

## Transforming Functions

Transformation	Description	Example	Graph
$y = f(x) + a$	Translate $\begin{pmatrix} 0 \\ a \end{pmatrix}$	$y = x^2 - 3$ <p>Translate <math>y = x^2</math> 3 units down</p>	<p>Graph showing two parabolas: a blue one opening upwards passing through (0,0) and a red one opening upwards shifted downwards by 3 units, passing through (0,-3).</p> <p>Equation 1: <math>y=x^2</math>  Equation 2: <math>y=x^2-3</math></p>
$y = f(x - a)$	Translate $\begin{pmatrix} a \\ 0 \end{pmatrix}$	$y = (x - 2)^2$ <p>Translate <math>y = x^2</math> 2 units to the right</p>	<p>Graph showing two parabolas: a blue one opening upwards passing through (0,0) and a red one opening upwards shifted to the right by 2 units, passing through (2,0).</p> <p>Equation 1: <math>y=x^2</math>  Equation 2: <math>y=(x-2)^2</math></p>
$y = af(x)$	Vertical stretch factor $a$	$y = 2\sin x$ <p>Stretch <math>y = \sin x</math> vertically by scale factor of 2</p>	<p>Graph showing two sine waves: a blue one with amplitude 2 and a red one with amplitude 1.</p> <p>Equation 1: <math>y=\sin x</math>  Equation 2: <math>y=2\sin x</math></p>
$y = f(ax)$	Horizontal stretch factor $\frac{1}{a}$	$y = \sin\left(-\frac{x}{2}\right)$ <p>Stretch <math>y = \sin x</math> horizontally by a scale factor -2</p>	<p>Graph showing two sine waves: a blue one with period 4 and a red one with period 2.</p> <p>Equation 1: <math>y=\sin x</math>  Equation 2: <math>y=\sin(-x/2)</math></p>