# Transformations of Graphs

## *Vertical Shifts*

| | |
|---|---|
| $y = f(x) + k$ | Shifts graph *k* units up<br>(Add *k* to *y*-coordinate) |
| $y = f(x) - k$ | Shifts graph *k* units down<br>(Subtract *k* from *y*-coordinate) |

## *Horizontal Shifts*

| | |
|---|---|
| $y = f(x - h)$ | Shifts graph *h* units to the right<br>(Add *h* to *x*-coordinate) |
| $y = f(x + h)$ | Shifts graph *h* units to the left<br>(Subtract *h* from *x*-coordinate) |

## *Stretching and Compressing*

Vertical

| | |
|---|---|
| $y = c \cdot f(x)$, where $c > 1$ | Stretches graph vertically away from *x*-axis by a factor of *c*<br>(Multiply *y*-coordinate by *c*) |
| $y = c \cdot f(x)$, where $0 < c < 1$ | Compresses graph vertically towards *x*-axis by a factor of *c*<br>(Multiply *y*-coordinate by *c*) |

Horizontal

| | |
|---|---|
| $y = f(c \cdot x)$, where $0 < c < 1$ | Stretches graph horizontally away from *y*-axis by a factor of $1/c$<br>(Multiply *x*-coordinate by $1/c$; i.e. the reciprocal of *c*) |
| $y = f(c \cdot x)$, where $c > 1$ | Compresses graph horizontally towards *y*-axis by a factor of $1/c$<br>(Multiply *x*-coordinate by $1/c$; i.e. the reciprocal of *c*) |

## *Reflections*

| | |
|---|---|
| $y = -f(x)$ | Reflects graph about the *x*-axis<br>(Multiply *y*-coordinate by $-1$) |
| $y = f(-x)$ | Reflects graph about the *y*-axis<br>(Multiply *x*-coordinate by $-1$) |