Warm-Up 3/26/18

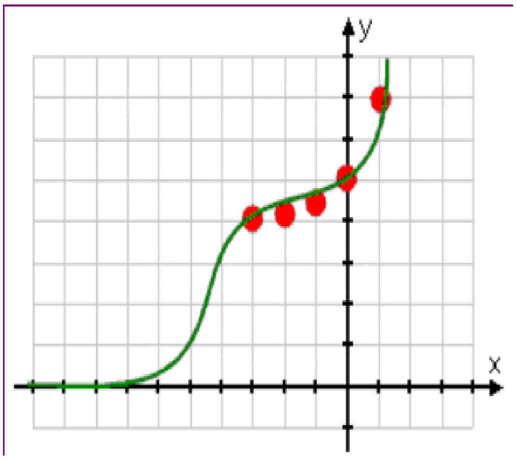
1. Which graph represents and exponential function? Find the A and the B of the exponential function.

$a \cdot b^x$

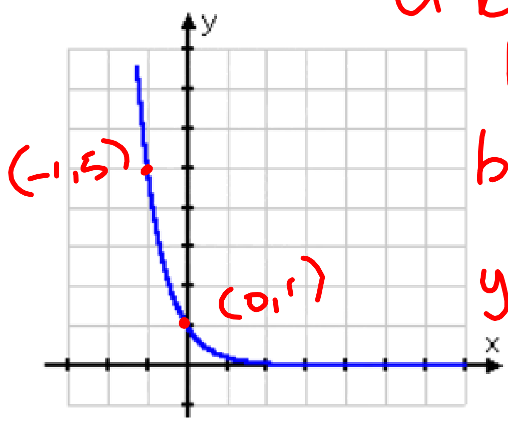
$b < 1$

$b = \frac{1}{5}$

$y = \frac{1}{5}^x$



A



B

2. Which of the following is not an exponential function? Find the A and the B of each exponential function.

$$f(x) = 2(4)^t$$

A $a=2$, $b=4$

$$f(x) = x^2 + 3$$

B

$$f(x) = 2^x - 1$$

C $a=1$, $b=2$

$$f(x) = 4^x + 5$$

D $a=1$, $b=4$

3. Which table of values represents an exponential function? Find the A and the B of the exponential function.

(-1, 1/2) (0, 1) (1, 2) (2, 4)

x	y
-1	1/2
0	1
1	2
2	4

$1 \div 1/2 = 2$

$2 \div \; = 2$

$4 \div 2 = 2$

x	y
-1	3/2
0	2
1	3
2	5

A

B

$y = 1(2)^x$

$y = 2^x$

Essential Question 3/26/18

- How can I use exponential functions to model real-world situations?

Learning Objective

- I can use exponential functions to model real-world situations.

DAY 6: APPLICATIONS OF EXPONENTIALS

Unit 4: Exponential Functions

Pages 21 - 24

Review Percents to Decimals

In order to be successful at creating exponential growth and decay functions, it is important you know how to convert a percentage to a decimal. Remember percentages are always out of 100.

Option 1: move decimal 2 places to left **Option 2:** divide by 100

25% = .25 6.5% = .065 2% = .02 10% = .10 3.05% = .0305

Growth or Decay?

As you have already begun to notice, we have been discussing growth and decay quite a bit with exponential functions. You already know how to identify a growth and decay function just from looking at the equation. In case you have forgotten, here are a few practice problems:

A. $y = 8(4)^x$	B. $f(x) = 2(5/7)^x$	C. $h(x) = 0.2(1.4)^x$	D. $y = ¾(0.99)^x$	E. $y = ½(1.01)^x$
G	D	G	D	G

Growth/Decay Models

Exponential Growth is where a quantity increases over time where **exponential decay** is where a quantity decreases over time. When we discuss exponential growth and decay, we are going to use a slightly different equation than $y = ab^x$. When you simplify your equation, it will look like $y = ab^x$, but to begin, you will use the following formulas:

Exponential Growth

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

where $a>0$

y = final amount
a = starting amount
r = growth rate (express as decimal)
t = time

(1 + r) represents the growth factor

Exponential Decay

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

where $a>0$

y = final amount
a = starting amount
r = decay rate (express as decimal)
t = time

(1 – r) represents the decay factor

$$a \cdot b^x \Rightarrow a(1 \pm r)^t$$

Factors versus Rates

Example 1: Identify the following equations as growth or decay. Then identify the initial amount, growth/decay factor, and the growth/decay percent.

a. $y = 3.5(1.03)^t$

Growth/Decay: Growth

Initial Amount: 3.5

Growth/Decay Factor: 1.03

$1.03 - 1 = .03 = 3\%$

Growth/Decay Percent: ________

b. $f(t) = 10{,}000(0.95)^t$

Growth/Decay: Decay

Initial Amount: 10,000

Growth/Decay Factor: 0.95

$1 - 0.95 = 0.05$

Growth/Decay Percent: 5%

Factors vs Rates

c. $g(t) = 400(0.925)^t$

Growth/Decay: Decay

Initial Amount: 400

Growth/Decay Factor: 0.925

Growth/Decay Percent: $1 - .925$

$= 0.075$

$= 7.5\%$

d. $y = 2{,}500(1.2)^t$

Growth/Decay: Growth

Initial Amount: 2500

Growth/Decay Factor: 1.2

Growth/Decay Percent: $1.2 - 1$

$= .2$

20%

Example 2

Example 2: The original value of a painting is \$1400 and the value increases by 9% each year. Write an exponential growth function to model this situation. Then find the value of the painting in 25 years.

Growth or Decay: Growth

Starting value (a): 1400

Rate (as a decimal): 0.09

$t = 25$

Function: $y = 1400(1 + 0.09)^{25}$

Simplified: $y = 1400(1.09)^{25}$

$\boxed{\$12,072.31}$

Example 3

Example 3: The population of a town is decreasing at a rate of 1% per year. In 2000, there were 1300 people Write an exponential decay function to model this situation. Then find the population in 2008.

Growth or Decay: decay

Starting value (a): 1300

Rate (as a decimal): .01

$t = 2008 - 2000$
$= 8$ yrs.

Function: $y = 1300(1 - 0.01)^8$

Simplified: $y = 1300(0.99)^8$

$y = 1{,}199.57$

$\simeq 1{,}199$ people in 2008

Example 4

Example 4: The cost of tuition at a college is \$12,000 and is increasing at a rate of 6% per year. Find the cost of tuition after 4 years.

Growth or Decay: Growth

Starting value (a): 12000

Rate (as a decimal): 0.06

$t = 4$

Function: $y = 12000(1 + 0.06)^4$

Simplified: $y = 12000(1.06)^4$

$\boxed{y = \$15,149.72}$

Example 5

Example 5: The value of a car is $18,000 and is depreciating at a rate of 12% per year. How much will your car be worth after 10 years?

Growth or Decay: Decay

Starting value (a): 18,000

Rate (as a decimal): .12

Function: $y = 18{,}000(1 - .12)$

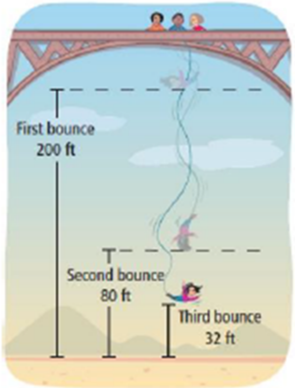
Simplified: $18{,}000(1-.12)^{10}$

$y = 5013.017568$

$y = \$5013.02$

Example 6

Example 6: A bungee jumper jumps from a bridge. The diagram shows the bungee jumper's height above the ground at the top of each bounce. What is the bungee jumper's height at the top of the 5th bounce?



Growth or Decay: Decay

Starting Value: 200

Rate (as a decimal): .4 $t=5$

Function: $y=200(0.6)^5$

15.6ft

Compound Interest

- As you get older, you will come to learn a great deal about investing your money…savings accounts, stock market, mutual funds, bonds, etc. Today, we are going to learn about compound interest, which is a form of saving and earning money by letting it sit in an account over time.

- **Compound Interest** is interest earned or paid on both the principal and previously earned interest.

- In middle school, you learned about **simple interest**, which is interest that is only earned on the principal. It's formula is $I = Prt$, where P represents principal, r represents rate, t represents time, and I represents interest.

Compound Interest

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

A = balance after *t* years
P = Principal (original amount)
r = interest rate (as a decimal)
n = number of times interest is compounded per year
t = time (in years)

annually = 1
Semi-annually = 2
quarterly = 4
monthly = 12

Example 1

P r

Example 1: Write a compound interest function that models an investment of $1000 at a rate of 3% compounded quarterly. Then find the balance after 5 years.

n t

P = 1000

r = .03

n = 4

t = 5

$$A = 1000\left(1 + \frac{0.03}{4}\right)^{4 \cdot 5}$$

$$A = 1000\left(1 + \left(\frac{0.03}{4}\right)\right)^{20}$$

$$\boxed{A = \$1,161.18}$$

Example 2

Example 2: Write a compound interest function that models an investment of $18,000 at a rate of 4.5% compounded annually. Then find the balance after 6 years.

P = 18,000

r = .045

n = 1

t = 6

$$A = 18000\left(1 + \frac{.045}{1}\right)^6$$

$$\boxed{A = \$23,440.68}$$

Example 3

Example 3: Write a compound interest function that models an investment of $4,000 at a rate of 2.5% compounded monthly. Then find the balance after 10 years.

P = 4000

r = .025

n = 12

t = 10

$$A = 4000\left(1 + \left(\frac{.025}{12}\right)\right)^{120}$$

$$A = \$5{,}134.77$$

Class Work (#1-8) 3/26/18

Directions: Label if the equation represents growth or decay. Then determine the growth/decay factor and growth/decay rate. Remember to write your rate as a percentage.

1) $y = 10(1.35)^x$ Growth

Growth/Decay Factor: 1.35

$1.35 - 1 = .35 = 35\%$

Growth/Decay Rate: ______

2) $y = 742(0.60)^x$ Decay

Growth/Decay Factor: 0.60

$1 - .60$

Growth/Decay Rate: ______ $= .40 = 40\%$

3) $y = (1.04)^x$ ______

Growth/Decay Factor: 1.04

Growth/Decay Rate: ______

4) $y = 7500(0.42)^x$ ______

Growth/Decay Factor: 0.42

Growth/Decay Rate: ______

5) $y = 50(1+.23)^x$ ______

Growth/Decay Factor: ______

Growth/Decay Rate: ______

6) $y = 1500(0.925)^x$ ______

Growth/Decay Factor: ______

Growth/Decay Rate: ______

Directions: Create an exponential growth/decay model and use it to solve each problem. Make sure your model problem is in simplified form (y = abx)

7) A new SUV depreciates at a rate of 23% per year. If the original selling price was $30,000, how much will the vehicle be worth after 4 years?

decay

Model: $A = 30000(1-0.23)^4$

$A = P(1-r)^t$

$P = 30{,}000$

$r = 0.23$

$t = 4$

$30{,}000(0.77)^4$

$\boxed{A = \$10{,}545.91}$

8) Two bacteria are discovered at the bottom of a shoe. If the bacteria multiply at a rate of 34% per hour, how many bacteria will be present after 48 hours?
Model: ______________________________

Home Work: #9 - 13

Day 7: Applications of Exponential Functions Name: ____________________

Practice Assignment

Growth: $y = a(1+r)^t$	Decay: $y = a(1-r)^t$	Compound Interest: $y = P\left(1+\frac{r}{n}\right)^{n \cdot t}$
Key Words:	Key Words:	Key Words:

Class Work # 1 - 4

Home Work # 5 - 8

Directions: Create an exponential model and use it to solve each problem.

Example 1: Russell's health and fitness blog is really taking off. The blog had 45,000 commenters this month and the number of commenters has consistently gone up by 10% per month. How many commenters can Russell expect to have in 5 months

Example 2: A pot of soup, currently at 84 C is left out to cool. If that temperature decreases by 5% per minute, what will the temperature be in 5 minutes? °

Example 3: The population of a small town started at 233 people in 1999. If the population grows at a rate of 16% per year, how many people are now in the town in 2006

Example 4: \$3000 is deposited in an account that pays 4% annual interest compounded monthly. How much will be in the account after 20 years?

Closing:

If there is a % change, the base is (_______) for growth and (_______) for decay.

What's going to be the base of your exponential in the following cases?

1. 20% increase

2. 15% decrease

3. 8% increase

4. 4% decrease

5. 12.5% increase

6. 42.5% decrease