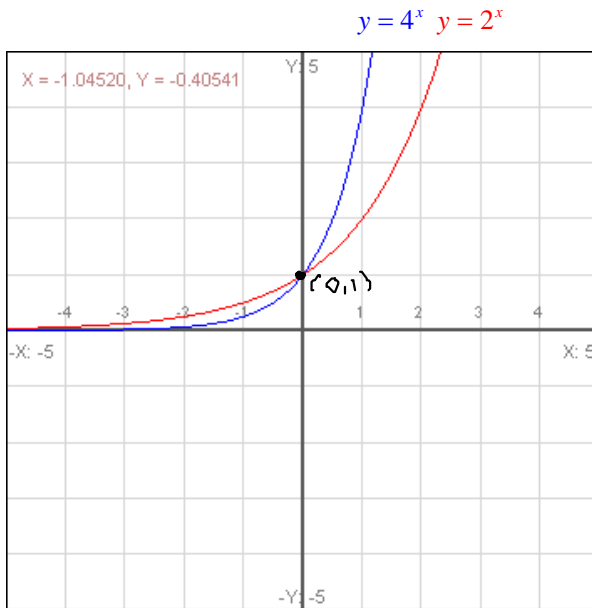


Graphs of Exponential Functions

$y = a^x$ represents the graph of an exponential function where $a > 0$ and $a \neq 1$



Properties of $y=2^x$

- Domain: All Real Numbers
- Range: $y > 0$
- y-intercept: $(0, 1)$
- Horizontal Asymptote: $y = 0$
- The function is increasing.

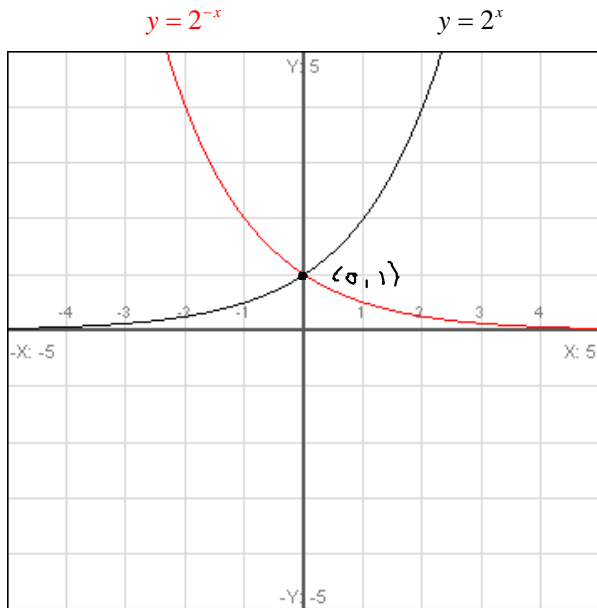
Properties of $y=4^x$

- Domain: All Real Numbers
- Range: $y > 0$
- y-intercept: $(0, 1)$
- Horizontal Asymptote: $y = 0$
- The function is increasing.
- The graph of $y = 4^x$ increases faster and is closer to the horizontal asymptote.**

Transformations of the Graph of the Exponential Function

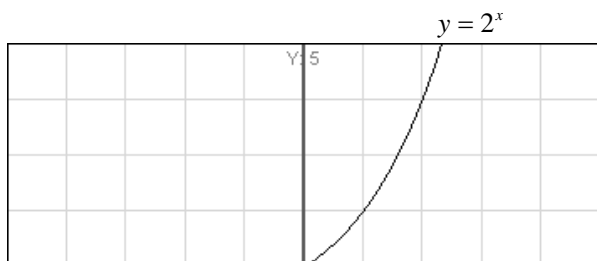
$y=a^{-x}$

- Reflected over the known point
- Domain: All Real Numbers
- Range: $y > 0$
- y-intercept: $(0, 1)$
- Horizontal Asymptote: $y = 0$
- The function is decreasing.

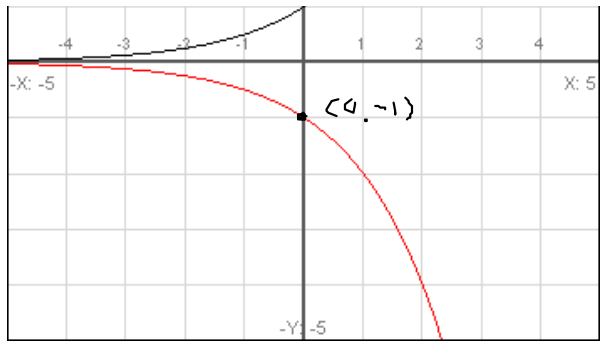


$y=-a^x$

- Reflected over the horizontal asymptote
- Domain: All Real Numbers
- Range: $y < 0$
- y-intercept: $(0, -1)$
- Horizontal Asymptote: $y = 0$



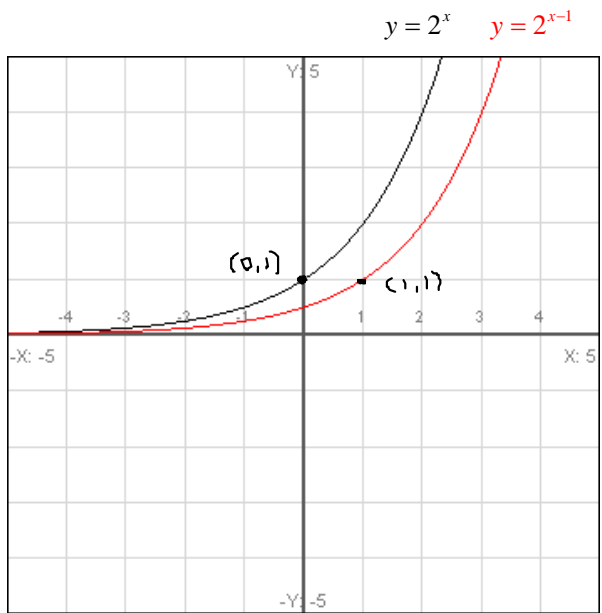
The function is decreasing.



$$y = -2^x$$

$$y = a^{(x-h)}$$

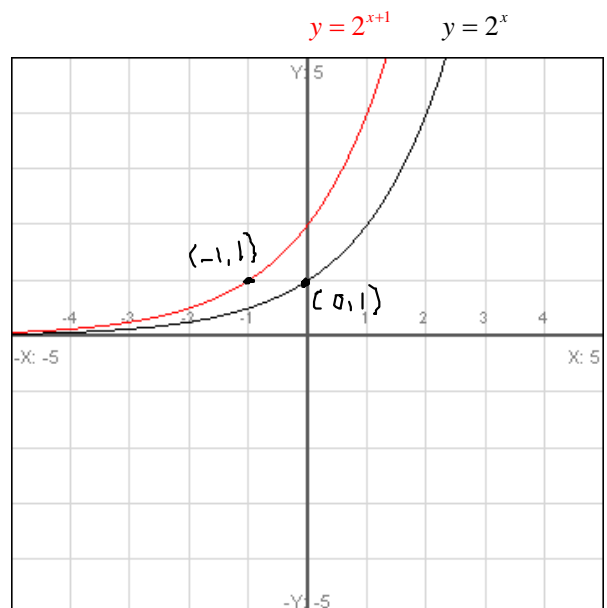
Shifted h units to the right
 Domain: All Real Numbers
 Range: $y > 0$
 Horizontal Asymptote: $y = 0$
 The function is increasing.



$$y = 2^x \quad y = 2^{x-1}$$

$$y = a^{(x+h)}$$

Shifted h units to the left
 Domain: All Real Numbers
 Range: $y > 0$
 Horizontal Asymptote: $y = 0$
 The function is increasing.



$$y = 2^{x+1} \quad y = 2^x$$

$$y = a^x + k$$

Shifted k units up

Domain: All Real Numbers

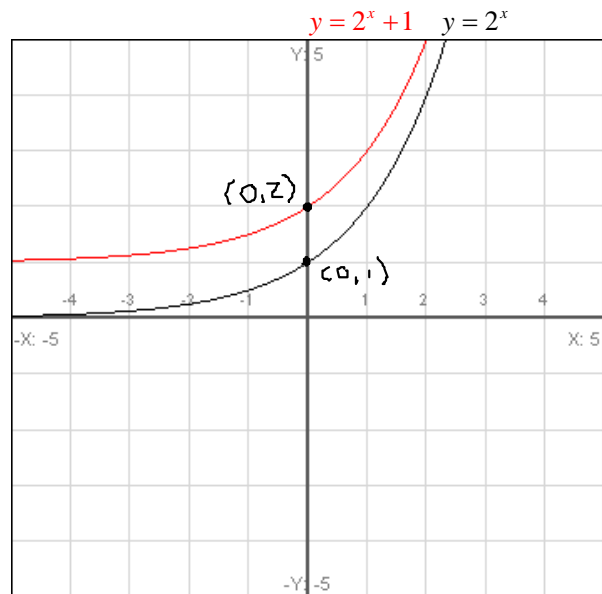
Range: $y > k$

y -intercept: $(0, 1+k)$

Horizontal Asymptote: $y = k$

The function is increasing.

$y > 1$
 $(0, 2)$
 $y = 1$



$$y = a^x - k$$

Shifted k units down

Domain: All Real Numbers

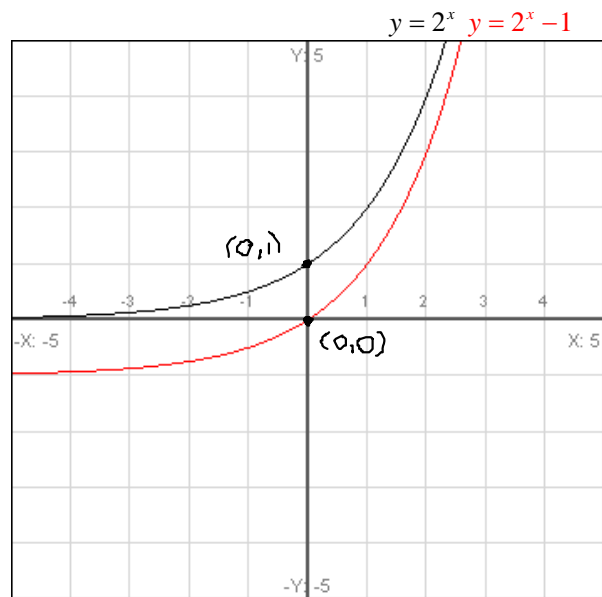
Range: $y > -k$

y -intercept: $(0, 1-k)$

Horizontal Asymptote: $y = -k$

The function is increasing.

$y > -1$
 $(0, 0)$
 $y = -1$



Directions: Graph each exponential function. Identify the domain, range, asymptotes, intercepts and determine if the function is increasing or decreasing.

1. $f(x) = 3^{x-4}$ 4 units to the right

Domain: All real numbers

Range: $y > 0$

Asymptote: $y = 0$

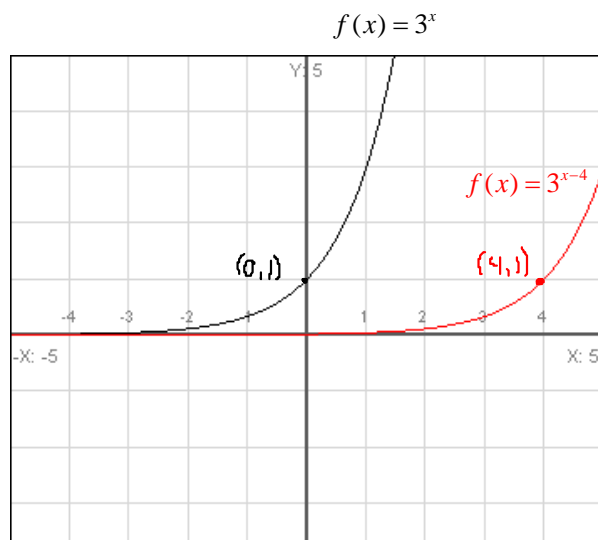
Intercept: $y = 3^{0-4}$

Set $x=0$

$$y = 3^{-4}$$

$$y = \frac{1}{3^4}$$

$(0, \frac{1}{81})$



1. $f(x) = 3^{x-4}$ 4 units to the right

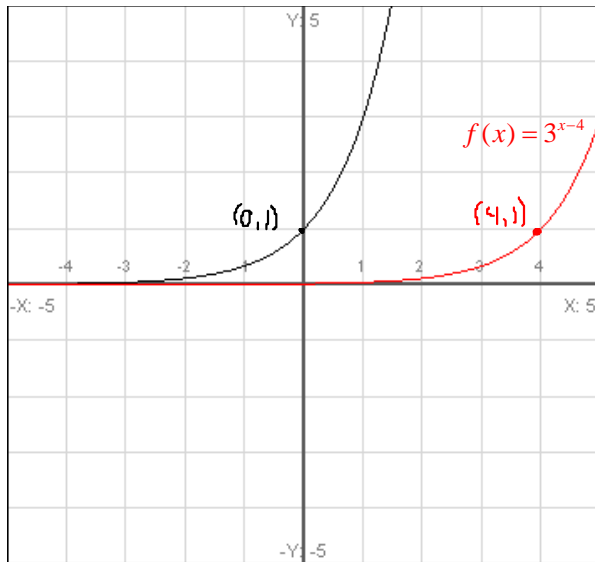
Domain: All real numbers

Range: $y > 0$

Asymptote: $y = 0$

Intercept: $y = 3^{0-4}$
 Set $x=0$ $y = 3^{-4}$
 $y = 1/3^4$
 $y = 1/81$ $(0, 1/81)$

Increasing/Decreasing: \uparrow



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

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

4 units to the left, 3 units down

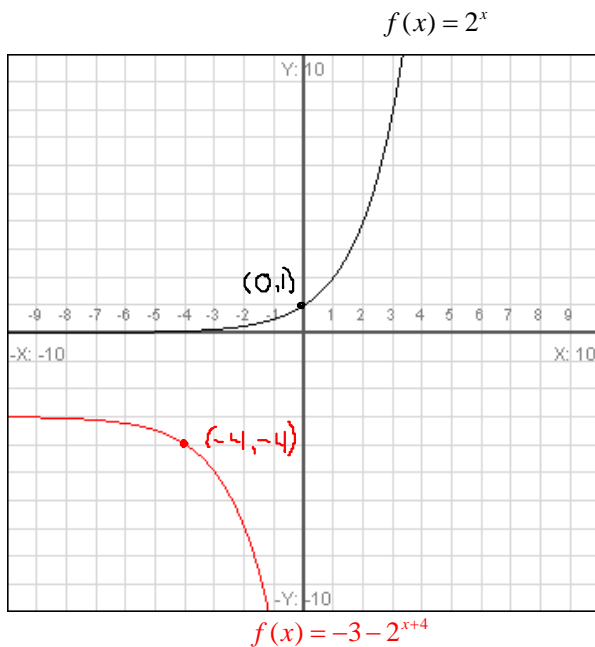
Domain: All real numbers

Range: $y < -3$

Asymptote: $y = -3$

Intercept: $y = -3 - 2^{0+4}$
 Set $x=0$ $y = -3 - 2^4$
 $y = -3 - 16$ $(0, -19)$

Increasing/Decreasing: \downarrow



$f(x) = 2^x$

$$3. f(x) = \left(\frac{1}{2}\right)^{x+2} + 1$$

2 units left, 1 unit up
 Reflect graph over known point

Domain: All real numbers

Range: $y > 1$

Asymptote: $y = 1$

Intercept:
 Set $x = 0$ $y = \left(\frac{1}{2}\right)^{0+2} + 1$

$$y = 2^{-2} + 1$$

$$y = \frac{1}{2^2} + 1$$

$$y = \frac{1}{4} + 1$$

$\left\{0, \frac{5}{4}\right\}$

Increasing/Decreasing: \downarrow

