A transformation is a change to the shape or location of our graph. In the following sections we will explore different types of transformations, achieved by changing numbers in our formula.

1. Parent Function

Start with a new Desmos graph. Type in "$f(x) = x^2$". This is our parent function. The graph you see is a parabola with vertex at $(0,0)$. It has the natural shape of a parabola with points at $(2,4)$ and $(-2,4)$.

2. Adding or Subtracting a Constant

Change your parent function to "$f(x) = x^2 + c$". Click the "add slider" button. Now "c" is a parameter, and you can change its value from -10 to 10. Use the slider to quickly view graphs of the following examples on your screen.

    a. $f(x) = x^2 + 5$ b. $f(x) = x^2 + 3$ c. $f(x) = x^2 - 3$ d. $f(x) = x^2 - 5$

When c is 1, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
When c is 4, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
In your own words, what is happening to the graph of the function as c changes? How does the value of c cause this affect?

From the choices given in Part 6 below, what would you name this transformation?

3. Multiplying by a Positive Number Greater Than One

Change your parent function to "$f(x) = ax^2$". Click the "add slider" button. Click the number 10 on the right-hand end of the slider, and change the minimum and maximum values so the slider reads "$1 \le a \le 20$". Now "a" is a parameter, and you can change its value from 1 to 20. Use the slider to quickly view graphs of the following examples on your screen.

    a. $f(x) = x^2$ b. $f(x) = 2x^2$ c. $f(x) = 10x^2$ d. $f(x) = 20x^2$

When a is 1, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
When a is 4, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
Given what's happening to your y-values, would you say the graph grows skinnier as a gets bigger, or does it grow taller as a gets bigger? How does the value of a cause this affect?

From the choices given in Part 6 below, what would you name this transformation?

4. <u>Multiplying by a Positive Number Less Than One</u>

Now click the number 20 on the right-hand end of the slider, and change the minimum and maximum values so the slider reads "$0 \le a \le 1$". For the "step" value enter ".01". Use the slider to quickly view graphs of the following examples on your screen.

a. $f(x) = x^2$ b. $f(x) = .8x^2$ c. $f(x) = .5x^2$ d. $f(x) = .01x^2$

When a is .5, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
When a is .01, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
Given what's happening to your y-values, would you say the graph grows fatter as a gets smaller, or does it grow shorter as a gets smaller? How does the value of a cause this affect?

From the choices given in Part 6 below, what would you name this transformation?

5. <u>Multiplying by a Negative Number</u>

Now click the number 1 on the right-hand end of the slider, and change the minimum and maximum values so the slider reads "$-20 \le a \le 20$". Use the slider to quickly view graphs of the following pairs of examples on your screen.

a. $f(x) = x^2$ b. $f(x) = -.1x^2$ c. $f(x) = 5x^2$ d. $f(x) = -20x^2$
   $f(x) = -x^2$ $f(x) = .1x^2$ $f(x) = -5x^2$ $f(x) = 20x^2$

When a is 1, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
When a is -1, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
When a is 5, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___
When a is -5, what is the value of $f(1)$? ___ $f(2)$? ___ $f(3)$? ___

When we change a from positive to negative, does this change affect the shape of the graph? What is the effect on our graph? How does the sign of the value of a cause this affect?

From the choices given in Part 6 below, what would you name this transformation?

6. <u>Vocabulary</u>

The transformations we've explored in parts 2 – 5 all have names. See if you can you pick appropriate names from the list below! Or, if you've studied a transformation before under a different name, what did you call it?

Vertical Shift (or Translation)
Vertical Stretch
Vertical Shrink
Reflection over the x-axis