

# L4 - Combining Transformations

December-14-15

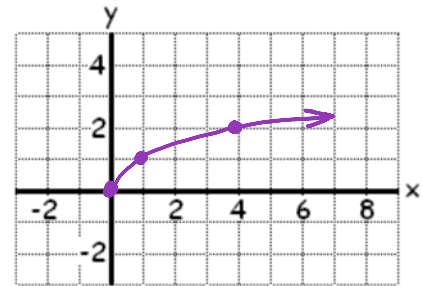
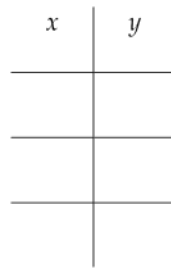
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**Unit 6: Transformations**

**Lesson 4 - Combinations of Transformations**

Does order matter? Let's explore.

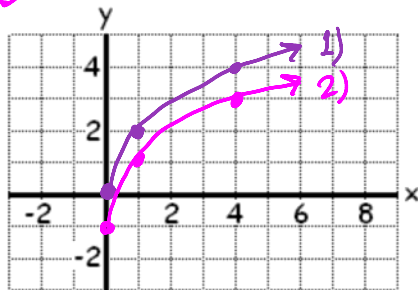
Ex. 1: Graph  $y = \sqrt{x}$



**Vertical Expansion first vs. Vertical Translation first: (Reverse Order)**

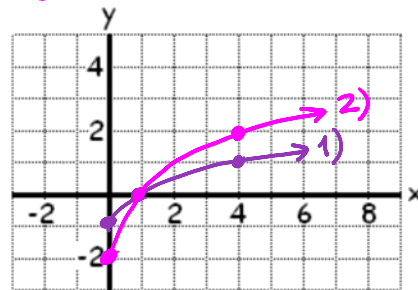
1) VE by factor of 2

2) VT by 1 unit down



1) VT by 1 unit down

2) VE by a factor of 2



→Did the order effect the outcome?

Yes!

Order: **BEDMAS!**  
 ↑ Stretches 1<sup>st</sup>  
 ↑ Translations 2<sup>nd</sup>

**"Build-it-up" Method:** Replace x with "new x" - Put in "new y" setting.

Ex. 2: Given the description, write the following transformations in function notation.

- |                                |                    |                                 |  |
|--------------------------------|--------------------|---------------------------------|--|
| a) VE of 2                     | $y = 2f(x)$        | b) HE of 2                      | $y = f(\frac{1}{2}x)$                    |
| VT down 3                      | $y = 2f(x) - 3$    | VC of 1/6                       | $y = \frac{1}{6}f(\frac{1}{2}x)$         |
| HT right 1                     | $y = 2f(x-1) - 3$  | VT up 1                         | $y = \frac{1}{6}f(\frac{1}{2}x) + 1$     |
| HC of 1/3 : $x \rightarrow 3x$ | $y = 2f(3x-1) - 3$ | HT left 6 : $x \rightarrow x+6$ | $y = \frac{1}{6}f(\frac{1}{2}(x+6)) + 1$ |

**SRT**

**Combinations of Transformations:**

We will perform transformations in the order **S (Stretches), R (Reflections), T (Translations)**  
 First, re-write the function as  $y = af(b(x-c)) + d$  to be able to read all of the transformations directly.

Notice: there is no coefficient on  $x \rightarrow$  it must be factored out!

- 1) A Vertical **Stretch** by a factor of  $a$  } S
- 2) A Horizontal **Stretch** by a factor of  $\frac{1}{b}$  } S
- 3) A Vertical **Reflection** if  $a < 0$  in the x-axis } R
- 4) A Horizontal **Reflection** if  $b < 0$  in the y-axis } R
- 5) A Vertical **Translation** by a factor of  $d$  } T
- 6) A Horizontal **Translation** by a factor of  $-c$  } T

Vertical: outside  
 Horizontal: inside  
 \*opposite

Ex. 3: Describe the order of transformations that occur for the following functions.

a)  $y = 3f(2x) + 4$   
 S: VE 3, HC  $\frac{1}{2}$   
 R: none  
 T: VT up 4

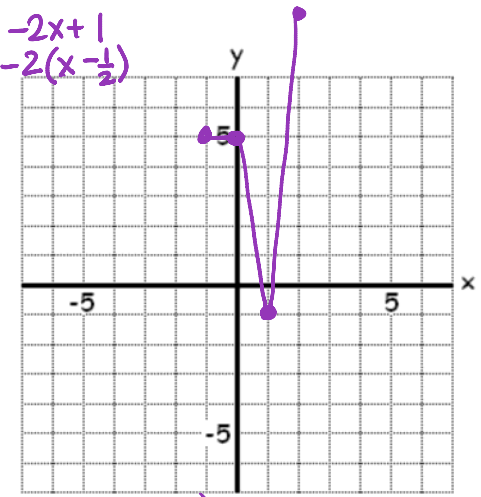
b)  $y = f[2(x-1)]$   
 S: HC  $\frac{1}{2}$   
 R: none  
 T: HT right 1

c)  $y = f(2x-1)$   
 factor!  
 $y = f(2(x-\frac{1}{2}))$   
 S: HC  $\frac{1}{2}$   
 R: none  
 T: HT right  $\frac{1}{2}$

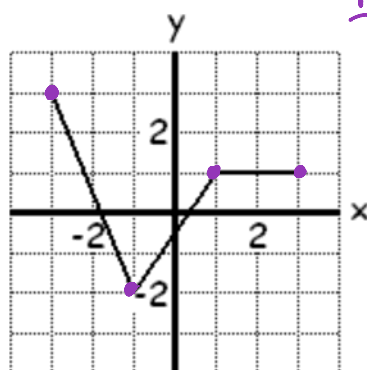
d)  $y = -2f[\frac{1}{3}(x+1)] + 5$   
 S: VE 2, HE 3  
 R: VR  
 T: VT up 5, HT left 1

Ex. 4: Given  $y = f(x)$ :

a) Describe the transformation  $y = 2f(1-2x) + 3$   
 S: VE 2, HC  $\frac{1}{2}$   
 R: HR  
 T: HT right  $\frac{1}{2}$ , VT up 3  
 $y = 2f(-2(x-\frac{1}{2})) + 3$



b) Graph the transformed function on the grid

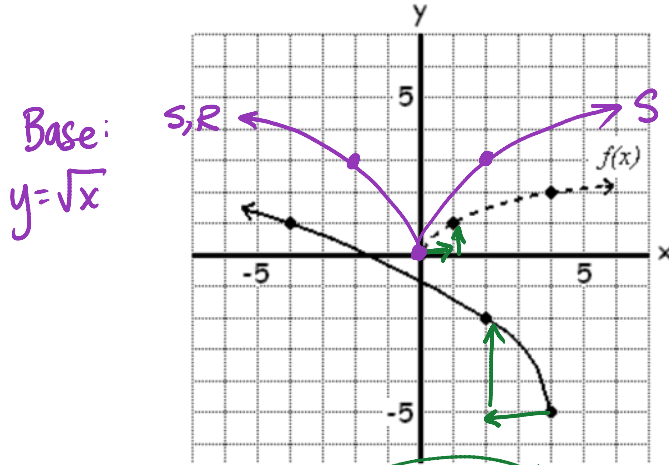


Mapping:

- $(x, y) \rightarrow (-\frac{1}{2}x + \frac{1}{2}, 2y + 3)$
- $(-3, 3) \rightarrow (2, 9)$
- $(-1, -2) \rightarrow (1, -1)$
- $(1, 1) \rightarrow (0, 5)$
- $(3, 1) \rightarrow (-1, 5)$

Ex. 5: Write the equation for both the base function and the transformed function.

a)



Base:  
 $y = \sqrt{x}$

S: Base:  $\Delta x = 1$  New:  $\Delta x = 2$  : HE 2 ✓  
 $\Delta y = 1$   $\Delta y = 3$  : VE 3 ✓

R: HR ✓

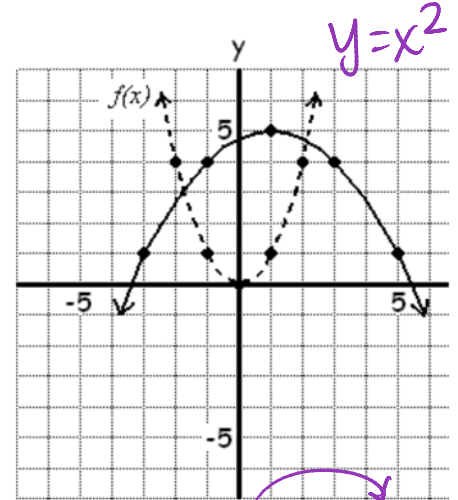
T: HT 4 right ✓  
VT 5 down ✓

$$y = 3f\left(-\frac{1}{2}(x-4)\right) - 5$$

or

$$y = 3\sqrt{-\frac{1}{2}(x-4)} - 5$$

b)



$y = x^2$

Base:  $\Delta x = 1$  New:  $\Delta x = 2$  HE 2  
 $\Delta y = 1$   $\Delta y = 1$

R: VR

T: HT right 1  
VT up 5

$$y = -f\left(\frac{1}{2}(x-1)\right) + 5$$

or

$$y = -\left(\frac{1}{2}(x-1)\right)^2 + 5$$

Practice: Worksheet H4 – Combinations of Transformations  
Combining Transformations (extra practice of graphing)