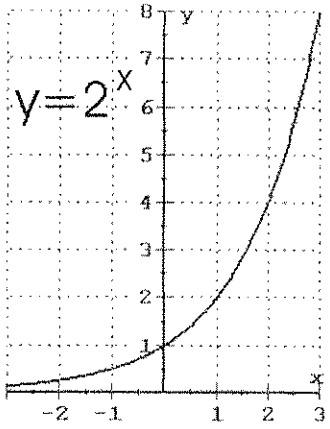
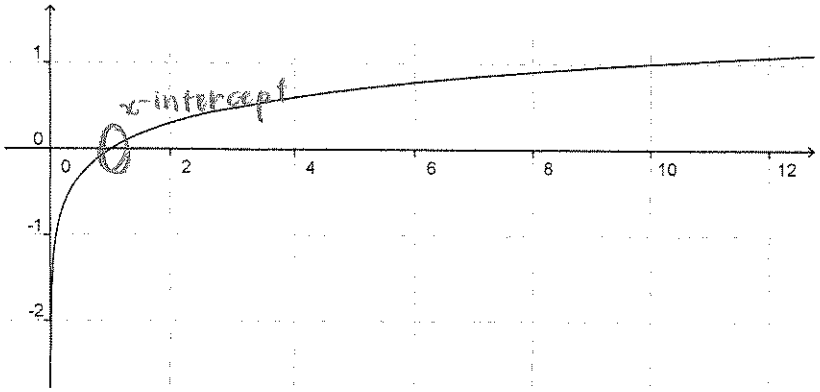
EXPONENTIAL



LOGARITHMIC



*Note: exponential and logarithmic are the same graph — functions

Define Asymptote: A line that a function approaches but never touches or crosses

horizontal line = y =

x = vertical line

Key Features of Exponential and Logarithmic Functions		
Characteristic	Exponential Function $y = 2^x$	Logarithmic Function $y = \log x$
Asymptote	$y = 0$	$x = 0$
Domain	all reals	$x > 0$
Range	$y > 0$	all reals
Intercept	(0,1) y-intercept	(1,0) x-intercept

only use ">" or "<" because the line never touches the value

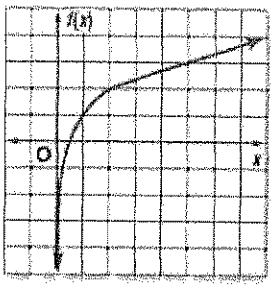
* domain is NOT all reals, if doesn't touch 0

Translations of logarithmic functions are very similar to those for other functions and are summarized in the table below.

Parent Function	y = logx	Y=2^x
Shift up	$y = \log x + k$	$y = 2^x + k$
Shift down	$y = \log x - k$	$y = 2^x - k$
Shift left	$y = \log(x+k)$	$y = 2^{(x+h)}$
Shift right	$y = \log(x-k)$	$y = 2^{(x-h)}$
Combination Shift	$y = \log(x-h) + k$	$y = 2^{(x-h)} + k$
Reflect over the x-axis	$y = -\log x$	$y = -(2^x)$ * take negative of 2^x
Stretch vertically	$y = a\log x$	$y = a(2^x)$
Stretch horizontally	$y = \log bx$	$y = 2^{bx}$

don't worry about horizontal stretch/shrink

Let's look at the following example.



The graph on the right represents a transformation of the graph of $f(x) = 3 \log_{10} x + 1$.

- $|x| = 3$: vertical stretch 3.
- $h = 0$: no left / right translation.
- $k = 1$: up 1.

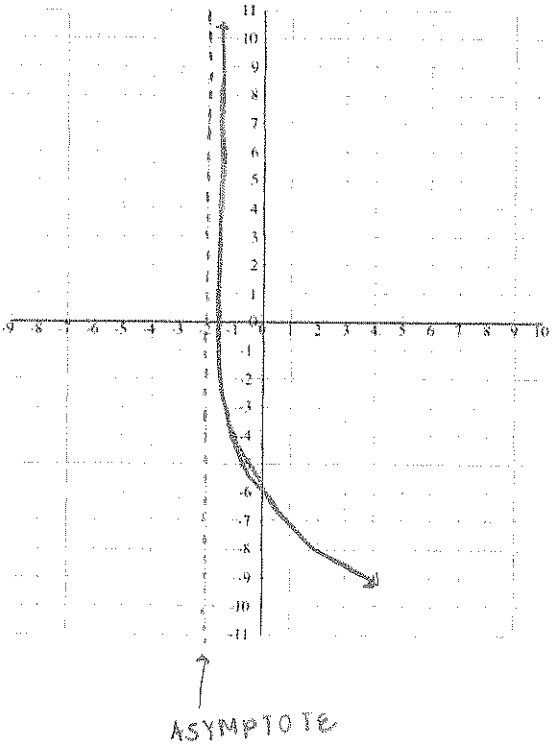
Domain: $x > 0$

Range: all reals

Asymptote: $x = 0$

TRY NOW

Graph the following function on the graph at right. Describe each transformation, give the domain and range, and identify any asymptotes.



$y = -2\log_{10}(x + 2) - 4$

* when the domain moves, so does the asymptote

Domain: $x > -2$

Range: all reals

* if the parent function has all reals, your new function will have all reals

Asymptote:

Description of transformations:

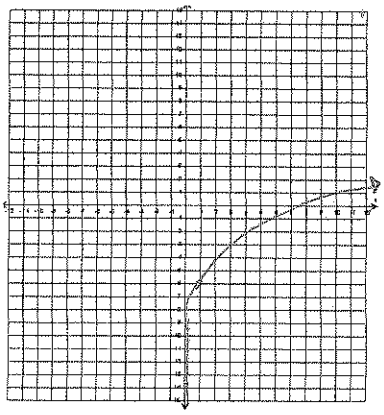
Reflect over the x, vertical stretch 2, left 2, down 4

Guided Practice with Logarithmic Functions

Graph the following transformations of the function $y = \log_{10} x$ on the coordinate planes. Determine the domain, range, and asymptotes of each transformation. Describe the transformations.

1) $y = \log_{10} x - 6$

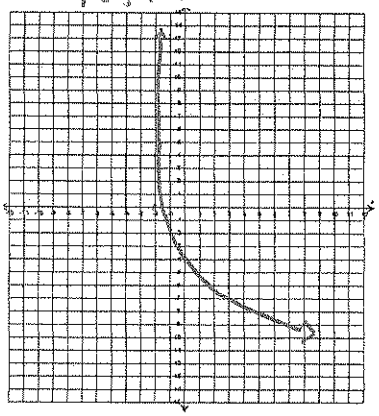
Domain: $x > 0$
Range: all reals
Asymptotes: $x = 0$
Description: down 6



2) $y = -\log_{10} (x + 2)$

Domain: $x > -2$
Range: all reals
Asymptotes: $x = -2$
Description: left 2

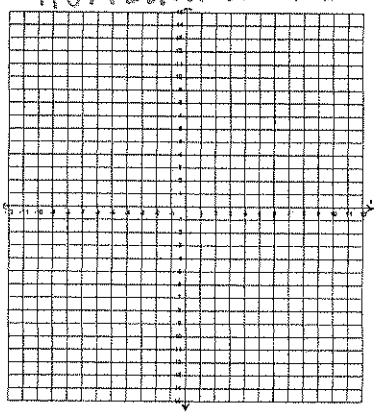
because it is on the inside with x, the asymptote will change



3) $y = \log_{10} 2x$

Domain:
Range:
Asymptotes:
Description: horizantal stretch 2.

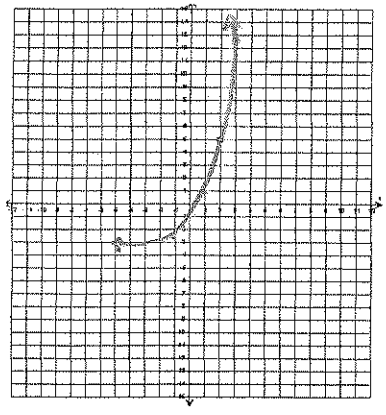
*don't worry about horizantal stretch



Graph the following transformations of the function $y = 2^x$ on the coordinate planes. Determine the domain, range, and asymptotes of each transformation. Describe the transformations.

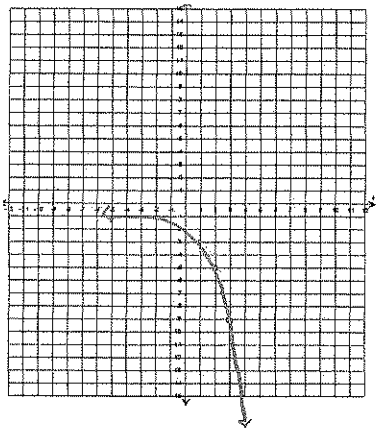
4) $f(x) = 2^{x+1} - 3$

Domain: all reals
Range: $y > -3$
Asymptotes: $y = -3$
Description: left 1, down 3



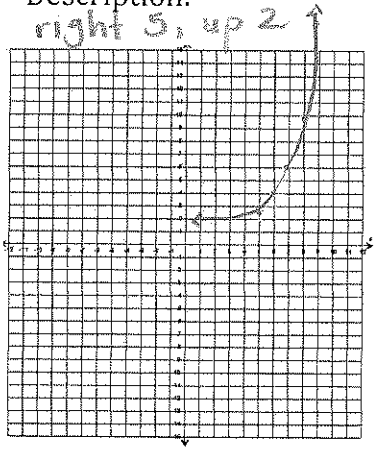
5) $f(x) = -2^x - 1$

Domain: all reals
Range: $y < -1$
Asymptotes: $y = -1$
Description: reflect over x, down 1



6) $f(x) = 2^{x-5} + 2$

Domain: all reals
Range: $y > 2$
Asymptotes: $y = 2$
Description: right 5, up 2



7) State the domain, range, intercepts and asymptotes of $f(x) = \log(x - 2) + 3$.

vertex = (2, 3)
domain = $x > 2$
range = $x > 3$
y-intercept = none
x-intercept = none

8) Describe the transformations of $y = 4 \log (2x - 4) + 6$ from the parent function $y = \log(x)$.

- vertical stretch 4
- horizontal stretch 2
- right 4
- up 6

9) Describe the transformations of $y = -3 \log_{10} (4x + 3) - 2$ from the parent function $y = \log_{10} (x)$.

- vertical stretch 3
- reflect over x-axis
- horizontal stretch 4
- left 3
- down 2