

Zombie Attack!



Background

2 strains of a zombie virus have been discovered in The United States. Each strain is described below.

Strain A	Strain B
Each minute, the original zombie "infects" 3 new people, but the new zombies cannot infect anyone.	Each minute, every zombie is able to infect 1 person. New zombies are able to infect people.

Make a prediction!

Which strain will create more zombies after 10 minutes? Explain your thinking.

Zombie Attack!

Let's begin the simulation. If you get infected with the zombie virus you must **report your name to the CDC** (Center for Disease Control) on the minute you were infected, so they can track the virus.

Tracking the virus.

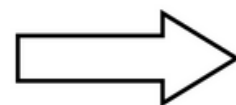
Use the CDC minute reports from the board to complete the tables below to track the number of zombies after each minute.

Strain A	
Minutes	# Zombies
0	
1	
2	
3	
4	
5	
6	
7	

Strain B	
Minutes	# Zombies
0	
1	
2	
3	
4	
5	
6	
7	



NOW,
graph the
data from
the tables!



Tracking the virus (continued).

Use data from the tables to sketch the graphs of each strain of the zombie virus.

<div style="text-align: center;">STRAIN A</div>	<div style="text-align: center;">STRAIN B</div>
Type of function:	Type of function:

Extension.

What if a zombie entered Century Link Stadium in Seattle, WA? The capacity of the stadium is 67,000 people.

Estimate how many minutes it will take for the whole Century Link stadium to be infected IF...

- The original strain A zombie walks into the stadium. _____
- One strain B zombie walks into the stadium. _____


Now, **determine** how many minutes it will take for the whole Century Link stadium to be infected IF...

Strain A zombie walks into the stadium	Strain B zombie walks into the stadium

Name _____ Date _____ Per _____

Exit Ticket

1. If a zombie outbreak occurred at the school, which of the two strains below would you prefer it to be? Explain why.

 **Strain 1:** One zombie infects 20 people each day. Only the original zombie can infect people.
Strain 2: Each zombie infects 3 people each day. New zombies also infect 3 people each day.

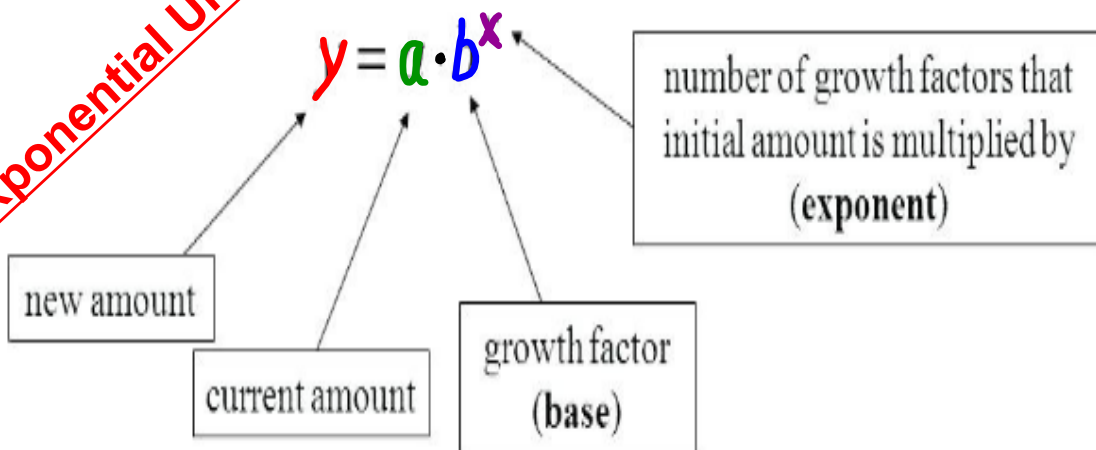
2. How many days would it take for the entire student body to become infected with the virus for each strain?

Strain 1:	Strain 2:
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• The general form of an exponential function is



Exponential Unit





x	y	ratio of y-values
0	4	$\frac{12}{4} = 3$
1	12	
2	36	$\frac{36}{12} = 3$
3	108	
4	324	$\frac{108}{36} = 3$

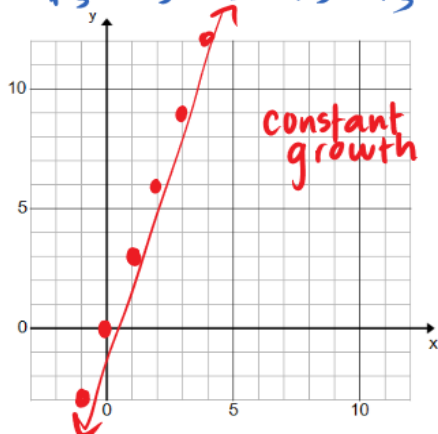
LINEAR VS. EXPONENTIAL FUNCTIONS

Day 7 Notes

1. $y = 3x$ (Linear Model)

x	-1	0	1	2	3	4
y	-3	0	3	6	9	12

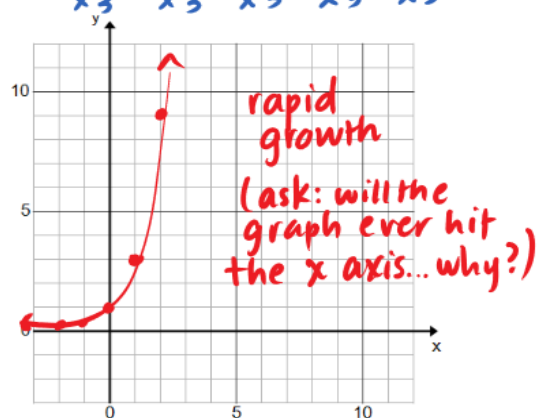
Handwritten annotations: Blue arrows above the table show a constant increase of +1 in x. Blue arrows below the table show a constant increase of +3 in y.



2. $y = 3^x$ (Exponential Model)

x	-2	-1	0	1	2	3
y	1/9	1/3	1	3	9	27

Handwritten annotations: Blue arrows above the table show a constant increase of +1 in x. Blue arrows below the table show a constant multiplication by 3 in y.



Linear

x	-2	-1	0	1	2
y	9	5	1	-3	-7



Exponential

x	-2	-1	0	1	2
y	0.25	1	4	16	64

x	y
10	1
11	6
12	36
13	216

x	y
11	27
12	29
13	31
14	33
15	35

x	y
1	16
2	4
3	1
4	$\frac{1}{4}$

Exponential Growth

+1 +1 +1 +1 +1

x	-2	-1	0	1	2	3
y	2	4	8	16	32	64

x2 x2 x2 x2 x2

$$y = 8 \cdot (2)^x$$

check...
 $y = 8(2)^1 = 16$
 $y = 8(2)^2 = 32$

Exponential Growth

+1 +1 +1 +1 +1

x	-2	-1	0	1	2	3
y	$\frac{2}{9}$	$\frac{2}{3}$	2	6	18	54

x3 x3 x3 x3 x3

$$y = 2 \cdot (3)^x$$

check
 $y = 2(3)^1 = 6$
 $y = 2(3)^2 = 18$

+1 +1 +1 +1 +1

x	-2	-1	0	1	2	3
y	-4	-1	2	5	8	11

+3 +3 +3 +3 +3

constant... (linear) growth

$$m = \frac{\Delta y}{\Delta x} = \frac{3}{1} = 3$$

$$b = (0, 2)$$

$$y = 3x + 2$$

+1 +1 +1 +1 +1

x	-2	-1	0	1	2	3
y	32	16	8	4	2	1

x 1/2 x 1/2 x 1/2 x 1/2

exponential decay

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

x	-2	-1	0	1	2	3
y	243	81	27	9	3	1

$\times \frac{1}{3}$ $\times \frac{1}{3}$ $\times \frac{1}{3}$ $\times \frac{1}{3}$
 exponential decay

$$y = 27 \cdot \left(\frac{1}{3}\right)^x$$

x	-2	-1	0	1	2	3
y	16	13	10	7	4	1

$+1$ $+1$ $+1$ $+1$ $+1$
 -3 -3 -3 -3 -3
 constantly decreasing (linear)

$$m = \frac{\Delta y}{\Delta x} = \frac{-3}{1}$$

$$b = (0, 10)$$

$$y = -3x + 10$$

Here are some partially complete input-output tables

1.

x	0	1	2	3	4	5	6	7	8
y	1	2	4	8					

- Fill in the table above.
- To move to the right in the table, you multiply by _____.
- The starting amount is _____.
- The function formula is $y =$ _____

2.

x	0	1	2	3	4	5	6	7	8
y					40	80	160		

- Fill in the table above.
- To move to the right in the table, you multiply by _____.
- The starting amount is _____.
- The function formula is $y =$ _____

The next problems are harder because the # you multiply by is NOT a whole number.
To figure out what that number is, take a y and divide by the number directly before it.

3.

x	0	1	2	3	4	5	6	7	8
y	10	7.5	5.625						

- Fill in the table above.
- To move to the right in the table, you multiply by _____.
- The starting amount is _____.
- The function formula is $y =$ _____

4 Make tables for these other exponential functions.

a. $y = 6^x$

x	0	1	2	3	4	5	6	7
y								

b. $y = 5 \cdot 2^x$ *Order of operations hint: Make sure you do the 2^x first, multiply by 5 last.*

x	0	1	2	3	4	5	6	7
y								

5. $f(x) = 3 - 4^x$

a. Find $f(2)$.

b. Find $f(-2)$.

What do you plug in?

$a =$ *Starting point*

$B =$ *Common ratio*

What is the first term?

Where $x=1$

The amount it multiplies by.

Determine if the relationship is exponential. If so, determine a function relating the variable.

x	y
1	2
2	3
3	5
4	8
5	12

$> 3 \div 2 = 1.5$
 $> 5 \div 3 = 1.66$
 $> 8 \div 5 = 1.6$
 $> 12 \div 8 = 1.5$

Determine if the relationship is exponential. If so, determine a function relating the variable.

x	y
1	-1
2	-2
3	-4
4	-8
5	-16

$> -2 \div (-1) = 2$
 $> -4 \div (-2) = 2$
 $> -8 \div (-4) = 2$
 $> -16 \div (-8) = 2$

Determine if the relationship is exponential. If so, determine a function relating the variable.

x	y
1	26
2	24
3	22
4	20
5	18

$> 24 \div 26 = .923$
 $> 22 \div 24 = .917$
 $> 20 \div 22 = .909$
 $> 18 \div 20 = .9$

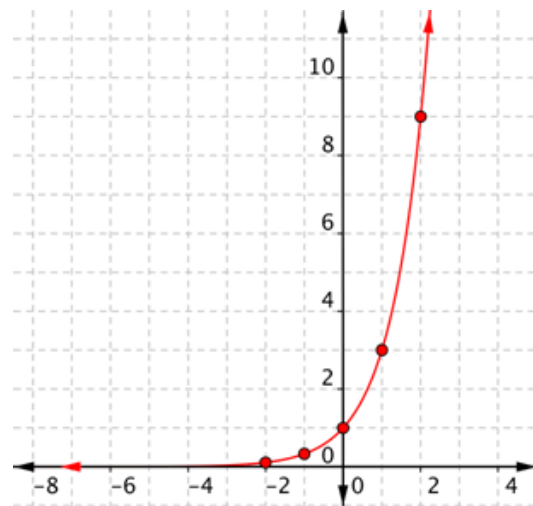
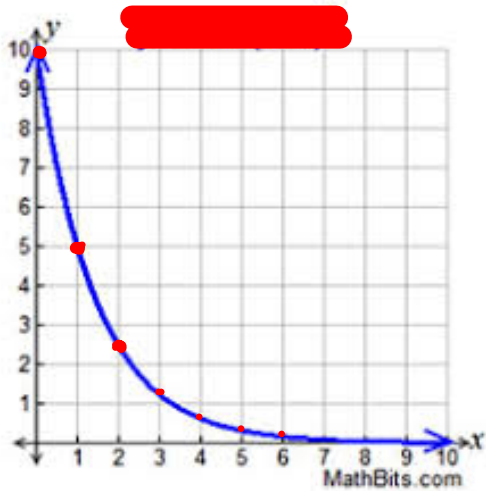
x	y
1	81
2	27
3	9
4	3
5	1

> $27 \div 81 = 1/3$

> $9 \div 27 = 1/3$

> $3 \div 9 = 1/3$

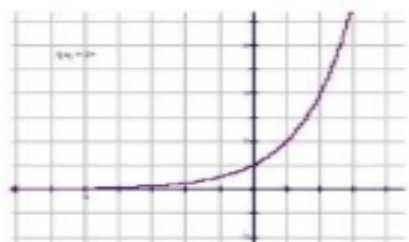
> $1 \div 3 = 1/3$



Day Two Exponentials

"Growth and Decay Formula"

Exponential Growth vs. Decay



Exponential Growth

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

$$b > 1$$

$$2 \cdot 2 \cdot 2 \cdot 2$$

getting bigger



Exponential Decay

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

$$b < 1$$

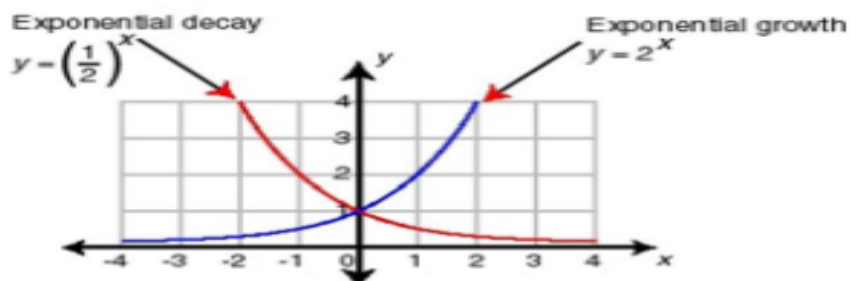
$$1/2 \cdot 1/2 \cdot 1/2 \cdot 1/2$$

getting smaller

Growth vs. Decay

Exponential growth: as the value of x increases, the value of y increases

Exponential decay: as the value of x increase, the value of y decreases, approaching zero.



Growth:

$$y = a(1 + r)^x$$

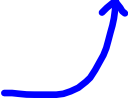
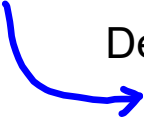
Decay:

$$y = a(1 - r)^x$$

a = initial amount before measuring growth/decay

r = growth/decay rate (often a percent)

x = number of time intervals that have passed

Exponential Growth	 Increases rapidly	$b > 0$
Exponential Decay	 Decreases rapidly	$0 < b < 1$

Exponential Growth	
Exponential Decay	

Exponential growth is given by the equation:

$y =$ _____

$a =$ _____

$r =$ _____

$t =$ _____

Example 1: In 1971, there were 294,105 females participating in high school sports. Since then, that number has increased an average of 8.5% per year.

a) Write an equation to represent the number of females participating in sports since 1971.

b) How many females participated in high school sports in 2008?

Exponential decay is given by the equation:

$$y = \underline{\hspace{2cm}}$$

$$a = \underline{\hspace{2cm}}$$

$$r = \underline{\hspace{2cm}}$$

$$t = \underline{\hspace{2cm}}$$

Example 4: The original price of a tractor was \$45,000. The value of the tractor depreciates (decreases in value) at a steady rate of 12% per year.

- a) Write an equation to represent the value of the tractor since it was purchased.
- b) What is the value of the tractor in 5 years?

The original value of a painting is \$9,000 and the value increases by 7% each year. Write an exponential growth function to model this situation.

Step 1 Write the exponential growth function for this situation.

$$y = a(1 + r)^t$$

$$= 9000(1 + 0.07)^t$$

$$= 9000(1.07)^t$$

Write the formula.

Substitute 9000 for a and 0.07 for r.

Simplify.

The value of the painting in 15 years is \$24,831.28.

A sculpture is increasing in value at a rate of 8% per year, and its value in 2000 was \$1200. Write an exponential growth function to model this situation.

Step 1 Write the exponential growth function for this situation.

$$\begin{aligned} y &= a(1 + r)^t \\ &= 1200(1 + 0.08)^6 \\ &= 1200(1.08)^t \end{aligned}$$

Write the formula

*Substitute 1200 for a and 0.08 for r.
Simplify.*

The value of the painting in 6 years is \$1,904.25.

The population of a town is decreasing at a rate of 3% per year. In 2000 there were 1700 people. Write an exponential decay function to model this situation.

Step 1 Write the exponential decay function for this situation.

$$\begin{aligned} y &= a(1 - r)^t \\ &= 1700(1 - 0.03)^t \\ &= 1700(0.97)^t \end{aligned}$$

Write the formula.

*Substitute 1700 for a and 0.03 for r.
Simplify.*

The population in 2012 will be approximately 1180 people.

The fish population in a local stream is decreasing at a rate of 3% per year. The original population was 48,000. Write an exponential decay function to model this situation.

Step 1 Write the exponential decay function for this situation.

$$y = a(1 - r)^t$$

Write the formula.

$$= 48,000(1 - 0.03)^t$$

Substitute 48,000 for a and 0.03 for r.

$$= 48,000(0.97)^t$$

Simplify.

The population after 7 years will be approximately 38,783 people.

Day Three Exponentials

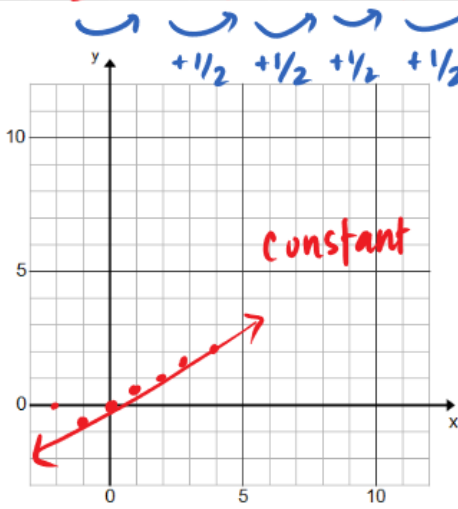
"Comparing Linear & Exponential's"

and also

"Growth and Decay
Factor/Rate"

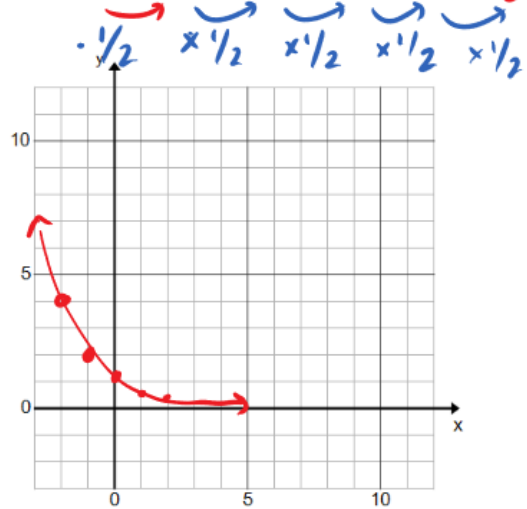
★ $y = \frac{1}{2}x$ Linear

x	-1	0	1	2	3	4
y	$-\frac{1}{2}$	0	$\frac{1}{2}$	1	$\frac{3}{4}$	2



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

x	-2	-1	0	1	2	3
y	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$



What is the solution to the given system?

$$h(x) = 3x - 2$$

$$f(x) = .25(2)^x$$

x	h(x)	f(x)

At what x value is $f(x)$ greater than $g(x)$?

$$g(x) = 2x + 5$$

$$f(x) = 3^x$$

x	$g(x)$	$f(x)$

What is the solution to the given system?

$$y_1 = 3x + 6$$

$$y_2 = 3(2)^x$$

x	y_1	y_2

State the greater growth/decay rate.

$$y = 5(1.35)^t \qquad b(x) = .45(0.87)^x$$

What is the Factor vs Rate
Is it easier to see the factor or rate in
these two scenarios?

$$y=5(1+.35)^x \qquad b(x)=.45(1-.13)^x$$

The table shows how the number of golf members in two different country clubs is increasing over time.

Country Club	Description of Increase
Blue Clay Creek Club	Currently 2,000 members Increasing by 200 members per year
True Manor Country Club	Currently 1,500 members Increasing by 14% per year

- A. Write two equations to describe the golf membership growth at these two clubs. For each equation, let x = the time in years from now, and let y = the number of members.
- B. Graph both equations from Part A using your calculator. How would you choose which country club to join? Be specific. You can also look at a table for more specific data points.