

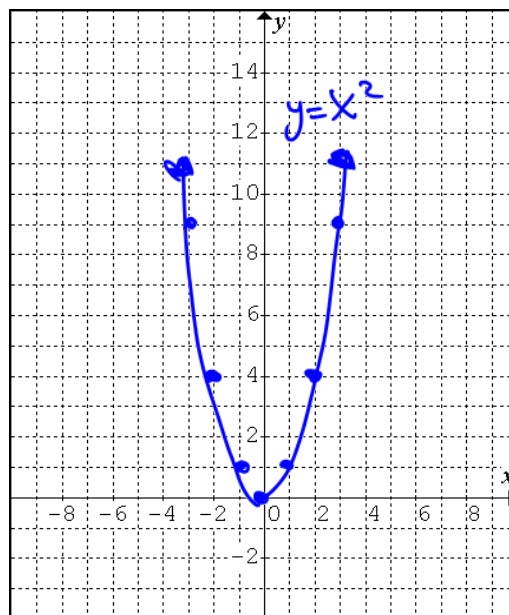
Stretches, Compressions and Reflections of Quadratic Relations

(Warm-Up) Task B: The Basic Parabola $y = x^2$

- Complete the table of values, including the first differences.
- Graph the parabola.

x	$y = x^2$	first differences
-4	16	
-3	9	
-2	4	
-1	1	
0	0	
1	1	1
2	4	3
3	9	5
4	16	7

Recall: these are the 'step pattern'. ↑

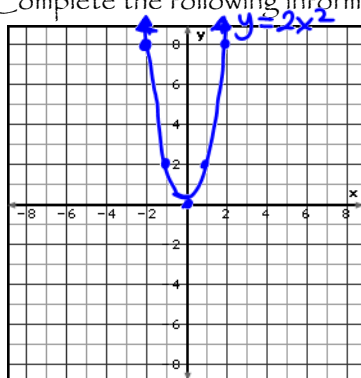


Task A: What happens when you graph $y = ax^2$?

- Change the slider for h and k to 0 and for a to 2. What equation does that produce? $y = 2x^2$

3. Describe the effect this had on the graph.
 The parabola stretches vertically.

4. Complete the following information.



x	$y = 2x^2$	first differences
-3	$2(-3)^2 = 18$	
-2	$2(-2)^2 = 8$	
-1	$2(-1)^2 = 2$	
0	$2(0)^2 = 0$	2
1	$2(1)^2 = 2$	6
2	$2(2)^2 = 8$	10
3	$2(3)^2 = 18$	

vertex = (0,0)

axis of symmetry = $x = 0$

direction of opening = UP

step pattern = 2 6 10

5. How does the value of a affect the step pattern?

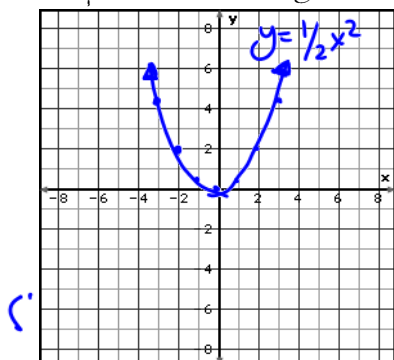
Doubled the step pattern

• Back in DESMOS, change the slider for a to $\frac{1}{2}$ (or 0.5). The equation: $y = 0.5x^2$

6. Describe the effect this had on the graph.

The graph gets compressed vertically

7. Complete the following information.



x	$y = \frac{1}{2}x^2$	first differences
-3	$\frac{1}{2}(-3)^2 = 4.5$	
-2	$\frac{1}{2}(-2)^2 = 2$	
-1	$\frac{1}{2}(-1)^2 = 0.5$	
0	$\frac{1}{2}(0)^2 = 0$	
1	$\frac{1}{2}(1)^2 = 0.5$	0.5
2	$\frac{1}{2}(2)^2 = 2$	1.5
3	$\frac{1}{2}(3)^2 = 4.5$	2.5

vertex = $(0,0)$

axis of symmetry = $x=0$

direction of opening = UP

step pattern = $0.5 \quad 1.5 \quad 2.5$

8. How does the value of a affect the step pattern?

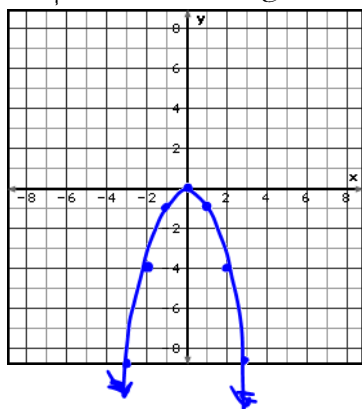
It halved the step pattern

• Back in DESMOS, change the slider for a to -1 . What equation does that produce? $y = -x^2$

9. Describe the effect this had on the graph.

The graph got reflected about the "x" axis

10. Complete the following information.



x	$y = -1x^2$	first differences
-3	$-1(-3)^2 = -9$	
-2	$-1(-2)^2 = -4$	
-1	$-1(-1)^2 = -1$	
0	0	
1	$-1(1)^2 = -1$	-1
2	$-1(2)^2 = -4$	-3
3	$-1(3)^2 = -9$	-5

vertex = $(0,0)$

axis of symmetry = $x=0$

direction of opening = $down$

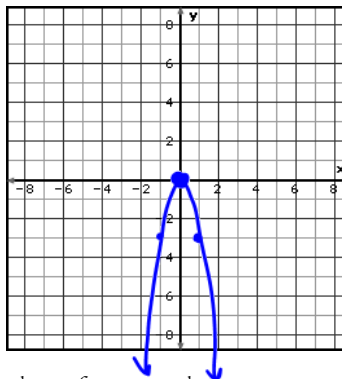
step pattern = $-1 \quad -3 \quad -5$

11. How does the value of a affect the step pattern?

It negated the a values.

12. If the equation was $y = -3x^2$, what do you think the properties and graph would be? Try them in PENCIL!

vertex = $(0,0)$
 axis of symmetry = $x=0$
 direction of opening = $down$
 step pattern = $-3 \quad -9 \quad -15$



• Back in DESMOS, change the slider for a to -3 and confirm or adjust your answer above.

The graph of $y = ax^2$ produces a

vertex = (0, 0)

• vertical reflection if $a < 0$ (e.g. $y = -2x^2$)

axis of symmetry = $x = 0$

• vertical stretch if $|a| > 1$ (e.g. $y = 4x^2$)

$4 \cdot (1, 3, 5, 7)$
 step pattern = 4 12 20 28

• vertical compression if $|a| < 1$ (e.g. $y = \frac{1}{4}x^2$)

direction of opening = if $a > 0$ UP
 if $a < 0$ DOWN

Note: the $| |$ signs around the a value are "absolute value" signs. It means to consider the numerical (number) value without considering the sign (positive or negative).

Task P: Practice!

13. Graph each parabola.

a. $y = 3x^2$

$3(1, 3, 5)$
 Step Pattern: 3 9 15
 Vertex (0, 0)

b. $y = -2x^2$

Step Pattern: -2 -6 -10

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

$0.25(1, 3, 5, 7)$
 Step Pattern: 0.25 0.75 1.25 1.75

