

## What's Going On?

**Checking In**

**Minds on**

Graphing  $y = x^2$

**Action!**

Investigating the effects of  $a$  and  $k$

**Consolidation**

Graphing  $y = ax^2 + k$

**Learning Goal - I will understand how to graph quadratic functions in the form  $y = ax^2 + k$ .**

 Minds onGraphing  $y = x^2$ 

If you were asked to graph the function  $y = x^2$ , how would you do it?  
Explain in words.

## Minds on

Graphing  $y = x^2$ 

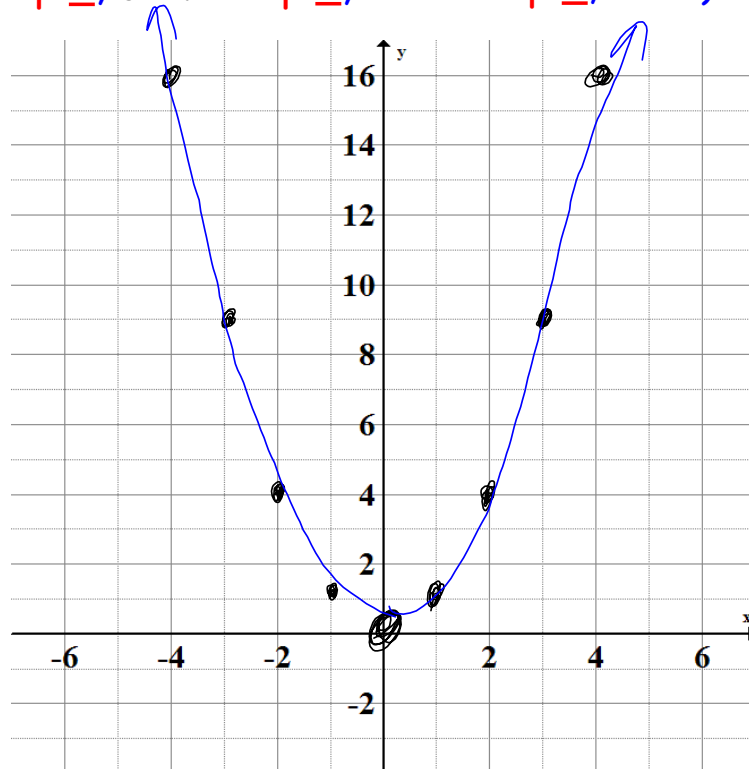
To graph the function  $y = x^2$ ,

1 3 5 7

1. Plot the **vertex** at  $(0, 0)$ .

2. Use the **step pattern** to plot additional points

(over 1 up 1, over 1 up 3, over 1 up 5, etc...)



**Action!**

Investigation

**Desmos!**

## Part A

1. Open Desmos.
2. Graph  $y = ax^2$  and turn on the slider for  $a$ .
3. Play with the slider, keeping it greater than 0.
4. Explain what changing the value of  $a$  does to the parabola when  $a$  gets larger and when  $a$  gets smaller.

When  $a$  gets larger the parabola gets thinner and when  $a$  gets smaller the parabola gets wider/fatter.

5. Play with the slider, go into the negatives and positives.
6. Explain what happens when  $a$  becomes negative.

When  $a$  becomes negative, the parabola flips upside down.

## Part B

1. Still in Desmos.
2. Graph  $y = x^2 + k$  and turn on the slider for  $k$ .
3. Play with the slider.
4. Explain what changing the value of  $k$  does to the parabola when  $k$  is positive and when  $k$  is negative.

Changing the value of  $k$  moves the vertex up when  $k$  is positive and down when  $k$  is negative.

$k$  is the  $y$ -value of the vertex

**Action!**

# Graphing $y = ax^2$

Equation

$y = 0.5x^2$

$y = x^2$

Normal Step Pattern

x	y
-4	8
-3	4.5
-2	2
-1	0.5
0	0
1	0.5
2	2
3	4.5
4	8

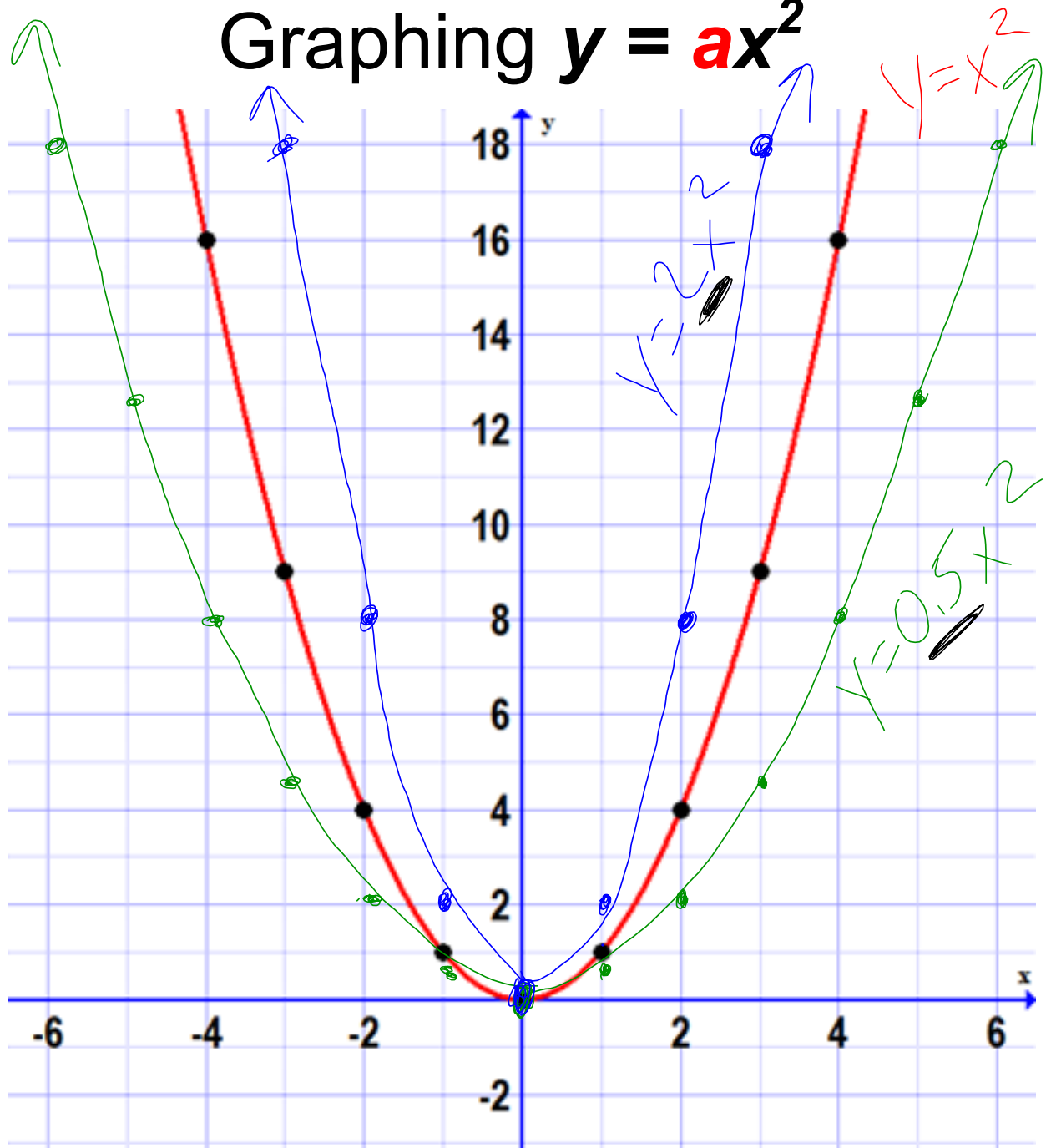
New Step Pattern

x	y
0.5	0.125
1.5	1.125
2.5	3.125
3.5	6.125

$\times 0.5$

**Action!**

# Graphing $y = ax^2$





## Action!

# Graphing $y = ax^2$

The value of  $a$  stretches the parabola when  $a$  is **greater than 1** and compresses the parabola when  $a$  is **less than 1**.

The value of  $a$  also changes the step pattern. Basically, to get the new step pattern, just multiply the original one by  $a$ !

Graph  $y = 2x^2$  on the axes above.

What is the step pattern of the parabola?

1 3 5 7 normal

$\times 2 \downarrow$   $\times 2 \downarrow$   $\times 2 \downarrow$   $\times 2 \downarrow$

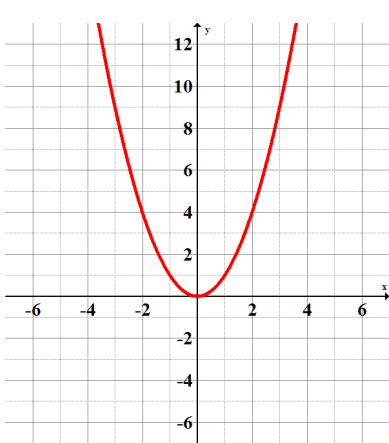
2	6	10	14
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step pattern of  $2x^2$

**Action!**

## Graphing $y = ax^2$

The value of  $a$  changes the step pattern of the curve.  
Specifically, each step is multiplied by  $a$ .

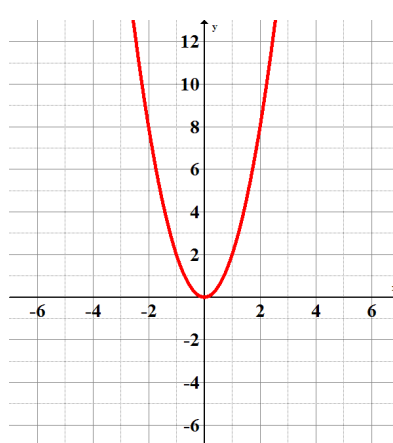


$$y = x^2$$

Step Pattern

1, 3, 5, 7, ...

$$a = 1$$

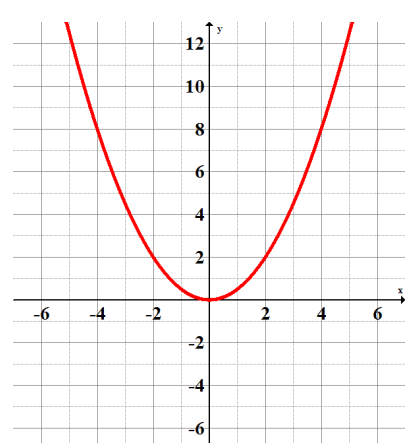


$$y = 2x^2$$

Step Pattern

2, 6, 10, 14, ...

$$a = 2$$



$$y = 0.5x^2$$

Step Pattern

.5, 1.5, 2.5, 3.5, ...

$$a = 0.5$$

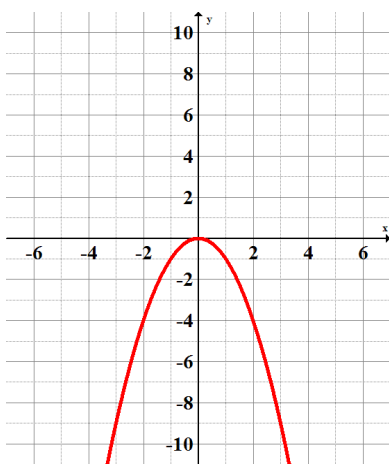
## Consolidation

NEGATIVE

Graphing  $y = -ax^2$ 

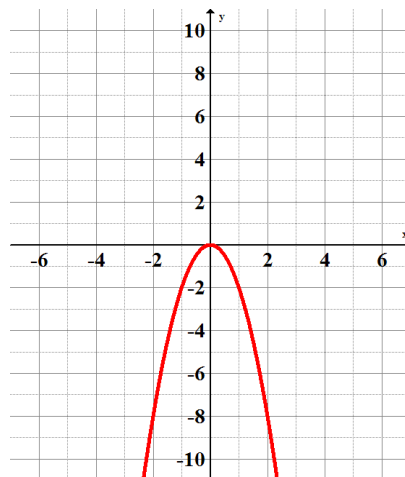
The value of  $a$  changes the step pattern of the curve.  
Specifically, each step is multiplied by  $a$ .

## What if $a$ is negative???



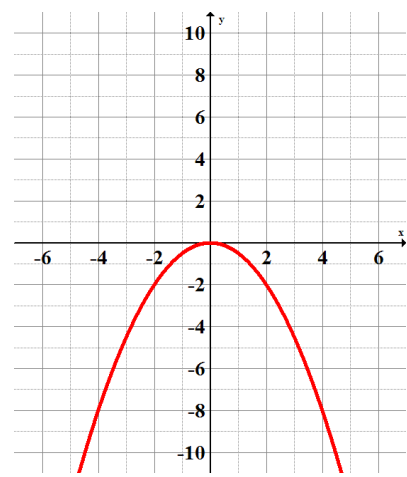
$$y = -x^2$$

Step Pattern

$$-1, -3, -5, -7, \dots$$


$$y = -2x^2$$

Step Pattern

$$-2, -6, -10, -14, \dots$$


$$y = -0.5x^2$$

Step Pattern

$$-0.5, -1.5, -2.5, -3.5, \dots$$

**Action!**

Graphing  $y = x^2 + k$

# Desmos

**Action!**

# Graphing $y = x^2 + k$

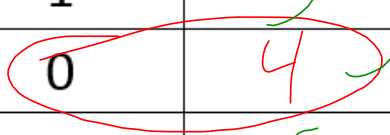
Equation

$$y = x^2 + 4$$

*Start of pattern*

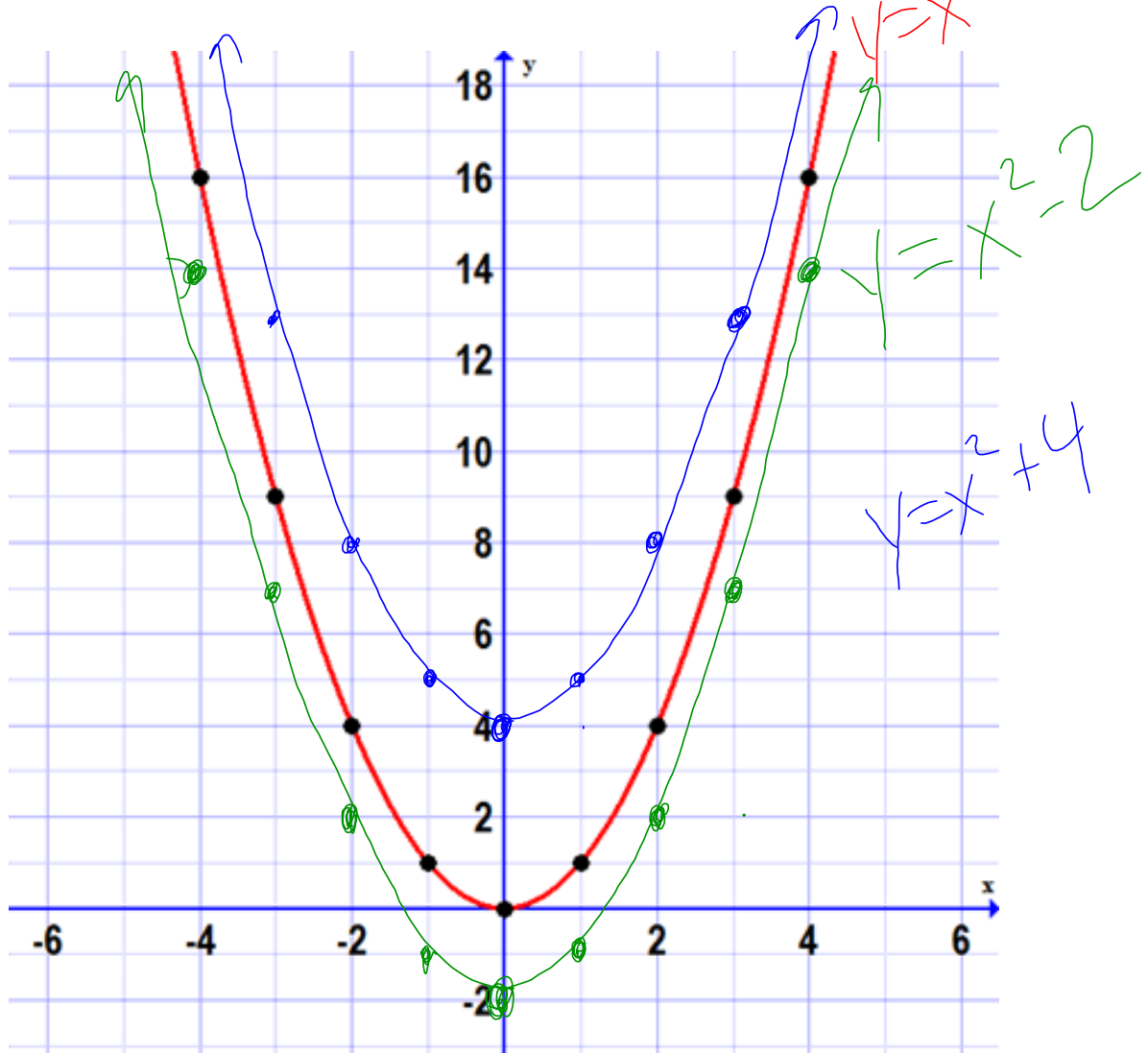
x	y
-4	20
-3	13
-2	8
-1	5
0	4
1	5
2	8
3	13
4	20

*1 3 5 7*



**Action!**

# Graphing $y = x^2 + k$



**Action!**

# Graphing $y = x^2 + k$

The value of  $k$  shifts the parabola up when  $k$  is *positive* and down when  $k$  is *negative*.

Graph  $y = x^2 - 2$  on the axes above.

What is the vertex of the parabola?

$(0, -2)$

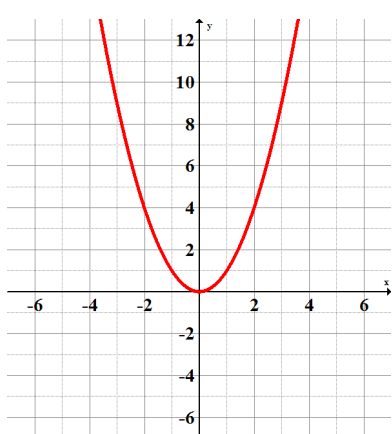
$k$

**Action!**

# Graphing $y = x^2 + k$

The value of  $k$  shifts the curve up and down.

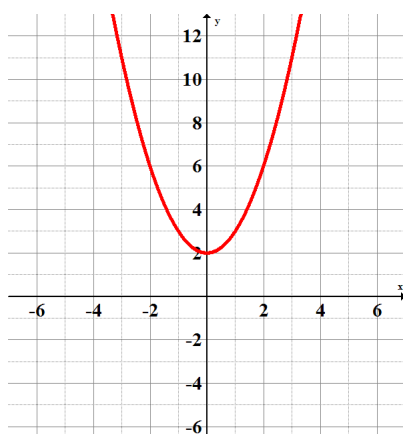
This means that it also shifts the vertex up or down by  $k$ .



$$y = x^2$$

Vertex = (0, 0)

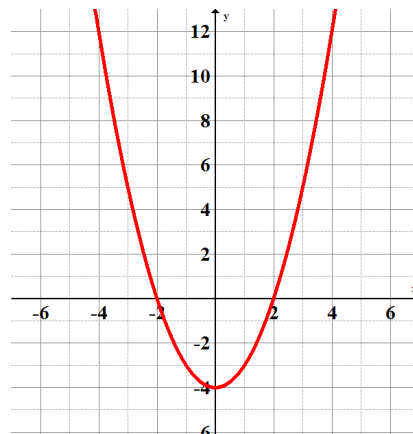
$$k = 0$$



$$y = x^2 + 2$$

Vertex = (0, 2)

$$k = 2$$



$$y = x^2 - 4$$

Vertex = (0, -4)

$$k = -4$$



## Consolidation

# Graphing $y = ax^2 + k$

The value of  $k$  shifts the curve up and down.  
This means that it also shifts the vertex up or down by  $k$ .

The value of  $a$  changes the step pattern of the curve.  
Specifically, each step is multiplied by  $a$ .

So if we put them together...

the vertex gets shifted up or down by  $k$ ,  
and the step pattern gets multiplied by  $a$ .

## Consolidation

# Graphing $y = ax^2 + k$

To graph  $y = ax^2 + k$ , first place the vertex by going up or down  $k$  units from  $(0, 0)$ . Then use the new step pattern to graph the remaining points.

**Note:** the new step pattern is found by multiplying each original step by the value of  $a$ . If  $a$  is positive, the steps will go up, if  $a$  is negative, the steps will go down.

## Consolidation

Graphing  $y = ax^2 + k$

$$y = -2x^2 + 8$$

