

# Exponential Graphs, Growth, and Decay

## Warm-up

L2

1) What is the equation for a linear function?

2) Is this set of data linear? How can you tell?

x	0	1	2	3
y	4	7	10	13

$$a > 0$$

$$a > 0$$

$b > 1$ $y = 2(3)^x$ Increasing $x \rightarrow \infty, y \rightarrow \infty$ $x \rightarrow -\infty, y \rightarrow 0$	$b < 1$ $y = 2\left(\frac{1}{2}\right)^x$ Decreasing $x \rightarrow \infty, y \rightarrow 0$ $x \rightarrow -\infty, y \rightarrow \infty$
$a < 0$ $b > 1$ $y = -2(3)^x$ Decreasing $x \rightarrow \infty, y \rightarrow -\infty$ $x \rightarrow -\infty, y \rightarrow 0$	$a < 0$ $b < 1$ $y = -2\left(\frac{1}{2}\right)^x$ Increasing $x \rightarrow \infty, y \rightarrow 0$ $x \rightarrow -\infty, y \rightarrow -\infty$

An **exponential function** has a variable as an exponent. The parent exponential function is  $f(x) = b^x$  where the base “b” is a constant and the exponent “x” is the independent variable.



The diagram shows the equation  $f(x) = b^x$  with a blue arrow pointing to the base 'b' labeled 'Base' and a red arrow pointing to the exponent 'x' labeled 'Exponent'. To the right of the equation, the conditions  $b > 0, b \neq 1$  are written in blue.

$$f(x) = b^x, \text{ where } b > 0, b \neq 1$$

A function of the form  $f(x) = ab^x$  with  $a > 0$  and  $b > 1$  is an **exponential growth function**.

When  $0 < b < 1$  the function is called an **exponential decay function**.

Decay rate is 90%

Decay factor is .1

Y intercept = a

An **Asymptote** is the line that the graph's end behavior approaches.

Examples:

I do:

Is this an exponential growth or decay function?

Where is the asymptote? What is the y-intercept?

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

Function	$f(x) = 10 \left(\frac{1}{2}\right)^x$
Identify b	$b = \frac{1}{2}$ $a = 10$
Identify growth or decay Asymptote	Decay Asymptote: $y = 0$ Y int = $(0, 10)$

We Try:

Is this an exponential growth or decay function?

Where is the end behavior? What is the y-intercept?

$$f(x) = 2(1.5)^x$$

Function	$f(x) = 2(1.5)^x$
Identify a, b	
Identify growth or decay asymptote y-int	

You Try With your partner:

Is this an exponential growth or decay function?

Where is the end behavior?

$$f(x) = 5(.5)^x$$

Function	$f(x) = 5(.5)^x$
Identify b	
Identify growth ( $b > 1$ )	

or decay $0 < b < 1$	
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You Try SOLO:

Is this an exponential growth or decay function?

Where is the end behavior?

$$f(x) = 2(-.10)^x$$

Function	$f(x) = 2(-10)^x$
Identify b	
Identify growth ( $b > 1$ ) or decay $0 < b < 1$	

### GROWTH DECAY BOX

	+a	-a
$b > 1$		
$1 > b > 0$		

## Exponential Function transformations

I do:

What are the parent functions?

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

$$y = -3(4)^{x-3} + 5$$

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

$$y = -\left(\frac{1}{4}\right)^x$$

*$y = b^x$  is the parent function*



We Do:

What are the parent functions?

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

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

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

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

You Do Solo:

What are the parent functions?

$$1) y = 12(.4)^x$$

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

What do you think the h does?

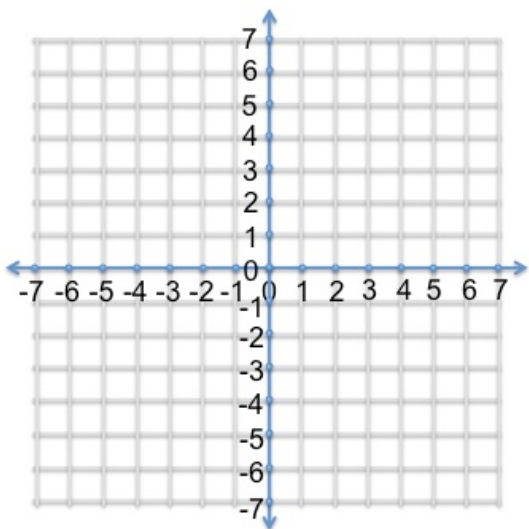
What do you think the k does?

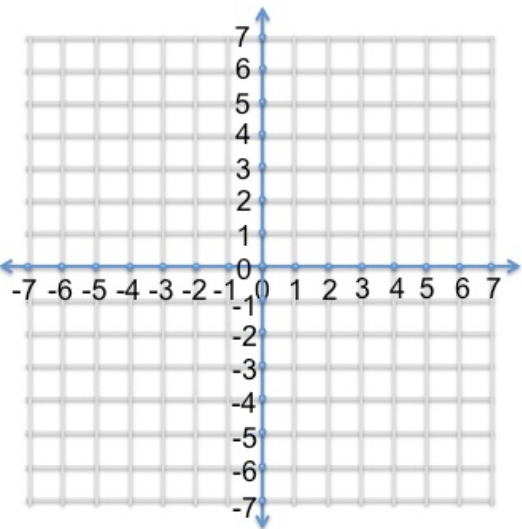
What if a was negative?

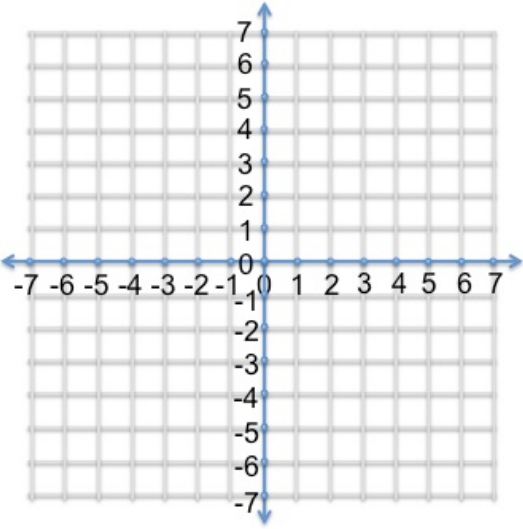
*a also affects the y intercept.*

Graph the equation, identify the asymptote, domain and range, and end behavior.

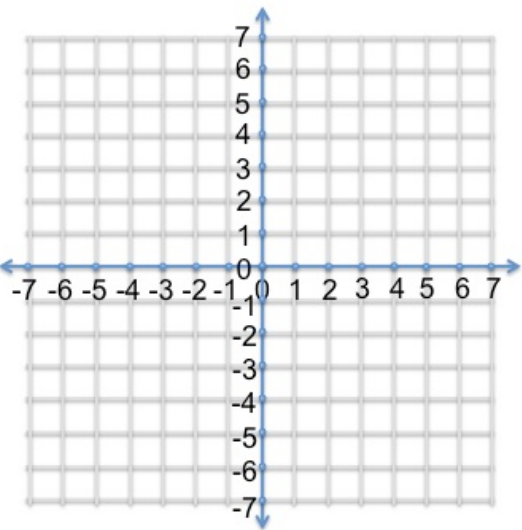
$$f(x) = (3)^{x-2} + 4$$

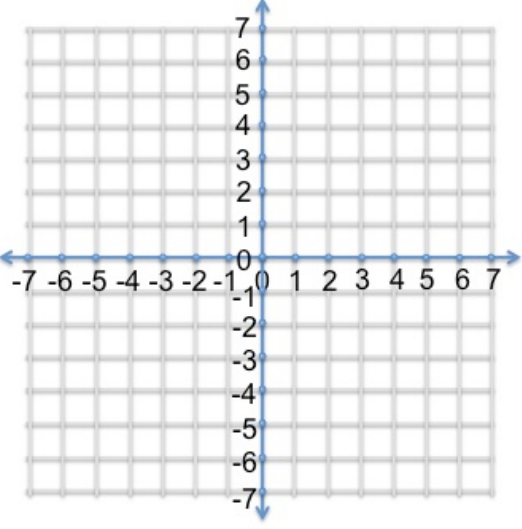
Function	$f(x) = (3)^{x-2} + 4$
Find the parent function	
<p>Plot the parent function points.</p> <p>Apply stretches, then translations</p>	$\left(-1, \frac{1}{b}\right) (0, 1) (1, b)$ 
<p>End behavior:</p> <p>Asymptote:</p> <p>Domain and</p> <p>Range:</p>	

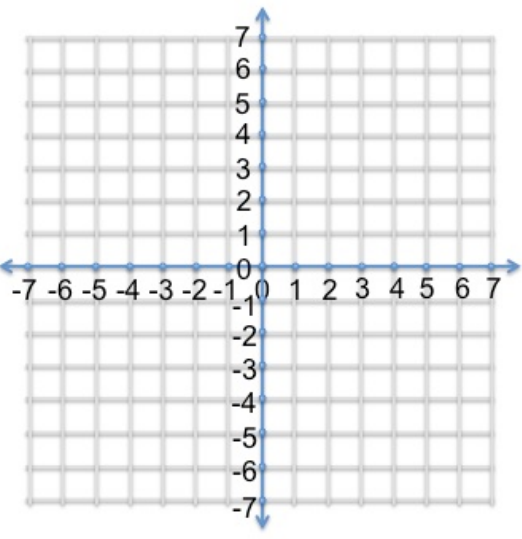
Function	$f(x) = (2)^x + 3$
Find the parent function	
<p>Plot the parent function points.</p> <p>Apply “a”(reflect, stretch/compress) transformations, then translations</p>	$\left(-1, \frac{1}{b}\right) (0, 1) (1, b)$ 
<p>End behavior:</p> <p>Asymptote:</p> <p>Domain and</p> <p>Range:</p>	

Function	$f(x) = -2(3)^{x-2} - 1$
Find the parent function	
<p data-bbox="237 705 613 831">Plot the parent function points.</p> <p data-bbox="237 915 613 1104">Apply "a"(reflect, stretch/compress) transformations, then translations</p>	<p data-bbox="841 705 1276 831"><math>(-1, \frac{1}{b})(0, 1)(1, b)</math></p> 

## Graphing exponential inequalities.

Function	$f(x) > (3)^{x-2} - 1$
Find the parent function	
Plot the parent function points.	$(-1, \frac{1}{b})(0, 1)(1, b)$
Apply "a" (reflect, stretch/compress) transformations, then translations	
Do the (0,0) test and shade.	

Function	$f(x) \leq -(2)^{x-1} + 3$
Find the parent function	
<p>Plot the parent function points.</p> <p>Apply “a”(reflect, stretch/compress) transformations, then translations</p> <p>Do the (0,0) test and shade.</p>	$\left(-1, \frac{1}{b}\right) (0, 1) (1, b)$ 

Function	$f(x) \geq 3(4)^x - 2$
Find the parent function	
<p>Plot the parent function points.</p> <p>Apply “a”(reflect, stretch/compress) transformations, then translations</p> <p>Do the (0,0) test and shade.</p>	$\left(-1, \frac{1}{b}\right) (0, 1) (1, b)$ 



2.29.16

Compound and continuous Interest

Warm-up

*Solve for x*

1)  $5 = 3^x$

2)  $6 = 2e^x$

Compound  
Quarterly , Monthly

$$A = P \left( 1 + \frac{r}{n} \right)^{nt}$$

P= Principal- the starting amount

R=*annual interest Rate*

N=Number of interest periods in a  
year

T= Time

A= Amount after years

Continuously

$$A = Pe^{rt}$$

P= Principal- the starting  
amount

R=*annual interest Rate*

T= Time

A= Amount after years

Jason recently inherited \$30,000. He has a couple of savings plans to choose from.

Plan 1

5.5% interest

Compounded Quarterly for 13 years

How much money would he earn using this plan?

Identify all the variables. Round to the nearest cent.

Plan 2

4.6% interest

Compounded Monthly for 13 years

How much money would he earn using this plan?

Identify all the variables. Round to the nearest cent.

Plan 3

4.21% interest

Compounded Continuously for 13 years

How much money would he earn using this plan?

Identify all the variables. Round to the nearest cent.

Jason wants to know if he can invest \$900,000 in his lifetime with plan 3. Jason is currently 60 years old. Justify his answer.

Quarterly, Monthly

$$A = P \left( 1 + \frac{r}{n} \right)^{nt}$$

P= Principal- the starting amount

R=*annual interest Rate*

N=Number of interest periods in  
a year

T= Time

A= Amount after years

Continuously

$$A = Pe^{rt}$$

P= Principal- the starting amount

R=*annual interest Rate*

T= Time

A= Amount after years

Jasona recently inherited \$15,000. She has a couple of savings plans to choose from.

Plan 1

5.2% interest

Compounded Quarterly for 12 years

How much money would he earn using this plan?

Identify all the variables. Round to the nearest cent.

Plan 2

4.1% interest

Compounded Monthly for 12 years

How much money would she earn using this plan?

Identify all the variables. Round to the nearest cent.

Plan 3

4.0% interest

Compounded Continuously for 12 years

How much money would she earn using this plan?

Identify all the variables. Round to the nearest cent.

Jasona wants to know if she can invest \$1,900,000 in her lifetime with plan 3. Justify her answer.

Sona recently inherited \$20,000. She has a couple of savings plans to choose from.

Plan 1

7.1% interest

Compounded Quarterly for 15 years

How much money would he earn using this plan?  
Identify all the variables. Round to the nearest cent.

Plan 2

6.1% interest

Compounded Monthly for 15 years

How much money would she earn using this plan?

Identify all the variables. Round to the nearest cent.

Plan 3

4.51% interest

Compounded Continuously for 15 years

How much money would she earn using this plan?

Identify all the variables. Round to the nearest cent.

Sona wants to know if she can invest \$1,500,000 in her lifetime with plan 3. Justify her answer.

Ona recently inherited \$12,000. She has a couple of savings plans to choose from.

Plan 1

4.1% interest

Compounded Quarterly for 17 years

How much money would he earn using this plan?

Identify all the variables. Round to the nearest cent.

Plan 2

3.1% interest

Compounded Monthly for 17 years

How much money would she earn using this plan?

Identify all the variables. Round to the nearest cent.



Plan 3

2.51% interest

Compounded Continuously for 17 years

How much money would she earn using this plan?

Identify all the variables. Round to the nearest cent.

Ona wants to know if she can invest \$300,000 in her lifetime with plan 3. Justify her answer.

Exit Slip:  
Graph

$$y < 2(3)^{x-3} + 2$$

2) Given:

3.1% interest

Compounded Monthly for 17 years

How much money would earn using this plan? Identify all the variables. Round to the nearest cent.