

Shifting, Scaling, and Reflecting

- $g(x) = f(x + a)$ : The  $g$ -graph is determined by a horizontal shift of the  $f$ -graph  $|a|$  units to the left if  $a > 0$ , or  $|a|$  units to the right if  $a < 0$ .
- $h(x) = f(x) + a$ : The  $h$ -graph is determined by a vertical shift of the  $f$ -graph  $|a|$  units up if  $a > 0$ , or  $|a|$  units down if  $a < 0$ .
- $k(x) = f(ax)$ : The  $k$ -graph is determined by a horizontal compression of the  $f$ -graph if  $a > 1$ , or horizontal stretch of the  $f$ -graph if  $0 < a < 1$ .
- $j(x) = af(x)$ : The  $j$ -graph is determined by a vertical stretch of the  $f$ -graph if  $a > 1$ , or vertical compression of the  $f$ -graph if  $0 < a < 1$ .
- $r(x) = f(-x)$ : The  $r$ -graph is determined by reflecting the  $f$ -graph across the  $y$ -axis.
- $s(x) = -f(x)$ : The  $s$ -graph is determined by reflecting the  $f$ -graph across the  $x$ -axis.

(Remarks: If  $f(-x) = f(x)$  for all  $x$  in the domain of  $f$ , then  $f$  is said to be even and its graph is symmetric with respect to the  $y$ -axis. If  $g(-x) = -g(x)$  for all  $x$  in the domain of  $g$ , then  $g$  is said to be odd and its graph is symmetric with respect to the origin.)