

Vertical and Horizontal Shifts (assume  $c > 0$ )

To obtain the graph of

$y = f(x) + c$ : Shift the graph of  $y = f(x)$  a distance of  $c$  units upwards  
 $y = f(x) - c$ : Shift the graph of  $y = f(x)$  a distance of  $c$  units downward

$y = f(x + c)$ : Shift the graph of  $y = f(x)$  a distance of  $c$  units to the left  
 $y = f(x - c)$ : Shift the graph of  $y = f(x)$  a distance of  $c$  units to the right

Vertical and Horizontal Stretching (assume  $c > 0$ )

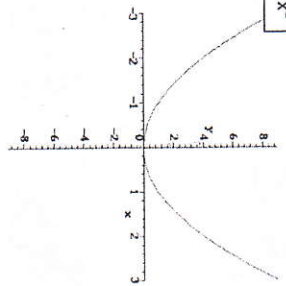
To obtain the graph of

$y = cf(x)$ : Stretch the graph of  $y = f(x)$  vertically by a factor of  $c$   
 $y = (1/c)f(x)$ : Shrink the graph of  $y = f(x)$  vertically by a factor of  $c$

$y = f(cx)$ : Shrink the graph of  $y = f(x)$  horizontally by a factor of  $c$   
 $y = f(x/c)$ : Stretch the graph of  $y = f(x)$  horizontally by a factor of  $c$

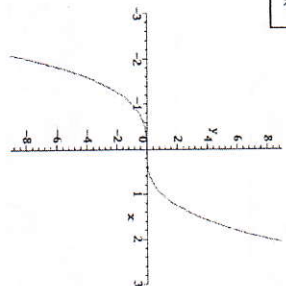
$y = -f(x)$ : Reflect the graph of  $y = f(x)$  about the  $x$  axis  
 $y = f(-x)$ : reflect the graph of  $y = f(x)$  about the  $y$ -axis

$y = x^2$



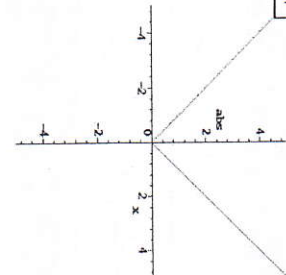
Domain: All real numbers  
 Range:  $y \geq 0$

$y = x^3$



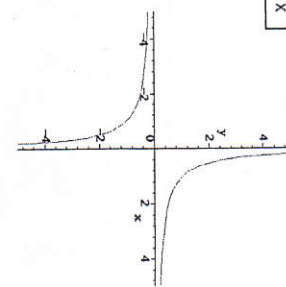
Domain: All real numbers  
 Range: All real numbers

$y = |x|$



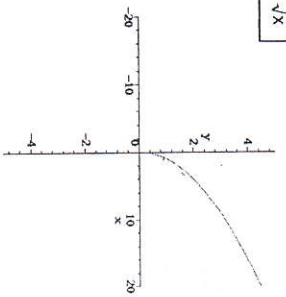
Domain: All real numbers  
 Range:  $y \geq 0$

$y = \frac{1}{x}$



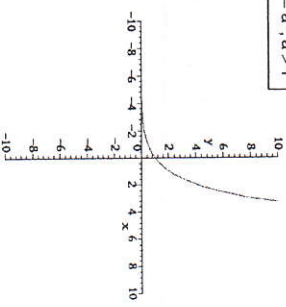
Domain: All real numbers, but  $x \neq 0$   
 Range: All real numbers, but  $y \neq 0$

$y = \sqrt{x}$



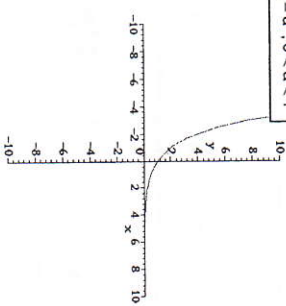
Domain:  $x \geq 0$   
 Range:  $y \geq 0$

$y = a^x, a > 1$



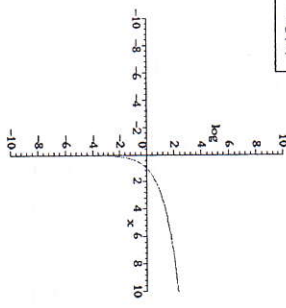
Domain: All real numbers  
 Range:  $y > 0$

$y = a^x, 0 < a < 1$



Domain:  $x = 0$   
 Range:  $y = 0$

$y = \log(x)$



Domain: All real numbers  
 Range:  $y \geq 0$

Translations	Vertical	Up	$f(x) \rightarrow f(x) + c$	Add C to function
		Down	$f(x) \rightarrow f(x) - c$	Subtract C from function
	Horizontal	Left	$f(x) \rightarrow f(x + c)$	Let $X = X + C$
		Right	$f(x) \rightarrow f(x - c)$	Let $X = X - C$
Reflection	x-axis	/	$f(x) \rightarrow -f(x)$	Change sign of everything
	y-axis	\	$f(x) \rightarrow f(-x)$	Let $x = -x$
Stretches/ Shrinks	Stretches (Toward y-axis)	$c > 1$	$f(x) \rightarrow cf(x)$	Multiply equation by c
		$c < 1$		Multiply equation by $1/c$
	Shrinks (Away from y-axis)	$0 < c < 1$		