Name: _____ Coordinate Algebra

Date: _____ LE.1: Linear vs. Exponential

Linear vs. Exponential Word Problems

At separate times in the course, you've learned about linear functions and exponential functions, and done word problems involving each type of function. Today's assignment combines those two types of problems. In each problem, you'll need to make a choice of whether to use a linear function or an exponential function. Below is some advice that will help you decide.

Linear Function	**Exponential Function**
$f(x) = mx + b$ or $f(x) = m(x - x_1) + y_1$	$f(x) = a \cdot b^x$
b is the *starting value*, m is the *rate* or the *slope*. m is positive for growth, negative for decay.	a is the *starting value*, b is the *base* or the *multiplier*. $b > 1$ for growth, $0 < b < 1$ for decay. See below for ways to find the base b.

Choosing linear vs. exponential

In growth and decay problems (that is, problems involving a quantity increasing or decreasing), here's how to decide whether to choose a linear function or an exponential function.

- If the growth or decay involves increasing or decreasing by a fixed number, use a **linear** function. The equation will look like:

$$y = mx + b$$

$$f(x) = (\textbf{rate})\, x + (\textbf{starting amount}).$$

- If the growth or decay is expressed using multiplication (including words like "doubling" or "halving") use an **exponential** function. The equation will look like:

$$f(x) = (\textbf{starting amount}) \cdot (\textbf{base})^x.$$

PRACTICE

1. Decide whether the word problem represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

a. "A library has 8000 books, and is adding 500 more books each year."

Linear or exponential? $y =$ 500x + 8000.

b. "A gym's customers must pay \$50 for a membership, plus \$3 for each time they use the gym."

Linear or exponential? $y =$ 3x + 50.

c. "A bank account starts with \$10. Every month, the amount of money in the account is tripled."

Linear or exponential? $y =$ $10(3)^x$.

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d. "At the start of a carnival, you have 50 ride tickets. Each time you ride the roller coaster, you have to pay 6 tickets."

Linear or exponential? $y =$ $-6x + 50$.

e. "There are 20,000 owls in the wild. Every decade, the number of owls is halved."

Linear or exponential? $y =$ $20000\left(\frac{1}{2}\right)^x$.

2. Decide whether the table represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

a.

x	0	1	2	3	4	5	6	7
y	2	5	8	11	14	17	20	23

+3 +3

Linear or exponential? $y =$ $3x + 2$.

b.

x	0	1	2	3	4	5	6	7
y	3	6	12	24	48	96	192	384

×2 ×2

Linear or exponential? $y =$ $3(2)^x$.

c.

x	0	1	2	3	4	5	6	7
y	10	5	2.5	1.25	.625	.3125	.15625	.078125

×½ ×½ ×½

Linear or exponential? $y =$ $10\left(\frac{1}{2}\right)^x$.

d.

x	0	1	2	3	4	5	6	7
y	12	8	4	0	-4	-8	-12	-16

−4 −4

Linear or exponential? $y =$ $-4x + 12$

e.

x	0	1	2	3	4	5	6	7
y	50	35	24.5	17.15	12.005	8.4035	5.88245	4.117715

×7/10 ×7/10

Linear or exponential? $y =$ $50\left(\frac{7}{10}\right)^x$

$50(.7)^x$

Harder:

$\frac{35}{50} = \frac{7}{10}$

$\frac{24.5}{35} = \frac{7}{10}$

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f.

x	0	1	2	3	4	5	6	7
y	40	35	30	25	20	15	10	5

-5

Linear or exponential? $y =$ $-5x+40$

g.

x	0	1	2	3	4	5	6	7
y	.4	.6	.9	1.35	2.025	3.0375	4.55625	6.834375

×1.5 ×1.5

× 1.5 or × $\frac{3}{2}$

Linear or exponential? $y =$ $.4(1.5)^x$

3. Without a calculator, make a table for $f(x) = \frac{1}{2}x + 8$.

x	$f(x) = \frac{1}{2}x + 8$
0	8
1	8.5
2	9
3	9.5
4	10
5	10.5
6	11

4. Without a calculator, make a table for $f(x) = 8 \cdot (\frac{1}{2})^x$. Express answers as fractions.

x	$f(x) = 8 \cdot (\frac{1}{2})^x$ in fractions
0	8
1	4
2	2
3	1
4	1/2
5	1/4
6	1/8

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5. A science experiment involves periodically measuring the number of mold cells present on a piece of bread. At the start of the experiment, there are 50 mold cells. Each time a periodic observation is made, the number of mold cells triples. For example, at observation #1, there are 150 mold cells.

a. Write a function formula equation ($y = \cdots$) for the number of mold cells present, where x stands for the observation number.

$y = 50(3)^x$

b. Fill in the missing outputs of this table.

x = observation number	0	1	2	3	4	5
y = mold cell count	50	150	450	1350	4050	12,150

c. Suppose that the mold begins to be visible as green coloration when the mold cell count exceeds 100,000. On which observation will this happen?

$100000 = 50(3)^x$

$x = 6 \rightarrow 36,450$

$x = 7 \rightarrow 109,350$

between the 6th & 7th observation

d. What will be the mold cell count on the 20th observation? When you find the answer on your calculator, it will be so large that it displays in scientific notation (E notation). Rewrite the answer as an ordinary big number.

174,339,220,050

6. Julie gets a pre-paid cell phone. Initially she has a $40.00 balance on the phone. Each minute of talking costs $0.15.

Let x stand for the amount of time in minutes that Julie has talked on the phone, and let $f(x)$ stand for the remaining dollar value of the phone.

a. Is $f(x)$ a linear function or an exponential function? Explain how you know.

answers will vary

b. Find a function formula equation $f(x) =$ $-.15x + 40$

c. Find the value of $f(0)$ and explain its meaning in terms of the cell phone.

40, initial price

d. Find the value of $f(100)$ and explain its meaning in terms of the cell phone.

25, balance after talking 100 mins.

e. Find the value of x that makes $f(x) = 10$, and explain its meaning in terms of the cell phone.

$-.15x + 40 = 10$ $x = 200$, $10 balance after talking 200 mins

f. Find the value of x that makes $f(x) = 0$, and explain its meaning in terms of the cell phone.

$-.15x + 40 = 0$

$x = 266.67$, $0 balance after 266 mins of talking