# Graph Transformations

| To Graph: | Draw the Graph of f and: | Changes in the Equations of y=f(x) | |
|---|---|---|---|
| Vertical Shifts<br>• $y = f(x) + c$<br>• $y = f(x) - c$ | • Raise the graph of ***f*** by ***c*** units<br>• Lower the graph of ***f*** by ***c*** units | • ***c*** is added to ***f(x)***<br>• ***c*** is subtracted from ***f(x)*** |  |
| Horizontal Shifts<br>• $y = f(x + c)$<br>• $y = f(x - c)$ | • Shift the graph of ***f*** to the left ***c*** units<br>• Shift the graph of ***f*** to the right ***c*** units | • x is replaced with $x + c$<br>• x is replaced with $x - c$ | |
| Reflection about the x-axis<br>$y = -f(x)$ | Reflect the graph of ***f*** about the ***x-axis*** | • $f(x)$ is multiplied by -1 |  |

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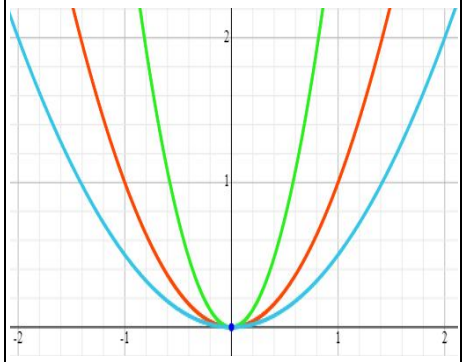
|---|---|---|---|
| Reflection about the y-axis<br>$y = f(-x)$ | Reflect the graph of ***f*** about the ***y-axis*** | • ***x*** is replaced by ***-x*** | |
| Vertical Stretching or Shrinking<br>• $y = cf(x),\ c > 1$<br>• $y = cf(x),\ 0 < c < 1$ | • Multiply each y-coordinate of $y = f(x)$ by ***c***, vertically stretching the graph of ***f***<br>• Multiply each y-coordinate of $y = f(x)$ by ***c***, vertically shrinking the graph of ***f*** | • $f(x)$ is multiplied by ***c*** $c > 1$<br>• $f(x)$ is multiplied by ***c*** $0 < c < 1$ |  |

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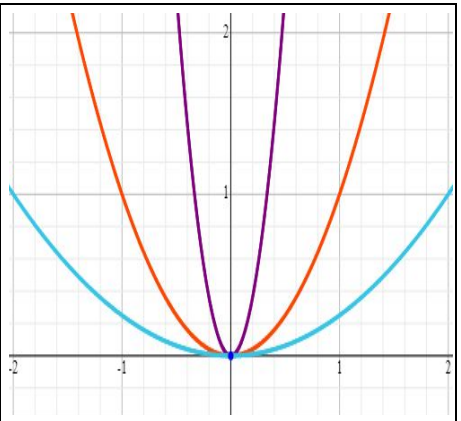
|---|---|---|---|
| Horizontal Stretching or Shrinking<br>• $y = f(cx),\ c > 1$<br>• $y = f(cx),\ 0 < c < 1$ | • Divide each c-coordinate of $y = f(x)$ by $\boldsymbol{c}$, horizontally shrinking the graph by $\boldsymbol{f}$<br>• Divide each x-coordinate of $y = f(x)$ by $\boldsymbol{c}$, horizontally stretching the graph of $\boldsymbol{f}$ | • $\boldsymbol{x}$ is replaced with $\boldsymbol{cx}$ $c > 1$<br>• $\boldsymbol{x}$ is replaced with $\boldsymbol{cx}$ $0 < c < 1$ |  |