

Vertical Transformations

<https://www.desmos.com/calculator/wkhmtawkzp>

In Desmos (click [here](#) or copy the url above), you have a parent graph of $f(x) = \sqrt{x}$ graphed with a domain of $[0, 16]$ and a range of $[0, 4]$. The sliders on the left help create a transformation graph, $g(x) = af(bx - c) + d$ where in this case $b = 1$ and $c = 0$. Move the sliders to answer the following questions.

- (a) Which slider will shift the graph up and down? Which slider will vertically stretch or compress the graph?
- (b) For each of the following cases, find the equation for $g(x)$ and the range for $g(x)$.
- (i) Vertically shift the graph up 3 units.
- (1) Using the graphs of $f(x)$ and $g(x)$ and/or the tables of $f(x)$ and $g(x)$, describe what happened to the x -values during the transformation. Similarly, describe what happened to the y -values. Use the placement of the 3 in your equation to explain your response.
- (ii) Vertically shift the graph down 2 units.
- (1) Using the graphs of $f(x)$ and $g(x)$ and/or the tables of $f(x)$ and $g(x)$, describe what happened to the x -values during the transformation. Similarly, describe what happened to the y -values. Use the placement of the 2 in your equation to explain your response.

- (iii) Vertically stretch the graph by a factor of 3.
- (1) Using the graphs of $f(x)$ and $g(x)$ and/or the tables of $f(x)$ and $g(x)$, describe what happened to the x -values during the transformation. Similarly, describe what happened to the y -values. Use the placement of the 3 in your equation to explain your response.

- (iv) Vertically compress the graph by a factor of 2.
- (1) Using the graphs of $f(x)$ and $g(x)$ and/or the tables of $f(x)$ and $g(x)$, describe what happened to the x -values during the transformation. Similarly, describe what happened to the y -values. Use the placement of the 2 in your equation to explain your response.

(c) What change in the domain of $f(x)$ occurred in the above transformations? Again use the placement of the **a** and the **d** in your equations to explain your response.

(d) Suppose $d = 0$. What value of **a** would make the range of $g(x)$ equal to $[0, 24]$?

(e) Suppose $d = 0$. What value of **a** would make the range of $g(x)$ equal to $[-8, 0]$?

(f) Suppose $a = 1$. What value of **d** would make the range of $g(x)$ equal to $[7, 11]$?