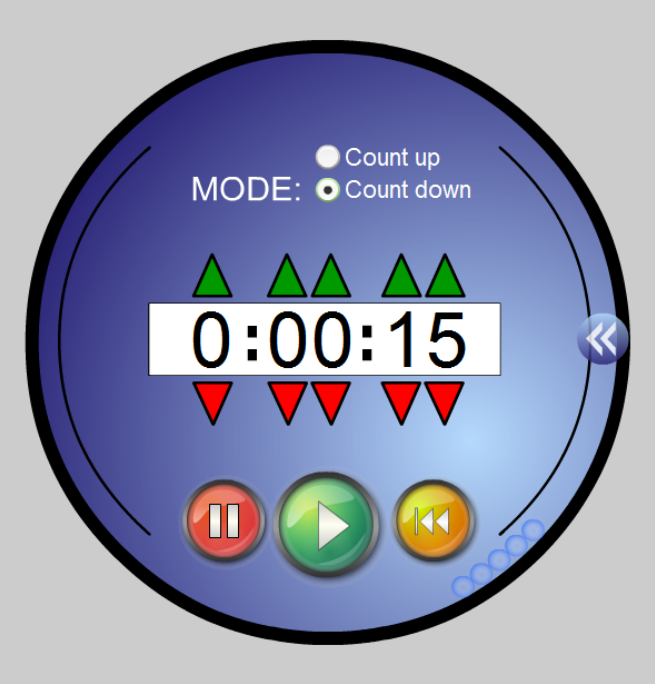
Class starts in 2 minutes. Make sure you have your math work, textbook and calculator!

If you do not have any of these items, get it NOW!



If you are not ready to class when time is up, you stay quiet or go to the office.

No washroom or drink or locker or leaving your seat!!

Worksheet 1-6: Vertical Reflection and Dilatation

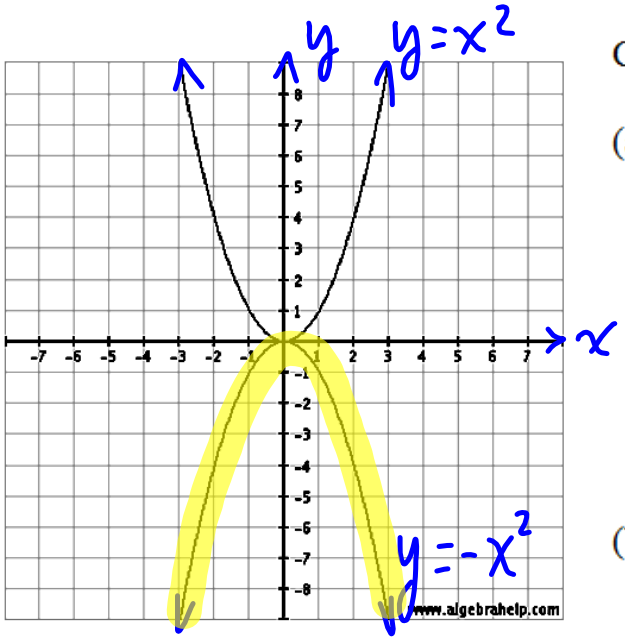
Investigation 1: $y = ax^2$, "positive a" vs. "negative a"

a = vertical factor

On the same axes, graph $y = x^2$ **and** $y = -x^2$.

x	$x^2 = y$	(x, y)
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)

x	$-x^2 = y$	(x, y)
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)



Compare to the basic parabola $y = x^2$,

(a) how is $y = -x^2$ similar to $y = x^2$?

- same vertex (0,0)
- same axis of symmetry
- same x and y intercepts
- same shape
- same domain

(b) how is $y = -x^2$ different from $y = x^2$?

- $y=x^2$ has a minimum but $y=-x^2$ has a maximum
- different openings
- different range

Conclusion: Vertical Reflection $y = ax^2$, $a < 0$

When a is positive,	When a is negative,
the parabola opens upward, and	the parabola opens downward, and
the vertex is at (0, 0).	the vertex is at (0, 0).

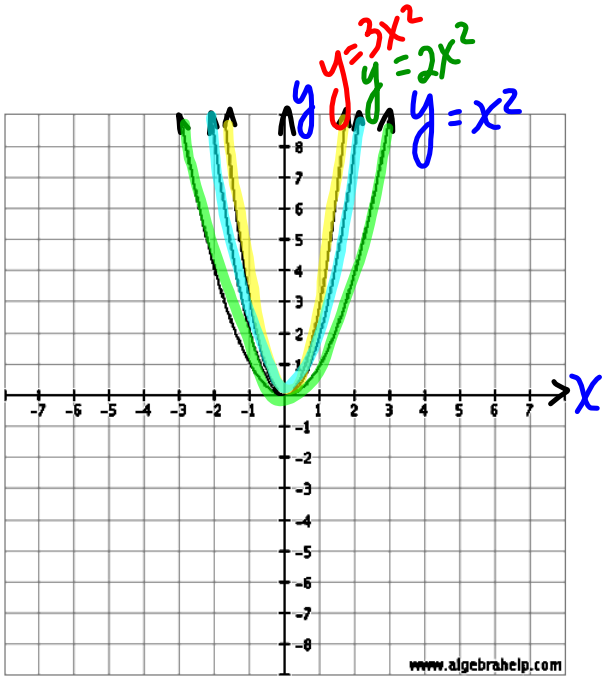
Investigation 2: $y = ax^2$, **when** a **is positive and greater than 1**

On the same axes, graph $y = x^2$, $y = 2x^2$ **and** $y = 3x^2$.

(2, 4)
(1, 1)
(0, 0)
} $y = x^2$

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

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



Compare the three parabolas,

(a) how are they similar?

- same vertex
- same opening
- same axis of symmetry
- same minimum value
- same domain & range

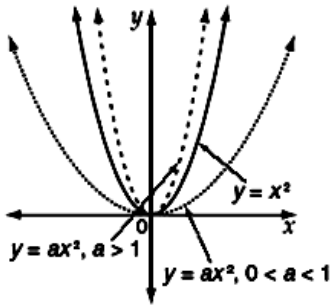
(b) how are they different?

- different shapes

Conclusion: Vertical Stretch $y = ax^2$, $a > 1$ **or** $a < -1$

Compared to $y = x^2$, **the graph of** $y = ax^2$ **is**

- **stretched vertically, and thus narrower, if** $a > 1$
- **the parabola opens upward and the vertex is at** $(0, 0)$
- **If** $a < -1$, **the parabola is still stretched vertically but opens downward**

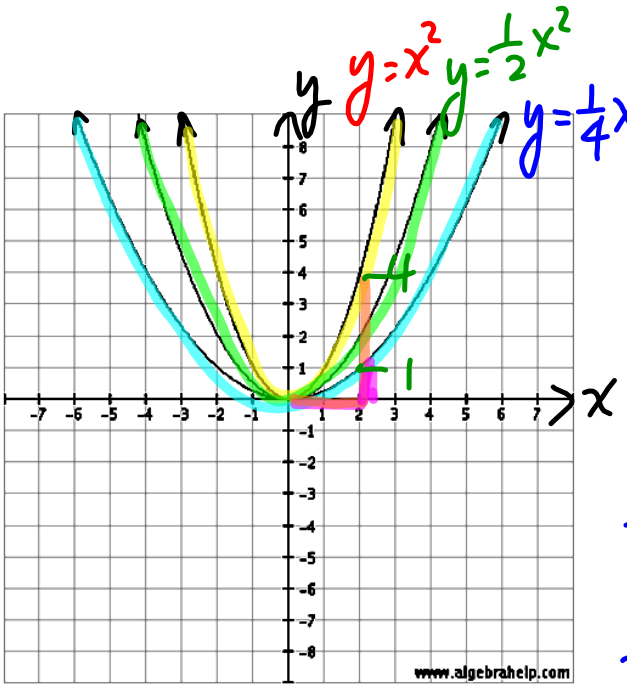


Investigation 3: $y = ax^2$, **when** a **is positive and less than 1**

On the same axes, graph $y = x^2$, $y = \frac{1}{2}x^2$ **and** $y = \frac{1}{4}x^2$. ****Hint: Use 2 units as 1 for the y-axis**

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

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



Compare the three parabolas,

(a) how are they similar?

- same vertex
- same domain & range
- same opening
- same minimum value
- same axis of symmetry

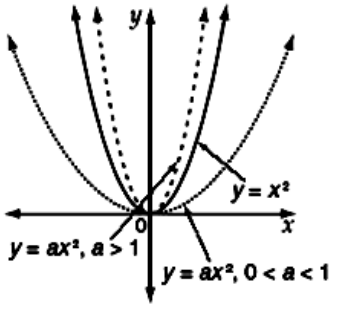
(b) how are they different?

- different shape

Conclusion: Vertical Compression $y = ax^2$, $-1 < a < 1$

Compared to $y = x^2$, **the graph of** $y = ax^2$ **is**

- **compressed vertically, and thus wider, if** $0 < a < 1$
- **the parabola opens upward and the vertex is at** $(0, 0)$
- **If** $-1 < a < 0$, **the parabola is still compressed vertically but opens downward**



Practice:

1. Match the following graphs to their corresponding equations.

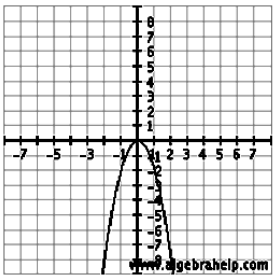
$y=\frac{1}{2}x^2$ $y=-2x^2$ $y=4x^2$ $y=-\frac{1}{3}x^2$

- opens up
- compression (away from y-axis)

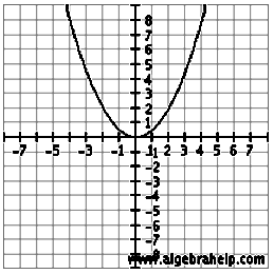
- opens down
- narrow + close to y-axis (stretch)

- opens up
- stretch (narrower)

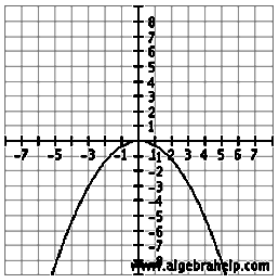
- opens down
- (wider) compression



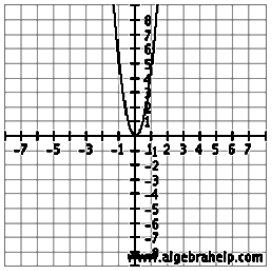
$y=-2x^2$



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



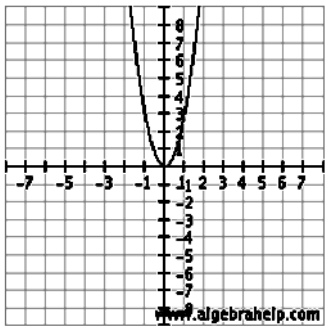
$y=-\frac{1}{3}x^2$



$y=4x^2$

2. State the vertex and the equation for each of the following graphs.

(a)



vertex = (0,0)

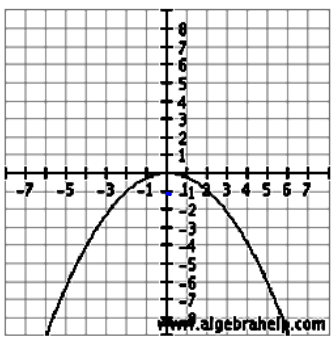
x	x^2	$?x^2$
1	1	3
2	4	?

$\times 3$

$a=3$

$y=3x^2$

(b)



vertex = (0,0)

x	x^2	$?x^2$
1	1	
2	4	1

$\times\frac{1}{4} = \div 4$

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