

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

7.7 - Exponential shifts

Reflected  
 ✓ Stretch  $> 1$   
 ✓ shrink  $0 < a < 1$

$b > 1$  Growth  
 $b < 1$  Decay

Name: \_\_\_\_\_

$a_n = a_1 (r)^{n-1}$   
 multiply

Exponentials have two graphs, GROWTH and DECAY

ALL OF THESE GRAPHS START AT (0, 1)!

GROWTH

PARENT GRAPH

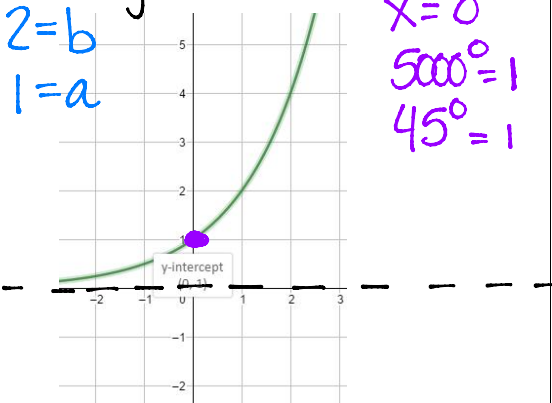
Asymptote:  $y = 0$

$2 = b$   
 $1 = a$

$y = 2^x$   $2^0 = 1$

y-int: (0, 1)

$x = 0$   
 $5000^0 = 1$   
 $45^0 = 1$



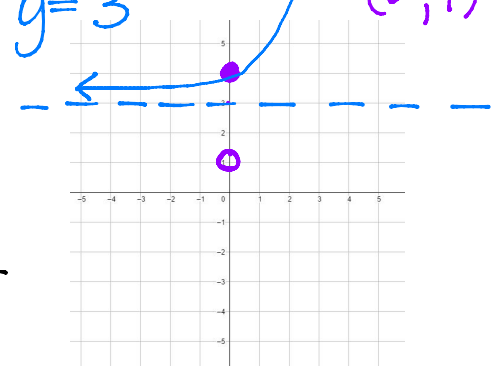
How do we move?

UP 3

$y = 2^{x+3}$

Asymptote:  $y = 3$

y-int: (0, 4)



How do we move?

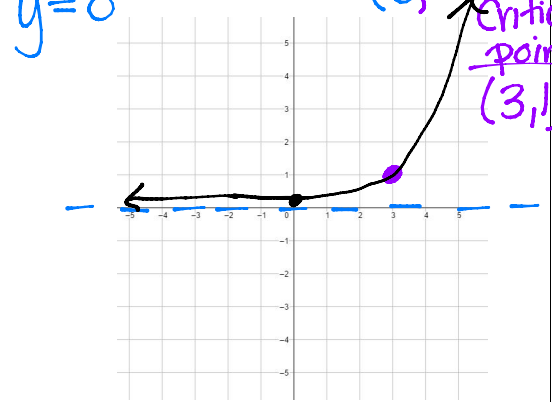
Right 3

$y = 2^{(x-3)}$   $2^{-3}$

Asymptote:  $y = 0$

y-int: (0, 0.125)

Critical point (3, 1)



How do we move?

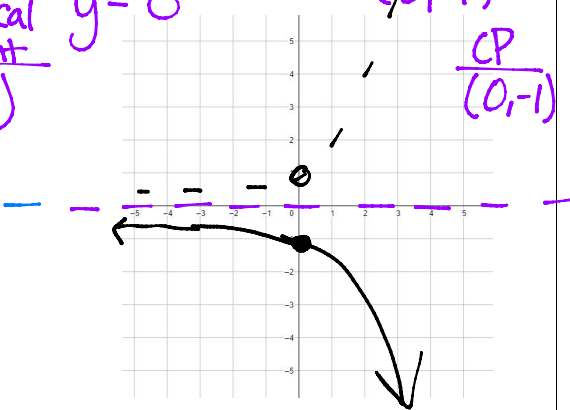
Reflection over x-axis

$y = -1(2)^x$

Asymptote:  $y = 0$

y-int: (0, -1)

CP (0, -1)



How do we move?

$$y = 4(2)^x$$

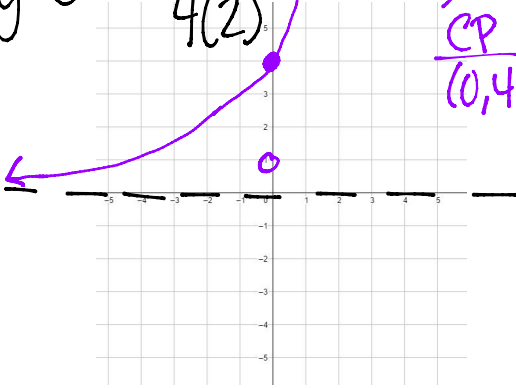
Vertical stretch (tall)

Asymptote:

$$y = 0$$

y-int: (0, 4)

CP  
(0, 4)



How do we move?

$$y = \frac{1}{2}(2)^x = \frac{1}{2}(2)^0$$

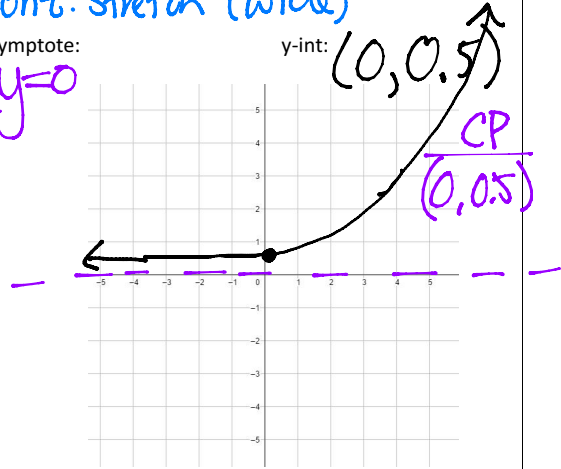
Horiz. stretch (wide)

Asymptote:

$$y = 0$$

y-int: (0, 0.5)

CP  
(0, 0.5)



How do we move?

$$y = 2^{(x+2)} - 2$$

left 2

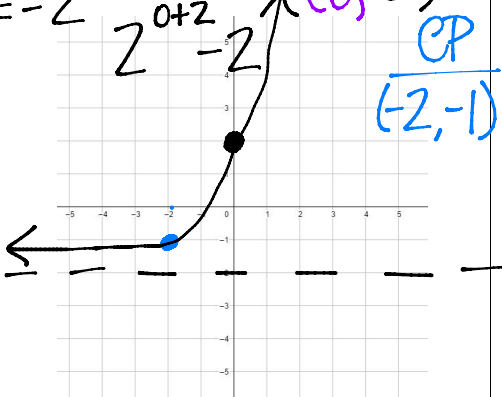
Down 2

Asymptote:

$$y = -2$$

y-int: (0, 2)

CP  
(-2, -1)



How do we move?

$$y = 3(2)^x - 4$$

Vertical stretch

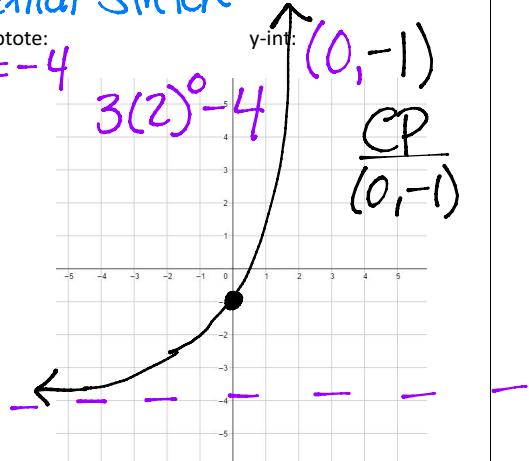
Down 4

Asymptote:

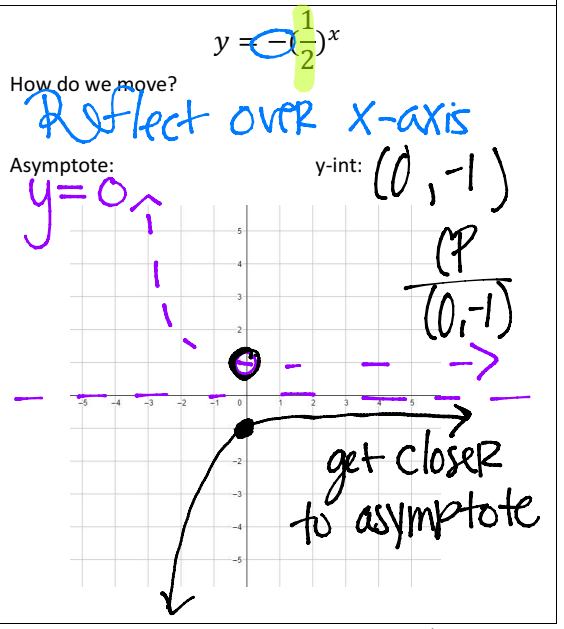
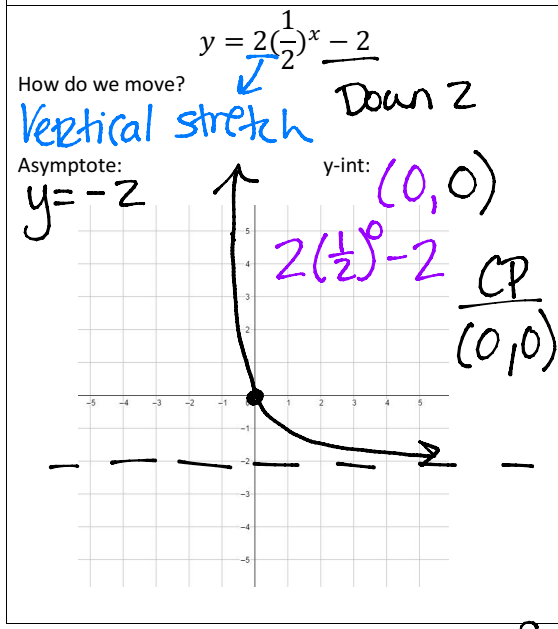
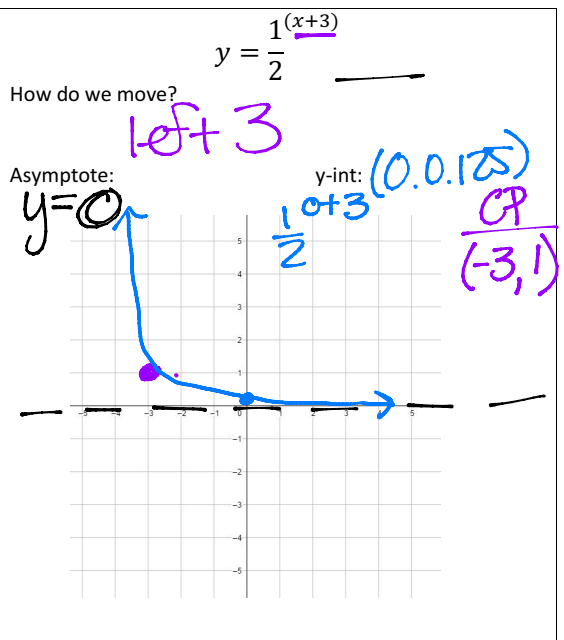
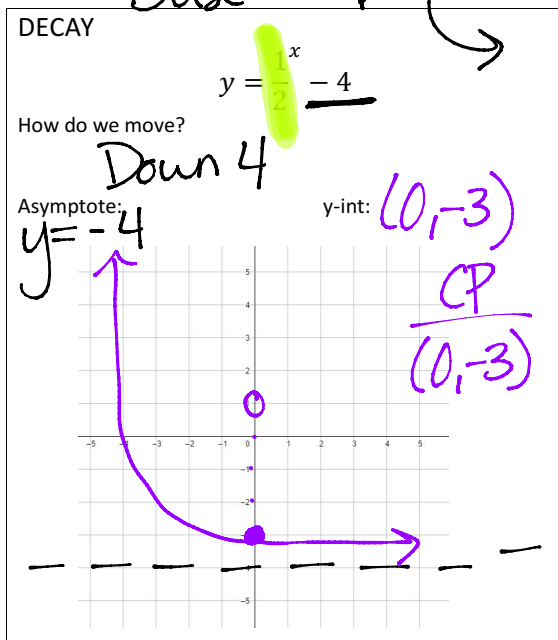
$$y = -4$$

y-int: (0, -1)

CP  
(0, -1)



base < 1 ↗



- When you are in the exponent, you move left or Right (think opposite)  $(x+7) \rightarrow$  left 7
- When you are in the back of the equation (Asymptote), you move up or Down

BIG DIFFERENCE BETWEEN GROWTH AND DECAY IS

Base  
 $b > 1 \rightarrow$  Growth ↗  
 $b < 1 \rightarrow$  Decay ↘

Write the equations for the following specific scenarios.

- 1) An exponential growth that has been shifted right 5 units and down 3 units.

$$y = 2^{(x-5)} - 3$$

Asymptote  $y = -3$

linear  
x  
Quad  
 $x^2$

- 2) A quadratic that has been reflected over the x-axis and left 3 units.

$$y = -(x+3)^2$$

Vertex  $(-3, 0)$

Growth  
 $2^x$   
Decay  
 $\frac{1}{2}^x$

- 3) An exponential decay that has been vertically stretch by a factor of 10.

$$y = 10\left(\frac{1}{2}\right)^x$$

- 4) An exponential growth that has an asymptote of 4 and moved right 2 units.

$$y = 5^{(x-2)} + 4$$

- 5) A quadratic that has been horizontally stretched by  $\frac{1}{4}$  and moved down 6 units.

$$y = \frac{1}{4}x^2 - 6$$

Vertex  $(0, -6)$

- 6) A line that has a slope of 10 and a y-intercept of 2.

$$y = 10x + 2$$

steep

- 7) An exponential decay that has been vertically shrunk by a factor of  $\frac{1}{6}$  and reflected over the x-axis.

$$y = -\frac{1}{6}(0.125)^x$$

- 8) An exponential growth that has been moved left 8 units and has an asymptote of -4.

$$y = 47^{(x+8)} - 4$$