

CH 1: Functions as models

1.3 New functions from old functions

This section presents transformations of functions.

1. VERTICAL AND HORIZONTAL SHIFTS:

- (a) $y = f(x) + c \implies$ to get the graph of y shift the graph of $f(x)$ up c units
- (b) $y = f(x) - c \implies$ to get the graph of y shift the graph of $f(x)$ down c units
- (c) $y = f(x + c) \implies$ to get the graph of y shift the graph of $f(x)$ left c units
- (d) $y = f(x - c) \implies$ to get the graph of y shift the graph of $f(x)$ right c units

2. VERTICAL AND HORIZONTAL STRETCHES AND REFLECTIONS:

- (a) $y = cf(x) \implies$ to get the graph of y stretch the graph of $f(x)$ vertically by a factor of c
- (b) $y = \frac{f(x)}{c} \implies$ to get the graph of y shrink the graph of $f(x)$ vertically by a factor of c
- (c) $y = f(cx) \implies$ to get the graph of y shrink the graph of $f(x)$ horizontally by a factor of c
- (d) $y = f\left(\frac{x}{c}\right) \implies$ to get the graph of y stretch the graph of $f(x)$ horizontally by a factor of c
- (e) $y = -f(x) \implies$ to get the graph of y reflect the graph of $f(x)$ about the x -axis
- (f) $y = f(-x) \implies$ to get the graph of y reflect the graph of $f(x)$ about the y -axis

3. addition, subtraction, multiplication and division (with nonzero denominator) of functions is done just by performing the same operation on the formulas of the functions. Also, addition and multiplication is commutative.

4. however, composition is different: $(f \circ g)(x) = f(g(x))$. Pay attention to the formulas, since first you have to apply $g(x)$, which is the second function, and then $f(x)$.