

Good morning!

1. "Here"
2. Troubleshoot test problems
3. Begin Unit 3
4. Notes on Transformations of Exponential Functions

Algebra 1
Unit 3
 Exponential Functions

Monday	Tuesday	Wednesday	Thursday	Friday
			March 25 th	March 26 th
			Transformations of Exponential Functions	
March 29 th	March 30 th	March 31 st	April 1 st	April 2 nd
Graphing and Characteristics of Exponential Functions	Practice; Quiz Opens	Quiz Due at Midnight	Exponential Word Problems	Geometric Sequences
April 5 th	April 6 th	April 7 th	April 8 th	April 9 th
Spring Break				
April 12 th	April 13 th	April 14 th	April 15 th	April 16 th
Review	Review	Test in Class		

Transformations of Exponential Functions

So far, we have learned about two types of functions – linear functions and quadratic functions. In this unit, we will learn about our third and final type of function – **exponential functions**.

When given an **equation**, you can determine whether it is linear, quadratic, exponential, or none of the above by looking for the following:

Linear: $y = mx + b$
 Quadratic: $y = ax^2 + bx + c$ or $y = a(x-h)^2 + k$
 Exponential: $y = a \cdot b^x$

Practice. Determine whether the following represent a linear, quadratic, exponential function, or none of the above functions.

- 1) $f(x) = 2x - 7$ 2) $y = 4^x + 3$ 3) $y = -6x^2 + 7x$ 4) $f(x) = 9x^3$
Linear *Exponential* *Quadratic* *Neither "Cubic"*

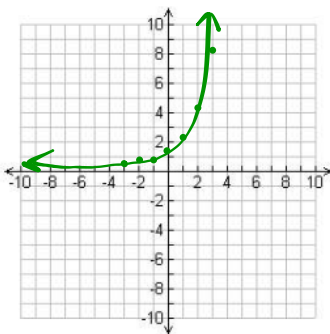
When given a **graph** of a function, how do you determine if it is linear or quadratic? (What do graphs of linear functions and quadratic functions look like?)

Linear "straight line" *Quadratic "U-shaped"* *Exponential "L-shaped"*

Just like with quadratic functions, we have a parent function for exponential functions. The difference is that there is more than one parent function we can have for exponential functions. Use your calculator to complete the tables below and then graph each function.

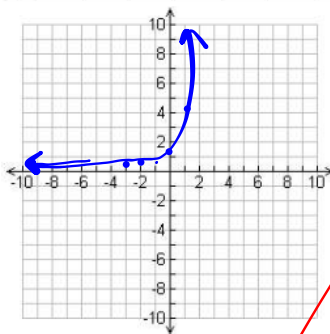
1) $y = 2^x$ *"doubling"*

x	-3	-2	-1	0	1	2	3
y	.125	.25	.5	1	2	4	8



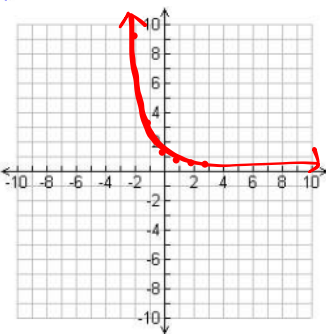
2) $y = 4^x$ *"quadruple" mult. by 4*

x	-3	-2	-1	0	1	2	3
y	.0156	.0625	.25	1	4	16	64

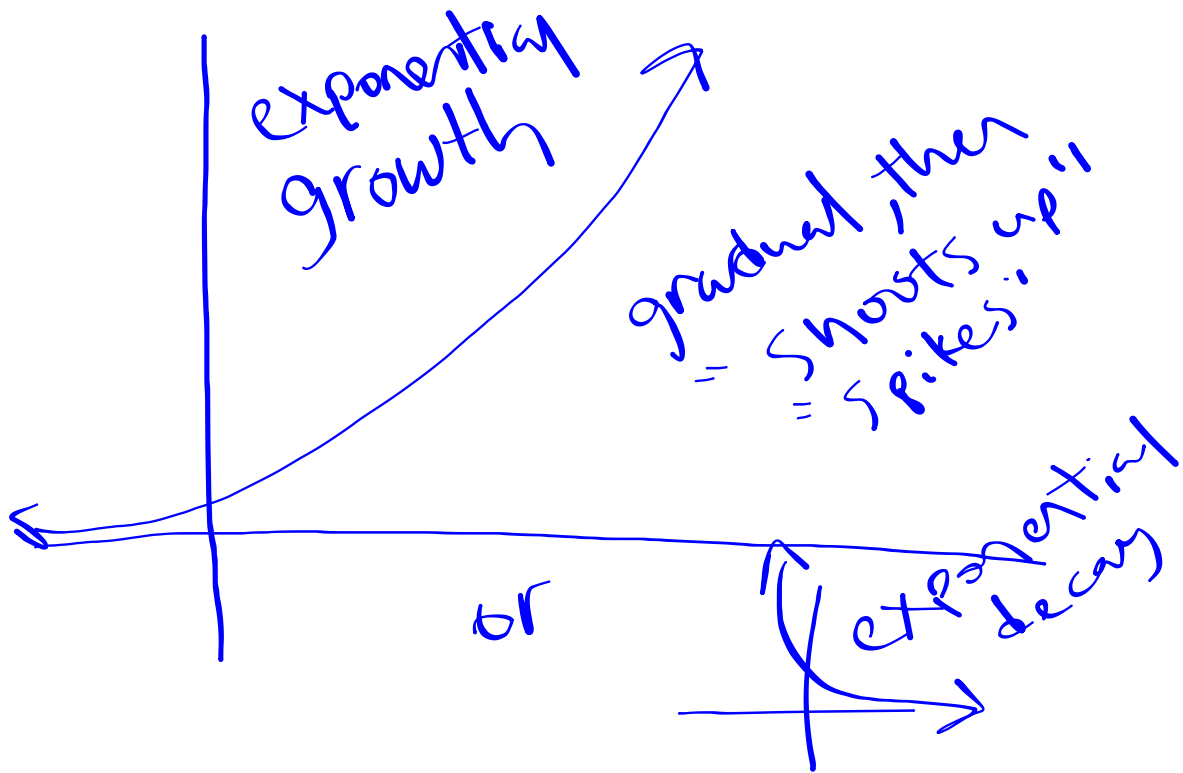


3) $y = (\frac{1}{3})^x$ *"divide by 3"*

x	-3	-2	-1	0	1	2	3
y	27	9	3	1	.33	.11	.037



GROWTH / Decay



The **general form** for exponential functions is $y = ab^x$. This can be written a few different ways:

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

Handwritten notes: "Starting point", "y-interceptor", "stretch or shrink", "base", "growth factor", "H. shift", "V. shift".

To help us determine what transformations have happened, we use the formula below where $y = b^x$ is the parent function.

$$y = ab^{x-h} + k$$

a, h, and k represent the same transformations that they did for quadratic functions.

a	sign	a is -	V. reflection
		a is +	no v. reflection
	number	a < 1	v. shrink
		a > 1	v. stretch
h	h is +	(x-#) H. shift right	
	h is -	(x+#) H. shift left	
k	k is +	v. shift up	
	k is -	v. shift down	

In addition to b giving us information about the parent function, b also tells us whether an exponential function is an example of exp. growth or exp. decay.

Handwritten notes: $b > 1$ growth, $b < 1$ decay, b is positive.

Given the parent functions below, write the new functions for the transformations listed. Then, classify each as an exponential growth or decay.

1) Given $f(x) = 4^x$; translation left 3, up 8, and reflected across x-axis.

Handwritten notes: $h = -3$, $k = 8$, $a < 0$.

$$y = -4^{(x+3)} + 8$$

2) Given $y = (\frac{4}{5})^x$; vertically stretched by a factor of 2, translated down 8 units, and right 1.

Handwritten notes: $h = 1$, $-8 = k$.

$$y = 2 \left(\frac{4}{5}\right)^{(x-1)} - 8$$

3) Given $y = \frac{3^x}{2}$; vertical shrink of $\frac{1}{2}$ and translation down 2 units.

$$y = \frac{1}{2} \left(\frac{3}{2}\right)^x - 2$$

4) Given $f(x) = 2.5^x$; vertical stretch of 4, up 3 units, right 7 units, and reflected across x-axis.

Handwritten notes: $h = 7$, $k = 3$.

$$f(x) = -4(2.5)^{(x-7)} + 3$$

Growth $b > 1$ b is positive
 Decay $b < 1$

Applying a, h, and k Practice

	Identify a, b, h and k	Reflection?	Translation Up or Down?	Vertical Shrink or Stretch?	Translation Left or Right?	Growth or Decay?
		a	k	a	h	b
$y = 2^{x+4} - 9$	$a=1$ $b=2$ $h=-4$ $k=9$	no	down 9	no	Left 4	Growth
$y = -3(0.8)^x + 2$	$a=-3$ $b=.8$ $h=0$ $k=2$	yes	up 2	stretch	no	Decay
$y = -\frac{1}{2}^{x-3} + 1$	$a=-1$ $b=1/2$ $h=3$ $k=1$	yes	up 1	no	Right 3	Decay
$y = 4^x + 5$	$a=1$ $b=4$ $h=0$ $k=5$	no	up 5	no	no	Growth
$y = 4(6)^x$						
$y = 5\left(\frac{2}{3}\right)^x + 4$						
$y = -\frac{7}{4}\left(\frac{3}{2}\right)^{x-11}$						
$y = 3^{x+2}$						
$y = \frac{1}{2}\left(\frac{1}{4}\right)^x - 1$						
$y = -2 \cdot 0.75^{x-6}$						

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

$|a| > 1$ v. stretch
 $|a| < 1$ v. shrink
 $a < 0$ reflection

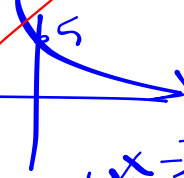
b has to be positive
 $b > 1$ Growth
 $b < 1$ Decay

$$y = a \cdot b^x$$

- $(-)$ $a < 0$
- $(-)$ $b < 1$
- $(-)$ $x < 0$
- $(+)$ $a > 0$
- $(+)$ $b > 1$
- $(+)$ $x > 0$

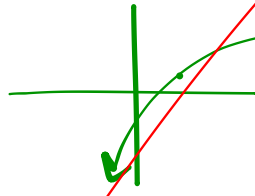
$$y = 5 \left(\frac{1}{2}\right)^x$$

$(+)(-)(+) = \text{Decay}$



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

$(-)(-)(+) = \text{Growth}$



Transformations of Exponential Functions Practice

1) Given the parent function $y = 2^x$, describe the transformations that have occurred from the parent function to the functions below.

a) $y = 2^x - 2$

b) $y = 2^{x+3}$

c) $y = 2 \cdot 2^x$

d) $y = -3 \cdot 2^x + 1$

*a = -3 a < 0 reflection
|a| = 3 > 1 stretch
k = 1 up 1*

e) $y = -2^{x+4} - 6$

f) $y = \frac{3}{4} \cdot 2^x + 4$

2) Write the equation for the functions created by transforming the parent function $y = 5^x$.

a) Translation down 3 units.

b) Translation right 2 units.

c) Translation left $\frac{1}{2}$ unit.

d) Translation up 1 unit and left 2.5 units.

k = 1
h = -2.5
 $y = 5^{(x+2.5)} + 1$

e) Reflection over x-axis and translation right 2 units and vertical shrink of $\frac{1}{2}$.

f) Vertical stretch of 3, translation right 4 units, translation down 4 units.

Transformations of Exponential Functions – Matching

- ___ 1) Reflection over x-axis, translation left 2 a) $y = -\frac{1}{2}(4)^{x+2}$
- ___ 2) Vertical stretch of 2, translation down 3 b) $y = 2 \cdot 4^{x+3}$
- ___ 3) Reflection over x-axis, vertical stretch of 3,
translation down 2 c) $y = -3 \cdot 4^x - 2$
- ___ 4) Vertical shrink of $\frac{1}{2}$, translation left 2, reflection
over x-axis d) $y = -3 \cdot 4^{x+2}$
- ___ 5) Reflection over x-axis, translation right 2, vertical
stretch of 3 e) $y = -4^{x+2}$
- ___ 6) Reflection over x-axis, translation up 2 f) $y = -\frac{1}{2}(4)^x + 2$
- ___ 7) Vertical stretch of 2, translation left 3 g) $y = 2 \cdot 4^x - 3$
- ___ 8) Vertical stretch of 2, translation right 3 h) $y = 2 \cdot 4^{x-3}$
- ___ 9) Vertical shrink of $\frac{1}{2}$, translation down 2, reflection
over x-axis i) $y = -3 \cdot 4^{x-2}$
- ___ 10) Vertical stretch of 2, translation up 3 j) $y = -4^x + 2$
- ___ 11) Vertical shrink of $\frac{1}{2}$, translation up 2, reflection
over x-axis k) $y = 2 \cdot 4^x + 3$
- ___ 12) Reflection over x-axis, translation left 2, vertical
stretch of 3 l) $y = -\frac{1}{2}(4)^x - 2$

