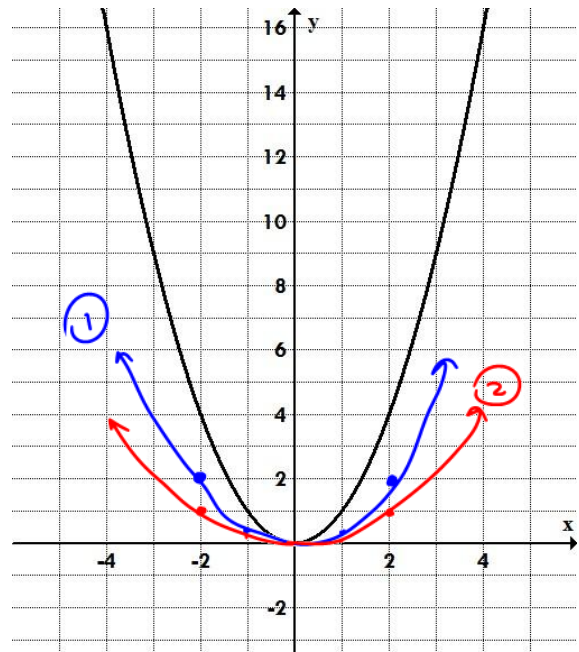
Does this function have a minimum or a maximum? min

If $a > 1$, the graph is vertically stretched and it looks narrower.
(stretched / compressed) (narrower / wider)

3. On the same axis graph the following functions:

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

② $y = \frac{1}{4}x^2 = 0.25x^2$	
-2	$0.25(-2)^2 = 1$
-1	$0.25(-1)^2 = 0.25$
0	0
1	0.25
2	1



How are the graphs the same?

open up / parabola / compressed vert.

How are the graphs different?

② is wider than ①

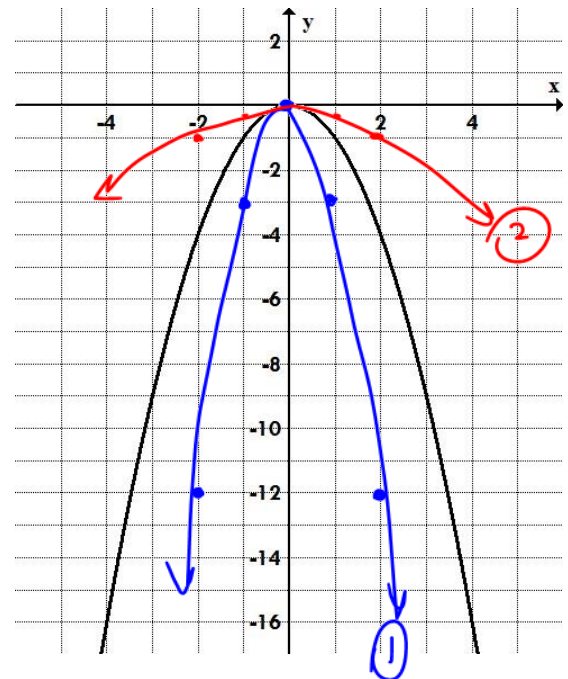
Does this function have a minimum or a maximum? min

If $1 > a > 0$, the graph is vertically compressed and it looks wider.
(stretched / compressed) (narrower / wider)

4. On the same axis graph the following functions:

① $y = -3x^2$	
-2	$-3(-2)^2 = -12$
-1	$-3(-1)^2 = -3$
0	0
1	-3
2	-12

② $y = -\frac{1}{4}x^2 = -0.25x^2$	
-2	$= -1$
-1	$= -0.25$
0	$= 0$
1	$= -0.25$
2	$= -1$



How are the graphs the same?

How are the graphs different?

Does this function have a minimum or a maximum? _____

If the value of 'a' is positive the parabola opens _____.

If the value of 'a' is negative then parabola opens _____.

This is called a _____ in the _____ - axis.