Warm-up 12/4

Identify each scenario as linear or exponential.

1. In 1995, there were 85 rabbits in Central Park. The population increased by 12% each year.

2. In 2001, Tomas started a bakery. He has to pay $1200 in rent and $0.30 cents for each item.

3. In 1985, there were 285 cell phone subscribers in the small town of Centerville. The number of subscribers increased by 75% per year after 1985.

Warm-up 12/5

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1. In 1995, there were 85 rabbits in Central Park. The population increased by 12% each year. exponential

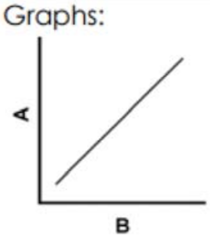
2. In 2001, Tomas started a bakery. He has to pay $1200 in rent and $0.30 cents for each item. linear

3. In 1985, there were 285 cell phone subscribers in the small town of Centerville. The number of subscribers increased by 75% per year after 1985. exponential

EXPLORING EXPONENTIAL FUNCTION
GROWTH & DECAY (DAY 3)

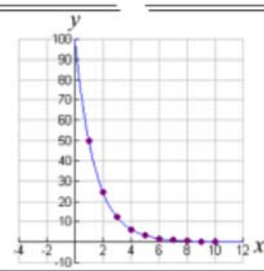
Linear Functions		Exponential Functions	
General Equation $y = ax + b$ $y = mx + b$	**Function Notation** $f(x) = ax + b$	**General Equation** $y = ab^x$	**Function Notation** $f(x) = ab^x$
		(recall: variable is the exponent for an exponential function)	
a = **b =**		**a =** **b =** **x =**	
		Exponential Function are able to have both a____________ or ____________ rate of change • Positive Rate of Change is called an ________________ ____________ **To Get b# R.O.C:** ______________ • Negative Rate of Change is called an ________________ ____________ **To Get b# R.O.C:** ______________	

Graphs:



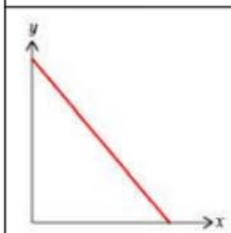
This is a graph of a __________ line

________ from left to right



This is a graph of an exponential ________

________ from left to right

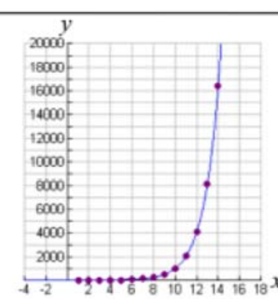


This is a graph of a __________ line

________ from left to right

This is a graph of an exponential ________

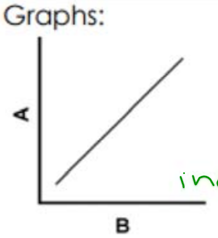
________ from left to right



EXPLORING EXPONENTIAL FUNCTION GROWTH & DECAY (DAY 3)

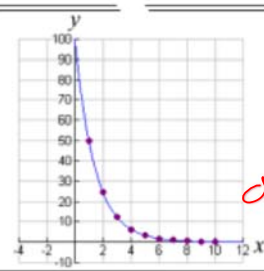
Linear Functions		Exponential Functions	
General Equation $y = ax + b$ $y = mx + b$	**Function Notation** $f(x) = ax + b$ $f(x) = mx + b$	**General Equation** $y = ab^x$	**Function Notation** $f(x) = ab^x$
		(recall: variable is the exponent for an exponential function)	
a = slope **b =** y-intercept (starting value)		**a =** initial value (starting amount) **b =** rate of growth or decay **x =** usually time (exponent)	
		Exponential Function are able to have both a positive or negative rate of change • Positive Rate of Change is called an exponential growth **To Get b# R.O.C:** $(1 + r)$ • Negative Rate of Change is called an exponential decay **To Get b# R.O.C:** $(1 - r)$	

Graphs:



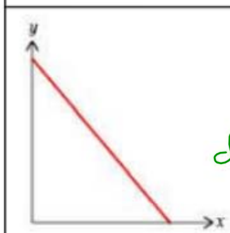
This is a graph of a positive line (slope)

increasing from left to right



This is a graph of an exponential decay

decreasing from left to right

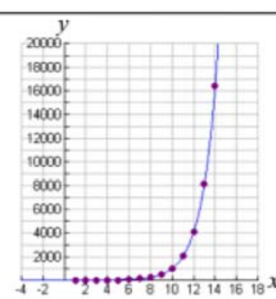


This is a graph of a negative line (slope)

decreasing from left to right

This is a graph of an exponential growth

increasing from left to right



How to set up an exponential model

Generally, in exponential growth and decay problems, you will use an equation that looks like:

$f(x)$ = (starting amount) · (**multiplier**)^x $y = ab^x$

There are several ways to find the **multiplier**, depending on the way that the change is described in the problem.

- If you're given a growth rate as a percent: **multiplier** = 1 + (growth rate as a decimal).
- If you're given a decay rate as a percent: **multiplier** = 1 – (decay rate as a decimal).
- If you're given a growth rate as a fraction: **multiplier** = 1 + fraction.
- If you're given a decay rate as a fraction: **multiplier** = 1 – fraction.
- If you're given a number that's used for repeated multiplication, **multiplier** = that number. (For example, if an amount triples every day, then **multiplier** = 3.)

100   increase 10% = 0.10

×1.1   +10   (1 + 0.10) = 1.10

110

×1.1   +11

121

×1.1   +12.1

133.10

Exponential Modeling: Identifying Multipliers

Many ways of changing a number can be accomplished through a single multiplication. Fill in this chart with the multiplier that would accomplish each of the described changes. Two examples are shown to get you started.

If you want to make this kind of change to any number...	*then you should multiply by...*
increase by 6%	1.06
decrease by 6%	0.94
increase by 20% 0.20 (1+0.20)	1.2
decrease by 20% 0.20 (1−0.20)	0.8
increase by 7.89% 0.0789 (1+0.0789)	1.0789
decrease by 7.89% 0.0789 (1−0.0789)	0.9211
double it	2
quadruple it	4
twenty times as much	20
half as much 0.5 (1−0.5)	÷2 0.5
increase by $\frac{1}{4}$ of the original number	
decrease by $\frac{1}{4}$ of the original number	
increase by $\frac{2}{3}$ of the original number	
decrease by $\frac{2}{3}$ of the original number	

1. Identify the following equation as either linear or exponential.

   a) $f(x) = 3^x + 2$ b) $2y = -5x + 1$ c) $y = 7$ d) $C(x) = 16,332(1.052)^x$

$b < 1$ decay
$b > 1$ growth

For questions #2 – 5:

a. State whether the function is a growth or decay.
b. State the initial value.

2. $c(t) = 100(.75)^t$ 3. $p(n) = 40(1.80)^n$ 4. $t(x) = 10,000(1.02)^x$ 5. $f(n) = 50(.1)^n$

Steps for writing and solving Functions:

- Identify the type of function (Linear: $y = ax + b$ or Exponential: $y = ab^x$)
- If Exponential:
  - Determine a# - initial amount (start #)
  - Determine b#:
    - Exponential Growth: 1+rate (%)
    - Exponential Decay: 1 – rate (%)

6. A tennis tournament has 128 competitors. Half of the competitors are eliminated each round. Write a function to represent the number of competitors that will be left after "x" rounds. Then determine how many players will be left after 5 rounds.

$y = 128(1-0.5)^x$ $y = 128(0.5)^x$

$y = 128(0.5)^5 = 4$ players

7. A three-bedroom house in Burbville was purchased for $190,000. If housing prices are expected to increase by 1.8% annually in that town, write a function that models the price of the house in ***t*** years. Find the price of the house in 6 years.

$f(t) = 190,000(1 + 0.018)^t$ $211,465.86

$f(t) = 190,000(1.018)^t$ $f(6) = 190,000(1.018)^6$

8. Jonathan makes a weekly allowance of $25. He also makes $9.50 an hour at his job. Write a function for the amount of money he makes each week based on the amount of hours, h, he works. How much will he make if he works 25 hours?

$y = 9.5h + 25$

$y = 9.5(25) + 25$

$y = \$262.50$

1. Identify the following equation as either linear or exponential.

a) $f(x) = 3^x + 2$ b) $2y = -5x + 1$ c) $y = 7$ d) $C(x) = 16,332(1.052)^x$

Exp. Linear Linear Exp.

For questions #2 – 5:

a. State whether the function is a growth or decay.
b. State the initial value.

ab^x

2. $c(t) = 100(.75)^t$ 3. $p(n) = 40(1.80)^n$ 4. $t(x) = 10,000(1.02)^x$ 5. $f(n) = 50(.1)^n$

a "initial value" b rate of decay 25% growth 80% growth 2% decay 90%

Steps for writing and solving Functions:

- Identify the type of function (Linear: $y = ax + b$ or Exponential: $y = ab^x$)
- If Exponential:
  - Determine a# - initial amount (start #)
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    - Exponential Growth: 1+rate (%)
    - Exponential Decay: 1 – rate (%)

a ½, 0.5 b

6. A tennis tournament has 128 competitors. Half of the competitors are eliminated each round. Write a function to represent the number of competitors that will be left after "x" rounds. Then determine how many players will be left after 5 rounds.

$128(1-0.5)^x = 128(0.5)^x$ $128(0.5)^5 = 4$ players

a

7. A three-bedroom house in Burbville was purchased for $190,000. If housing prices are expected to increase by 1.8% annually in that town, write a function that models the price of the house in t years. Find the price of the house in 6 years. ab^x

b

$1.8\% = 0.018$ $190,000(1+0.018)^x = 190,000(1.018)^x$

$190000(1.018)^6 \approx \$211,465.86$

grow Linear

8. Jonathan makes a weekly allowance of $25. He also makes $9.50 an hour at his job. Write a function for the amount of money he makes each week based on the amount of hours, h, he works. How much will he make if he works 25 hours?

~~$25(1+9.5)^x$~~ ~~25 – a, 9.5 – b~~

6

$y = 25 + 9.50h$

$25 + 9.50(25) = \$262.50$

EXPONENTIAL APPLICATION WORD PROBLEMS (DAY 4)

1. In 1995, there were 85 rabbits in Central Park. The population increased by 12% each year. How many rabbits were in Central Park in 2005?

2. There are 500 rabbits in Lancaster on February 1st. If the amount of rabbits triples every month, write a function that represents the number of rabbits in Lancaster after "m" months. How many rabbits are there in Lancaster on August 1st?

3. The value of an early American coin increases in value at the rate of 6.5% annually. If the purchase price of the coin this year is $1,950, what is the value to the nearest dollar in 15 years?

4. In 1985, there were 285 cell phone subscribers in the small town of Centerville. The number of subscribers increased by 75% per year after 1985. How many cell phone subscribers were in Centerville in 1994?

5. The cost of Bob's house in 2005 was $220,000. If his house appreciates in value at a rate of 3.5% every year, what will the price of his house be in 2015?

6. Kelli's mom takes a 400 mg dose of aspirin. Each hour, the amount of aspirin in a person's system decreases by about 29%. To the nearest tenth of a milligram, how much aspirin is left in her system after 6 hours?

7. Ryan bought a new computer for $2,100. The value of the computer decreases by 50% each year. After what year will the value drop below $300?

8. Malik bought a new car for $15,000. His best friend, Will, told him that the car's value will drop by 15% every year. What will the car's value be after 5 years, according to Will?

9. In the 2000-2001 school year, the average cost for one year at a four-year college was$16, 332, which was an increase of 5.2% from the previous year. If this trend were to continue, the equation $C(x) = 16,332(1.052)^x$ could be used to model the cost, $C(x)$, of a college education x years from 2000.

a) Find C(4). What does this number represent?

b) If this trend continues, how much would parents expect to pay for their new born baby's first year of college? (Assume the child would enter college in 18 years.)

10. In 1993, the population of New Zealand was 3,424,000, with an average annual growth rate of 1.3%. Suppose that this growth rate were to continue.

a) Express the population P as a function of n, the number of years after 1993.

b) Estimate New Zealand's population in the year 2010.

Practice

1. A population of 500 elk is released in a wildlife preserve. Each year, the population grows by 6.4%. Let x stand for the number of years since the release, and let y stand for the elk population.

a. Write an exponential equation that relates x and y, using the given information.

b. After 5 years, how many elk are there?

c. How many years will it take for the elk population to exceed 800 elk?

2. A store receives a shipment of 1000 greeting cards. Each day, the store sells 2.5% of its stock of cards. Let $x =$ # of days passed; $f(x) =$ # of cards remaining in the store.

a. Write an exponential equation that relates x and $f(x)$, using the given information.

b. After 15 days, how many cards will remain in the store?

c. The store manager wants to order a new shipment when the inventory reaches 200 cards. After how many days will this happen?

Project

Infectious Disease or Zombie Apocalypse

Homework

Exponential Functions
worksheet #1-6