Warm-up: Solve the following inequalities.

1. $6(2)^{3x-2} < 54$

2. $3 \log_3 (x-8) < 12$

Graphing Logarithms

MGSE9-12.F.IF.7e Graph exponential and logarithmic functions, showing intercepts and end behavior

What am I learning today?

How to graph logarithmic functions

How will I show that I learned it?

Graph a logarithm and find the characteristics

Reminder: What is the relationship between x and y-values of inverses?

they switch

What is the inverse of a logarithm?

exponential

Characteristics of all exponential parent functions:

a) Horizontal asymptote at y=0

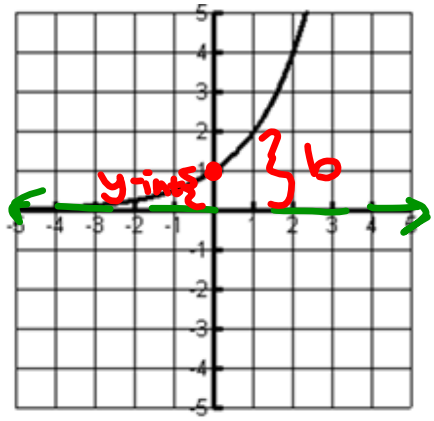
b) Y-intercept of (0,1)

Characteristics of all logarithmic parent function:

a) Vertical asymptote at x=0

b) X-intercept of (1,0)

Exponential



Equation: $y = 2^x$

D: $(-\infty, \infty)$ R: $(0, \infty)$

Max/Min: none Asymp: $y = 0$

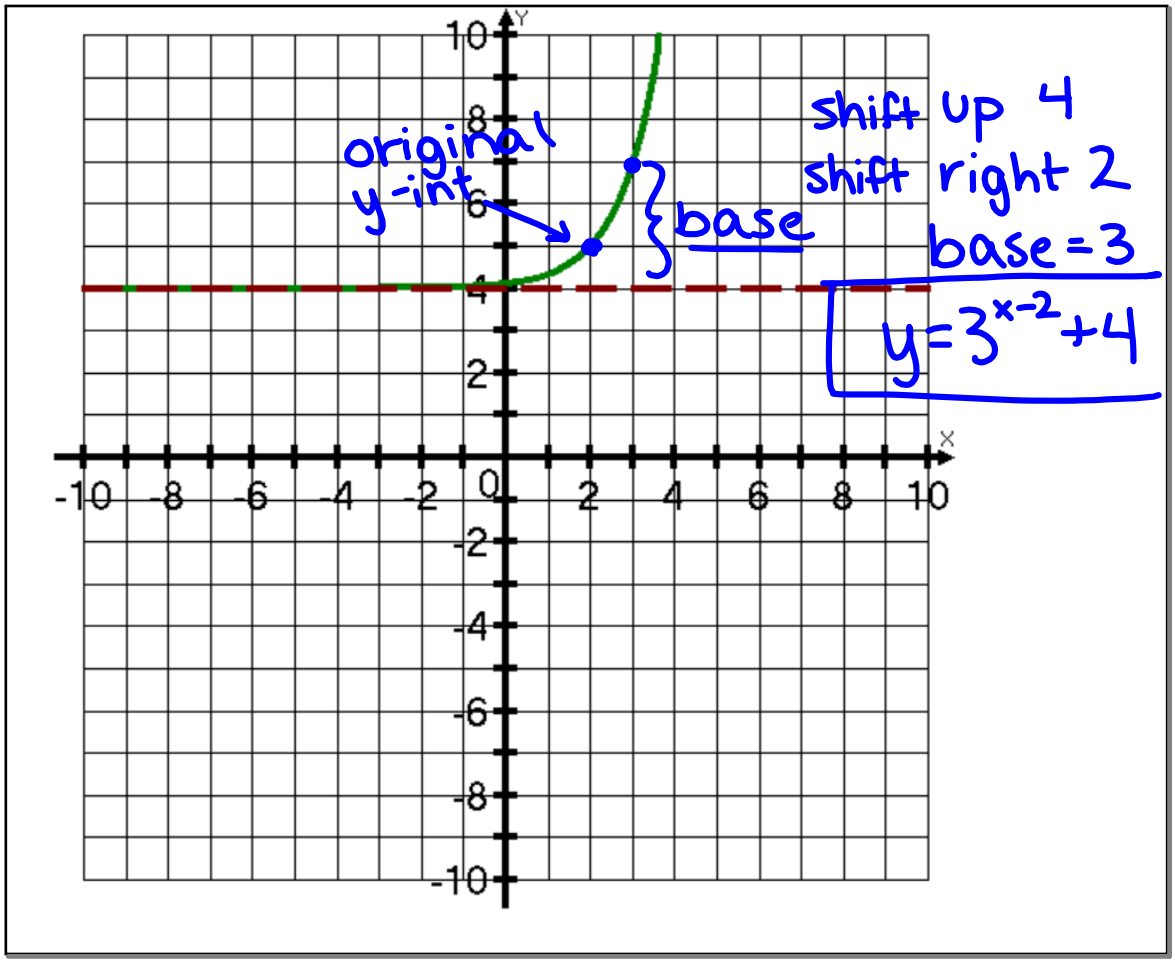
X-Int: none Y-Int: $(0, 1)$

Inc/Dec/Const: $(-\infty, \infty)$

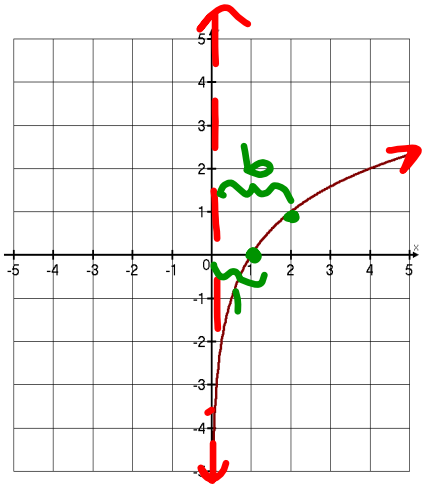
End Behavior:

As $x \to -\infty$, $y \to 0$

As $x \to \infty$, $y \to \infty$



Logarithmic



Equation: $y = \log_2 x$

D: $(0, \infty)$ R: $(-\infty, \infty)$

Max/Min: none Asymp: $x = 0$

X-Int: $(1, 0)$ Y-Int: none

Inc/Dec/Const: $(0, \infty)$

End Behavior:

As $x \to 0$, $y \to -\infty$

As $x \to \infty$, $y \to \infty$

$$f(x) = a\log_B(b(x-h)) + k$$

- reflect over x-axis
- v. dilate
- reflect over y-axis
- h. dilate
- shift horizontally
- shift vertically

Inverse: $f^{-1}(x) = B^x$

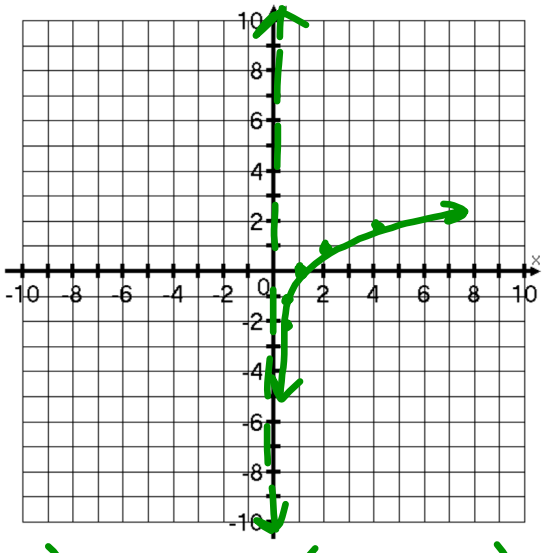
$$f(x) = log_2 x$$

Exponential Table

x	2^x
-2	1/4
-1	1/2
0	1
1	2
2	4

Logarithm Table

x	$\log_2 x$
1/4	-2
1/2	-1
1	0
2	1
4	2



Domain: $(0, \infty)$ Range: $(-\infty, \infty)$

Asymptote: $x = 0$ Extrema: none

Interval of increase: $(0, \infty)$

X-Intercept: $(1, 0)$ Y-Intercept: none

End Behavior: As $x \to 0$, $f(x) \to -\infty$ As $x \to \infty$, $f(x) \to \infty$.

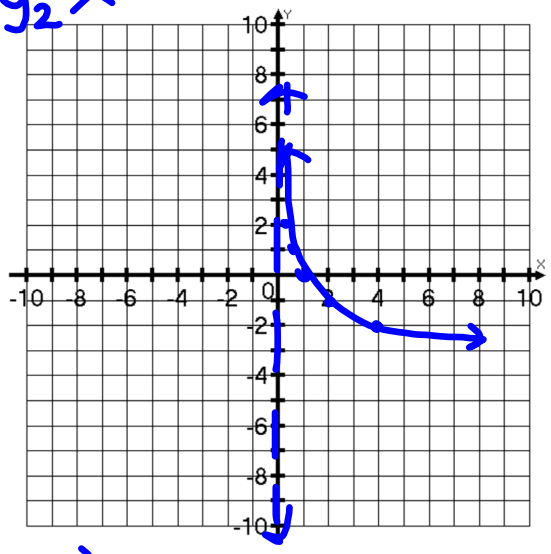
$f(x) = log_{\frac{1}{2}} x$ $= -\log_2 x$

Exponential Table

x	$(\frac{1}{2})^x$
-2	4
-1	2
0	1
1	1/2
2	1/4

Logarithm Table

x	$\log_{1/2} x$
4	-2
2	-1
1	0
1/2	1
1/4	2



Domain: $(0, \infty)$ Range: $(-\infty, \infty)$

Asymptote: $x = 0$ Extrema: none

Interval of decrease: $(0, \infty)$

X-Intercept: $(1, 0)$ Y-Intercept: none

End Behavior: As x → 0, f(x) → ∞. As x → ∞, f(x) → $-\infty$.

$f(x) = log_2(x + 3)$

• shift left 3 (x)

Exponential Table

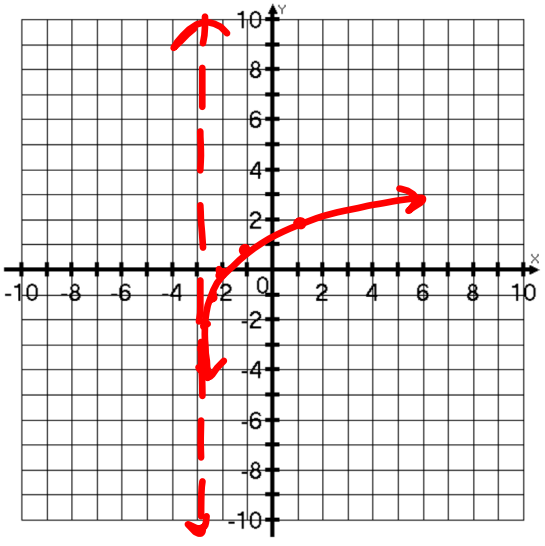
x	2^x
-2	1/4
-1	1/2
0	1
1	2
2	4

Logarithm Table

x	$\log_2 x$
1/4	-2
1/2	-1
1	0
2	1
4	2

Transformed Table

x-3	y
-11/4	-2
-5/2	-1
-2	0
-1	1
1	2



Y-int

$\log_2(0+3)$

$\log_2 3$

Domain: $(-3, \infty)$ Range: $(-\infty, \infty)$

Asymptote: $x = -3$ Extrema: none

Interval of increase: $(-3, \infty)$

X-Intercept: $(-2, 0)$ Y-Intercept: $(0, \log_2 3)$

End Behavior: As x → -3, f(x) → $-\infty$ As x → ∞, f(x) → ∞.

$f(x) = log_2(x+2) - 3$

· shift down 3 (y) and left 2 (x)

Exponential Table

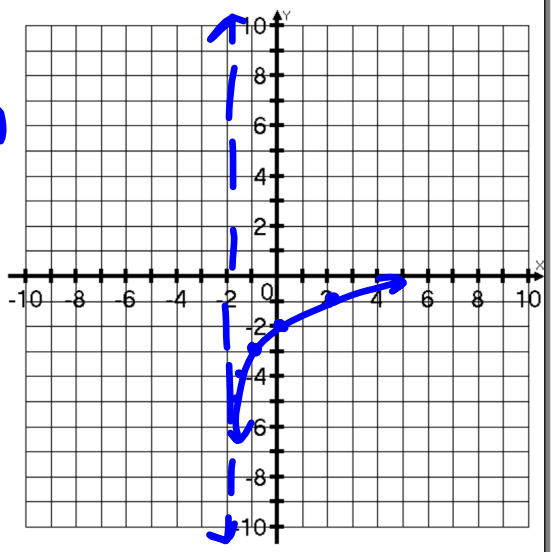
x	2^x
-2	1/4
-1	1/2
0	1
1	2
2	4

Logarithm Table

x	$\log_2 x$
1/4	-2
1/2	-1
1	0
2	1
4	2

Transformed Table

x-2	y-3
-7/4	-5
-3/2	-4
-1	-3
0	-2
2	-1



x-int

$0 = \log_2(x+2) - 3$

$3 = \log_2(x+2)$

$2^3 = x+2$

$8 = x+2 \therefore x = 6$

Domain: (-2, ∞) Range: (-∞, ∞)

Asymptote: x = -2 Extrema: none

Interval of increase: (-2, ∞)

X-Intercept: (6, 0) Y-Intercept: (0, -2)

End Behavior: As x → -2, f(x) → -∞. As x → ∞, f(x) → ∞.

· reflect over x-axis (y)

$f(x) = -\log_{.5}(x+4)$

· shift left 4 (x)

Exponential Table

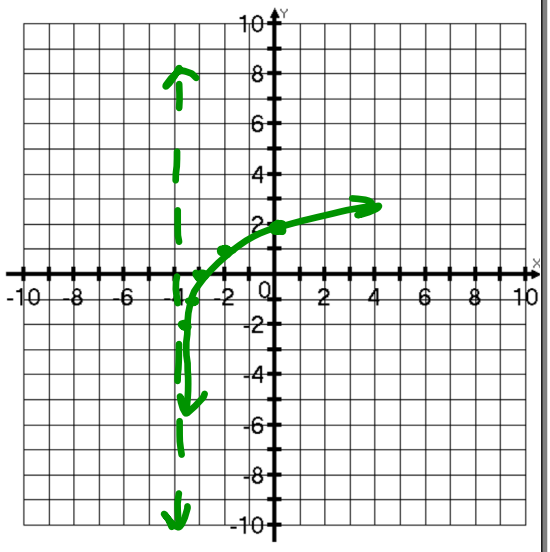
x	$(\frac{1}{2})^x$
-2	4
-1	2
0	1
1	1/2
2	1/4

Logarithm Table

x	$\log_{.5} x$
4	-2
2	-1
1	0
1/2	1
1/4	2

Transformed Table

x-4	-y
0	2
-2	1
-3	0
-7/2	-1
-15/4	-2



Domain: (-4, ∞) Range: (-∞, ∞)

Asymptote: x = -4 Extrema: none

Interval of increase: (-4, ∞)

X-Intercept: (-3, 0) Y-Intercept: (0, 2)

End Behavior: As x → -4, f(x) → -∞. As x → ∞, f(x) → ∞.

· reflect over y-axis (x)

$$f(x) = \log_3(-x+2) = \log_3(-(x-2))$$

· shift right 2 (x)

Exponential Table

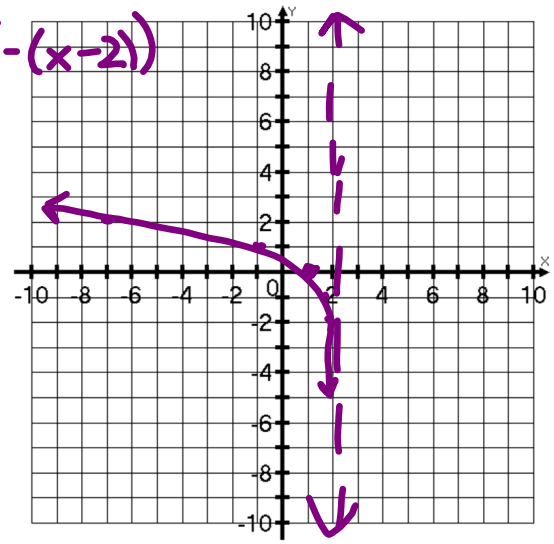
x	3^x
-2	1/9
-1	1/3
0	1
1	3
2	9

Logarithm Table

x	$\log_3 x$
1/9	-2
1/3	-1
1	0
3	1
9	2

Transformed Table

$-x+2$	y
17/9	-2
5/3	-1
1	0
-1	1
-7	2



Domain: $(-\infty, 2)$ Range: $(-\infty, \infty)$

Asymptote: $x = 2$ Extrema: none

Interval of decrease: $(-\infty, 2)$

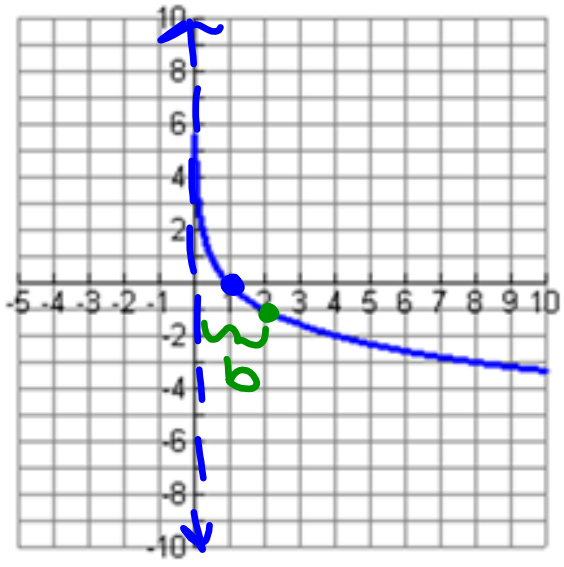
X-Intercept: $(1, 0)$ Y-Intercept: $(0, \log_3 2)$

End Behavior: As $x \to -\infty$, $f(x) \to \infty$. As $x \to 2$, $f(x) \to -\infty$.

Ex. A

Equation:

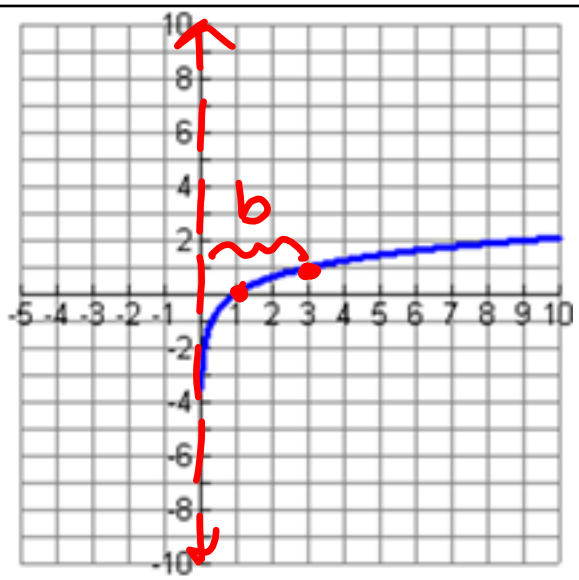
$$y = -\log_2 x$$



Ex. B

Equation:

$y = \log_3 x$

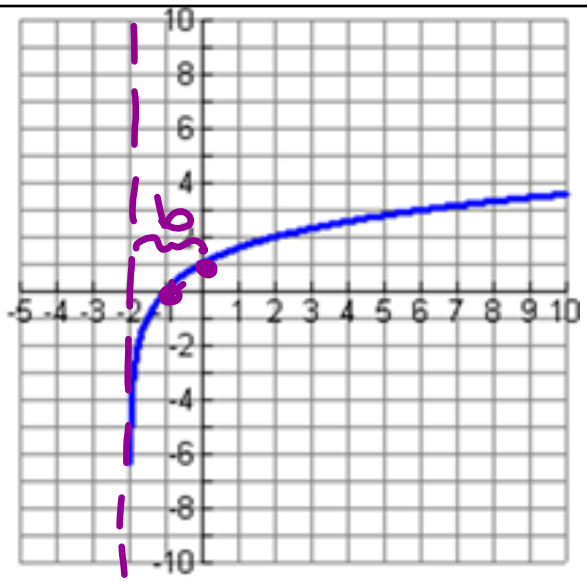


Ex. C

Equation:

·shift left 2

$y = \log_2(x+2)$

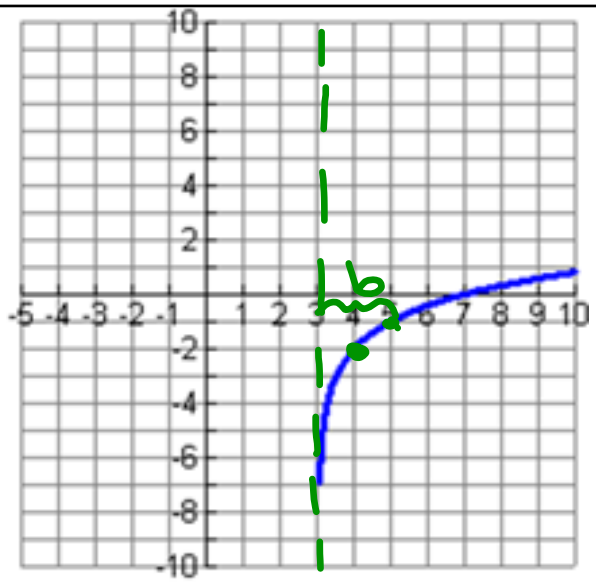


Ex. D

Equation:

shift right 3
shift down 2

$y = \log_2(x-3) - 2$



Ex. E

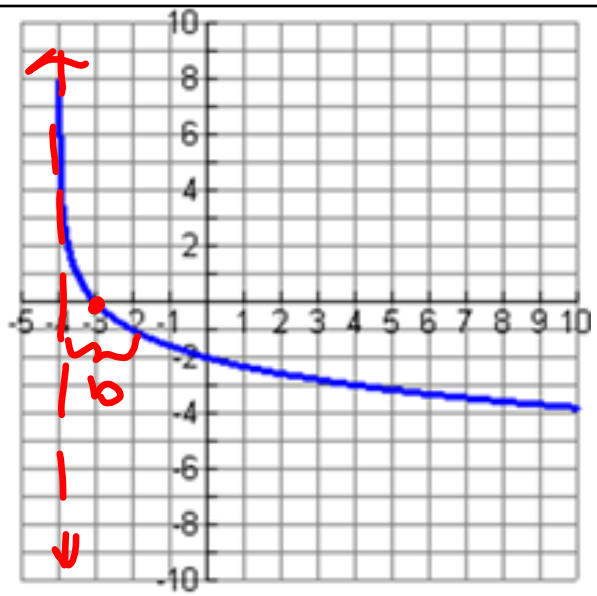
Equation:

- reflect over x-axis
- shift left 4

$y = -\log_2(x+4)$

or

$y = \log_{1/2}(x+4)$



Ex. F

Equation:

$y = \log_2(-x)$