

## Vertical & horizontal Shifts

$y = f(x) + c \rightarrow$  shifts graph  $c$  units upwards

$y = f(x) - c \rightarrow$  shifts graph  $c$  units downwards

$y = f(x + c) \rightarrow$  shifts graph  $c$  units leftwards

$y = f(x - c) \rightarrow$  shifts graph  $c$  units rightwards

## Vertical & horizontal Stretching & reflecting

$y = cf(x) \rightarrow$  stretches vertically by  $c$  units

$y = \frac{1}{c}f(x) \rightarrow$  shrinks graph vertically by a factor of  $c$

$y = f(cx) \rightarrow$  shrinks graph horizontally by a factor of  $c$

$y = f(x/c) \rightarrow$  stretches the graph horizontally by a factor of  $c$

$y = -f(x) \rightarrow$  reflects the graph about the  $x$ -axis

$y = f(-x) \rightarrow$  reflects the graph about the  $y$ -axis

Given two functions  $f$  &  $g$ , the composition function  $f \circ g$  (also called the composition of  $f$  &  $g$ ) is described by

$$(f \circ g)(x) = f(g(x))$$