

# A46: Change of Base & Graph Logs WKS

## 23.2/23.3 Change of Base Formula & Graphing Logs

### Change of Base Formula

Some calculators can input bases, but most cannot.

The Change of Base formula helps us put any log into any scientific calculator.

$$\log_b x = \frac{\log x}{\log b}$$

Ex #1 Evaluate on the calculator

a)  $\log_2 12 = \frac{\log(12)}{\log(2)} = 3.585$       c)  $\log_4(-10) = \text{Not a real \#}$

b)  $\log_3 7 = \frac{\log 7}{\log 3} = 1.771$       d)  $\log_2\left(\frac{1}{4}\right) = \frac{\log(1/4)}{\log 2} = -2$

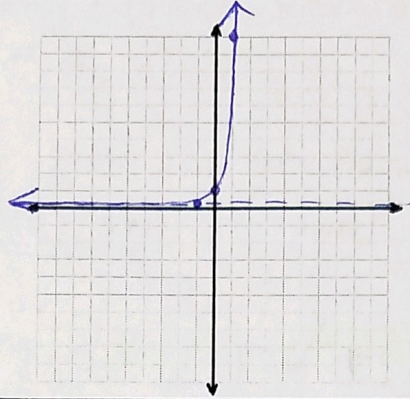
Log Property Name	Property	Example
Product Property	$\log(mn) = \log m + \log n$	
Quotient Property	$\log\left(\frac{m}{n}\right) = \log m - \log n$	
Power Property	$\log(m^n) = n \log m$	
Inverse Property 1	$\log_b b^x = x$	
Inverse Property 2	$b^{\log_b x} = x$	
Change of Base Formula	$\log_b x = \frac{\log x}{\log b}$	



(Some) Parent Graphs

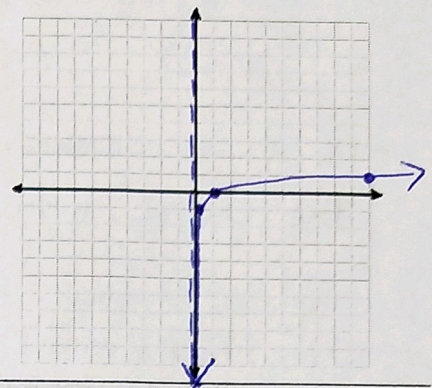
exponents

$(-1, \frac{1}{b})$   $(0, 1)$   $(1, b)$



logs

$(\frac{1}{b}, -1)$   $(1, 0)$   $(b, 1)$



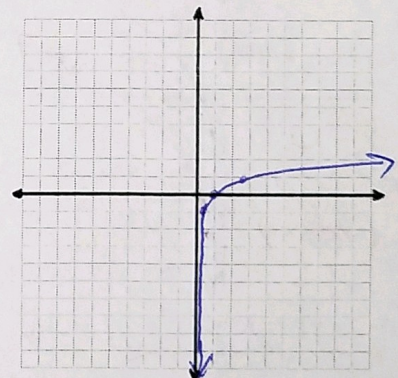
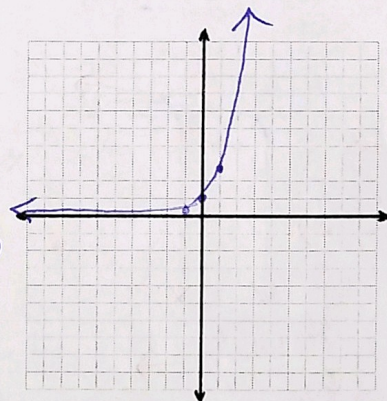
THE COMMON LOG AND ITS INVERSE

EQUATION	$f(x) = 10^x$	$f(x) = \log_{10} x$
INTERCEPTS	$(0, 1)$	$(1, 0)$
INCREASING/DECREASING	↑	↑
END BEHAVIOR	$x \rightarrow -\infty, y \rightarrow 0$ & $x \rightarrow \infty, y \rightarrow \infty$	$x \rightarrow 0, y \rightarrow -\infty$ & $x \rightarrow \infty, y \rightarrow \infty$
DOMAIN	$(-\infty, \infty)$	$(0, \infty)$
RANGE	$(0, \infty)$	$(-\infty, \infty)$
ASYMPTOTE	$y = 0$	$x = 0$

$e \approx 2.7$

THE NATURAL LOG AND ITS INVERSE

$(-1, .4)$   
 $(0, 1)$   
 $(1, 2.7)$



EQUATION	$f(x) = e^x$	$f(x) = \ln_e x$
INTERCEPTS	$(0, 1)$	$(1, 0)$
INCREASING/DECREASING	↑	↑
END BEHAVIOR	$x \rightarrow -\infty, y \rightarrow 0$ & $x \rightarrow \infty, y \rightarrow \infty$	$x \rightarrow 0, y \rightarrow -\infty$ & $x \rightarrow \infty, y \rightarrow \infty$
DOMAIN	$(-\infty, \infty)$	$(0, \infty)$
RANGE	$(0, \infty)$	$(-\infty, \infty)$
ASYMPTOTE	$y = 0$	$x = 0$



### Key Features of Logarithms

Where is the asymptote for log functions? What is the end behavior around the asymptotes?

$$x = 0$$

$$x \rightarrow 0$$

What is true about the domain and range of inverse functions?

The D & R of inverse functions are swapped.

### Logarithmic Transformations

$f(x) = \log_b x$  has the points:  $(\frac{1}{b}, -1)$   $(1, 0)$   $(b, 1)$

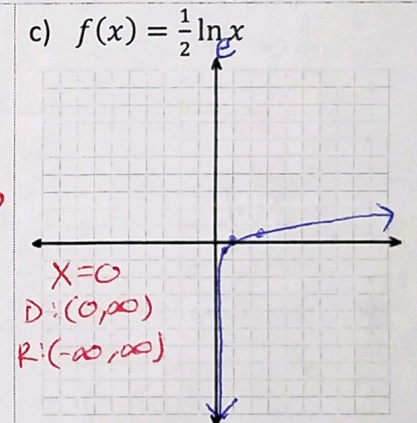
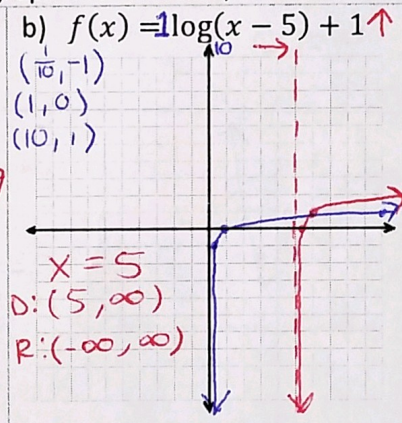
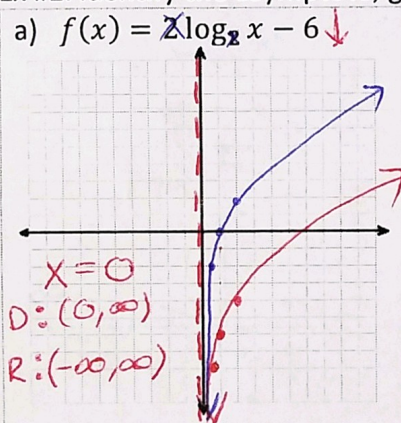
$$f(x) = a \log_b(x - c) + d$$

- +d up
- d down
- +c left
- c right
- negative: reflects over x-axis
- |a| < 1: vertical shrink
- |a| > 1: vertical stretch

### COMPLETE THE FOLLOWING ON THE GRAPHS PROVIDED

Ex #2: Identify the asymptote, graph the function, then state the domain and range.

$(\frac{1}{2}, -1)$   
 $(1, 0)$   
 $(2, 1)$   
 ↓ multiply's by a  
 $(\frac{1}{2}, -2)$   
 $(1, 0)$   
 $(2, 2)$



$(\frac{1}{2.7}, -1)$   
 $(1, 0)$   
 $(2.7, 1)$   
 ↓  
 $(0.4, \frac{1}{2})$   
 $(1, 0)$   
 $(2.7, \frac{1}{2})$

