Geometry Lomac 2015-2016 **Date** 11/19 **due** 11/20 **Linear vs. Exponential 5.6L**

Name ________________________________ **Per**______

LO: I can describe how growth is different for linear and exponential models in tables, graphs, equations, and situations.

emath 6.8

☐ **DO NOW** On the back of this packet

☐ (1) **Linear vs Exponential Growth**

Linear and exponential functions share many characteristics. This is because they are based on two different, but similar, sets of principles.

LINEAR VERSUS EXPONENTIAL

Linear functions are based on **repeatedly adding** the same amount (the slope).

Exponential functions are based on **repeatedly multiplying** by the same amount (the base).

***Exercise* #1:** The two tables below represent a linear function and an exponential function. Which is which? Explain how you arrive at your answer.

TABLE 1

x	0	1	2	3	4
y	5	10	20	40	80

TABLE 2

x	0	1	2	3	4
y	8	11	14	17	20

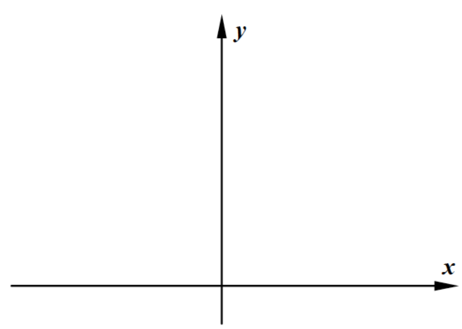
***Exercise* #2:** Find equations in standard form for each of the functions from *Exercise* #1.

(a) Table 1

(b) Table 2

It is interesting that linear and exponential functions are ones where two points on the curve will always determine the equation of the curve.

***Exercise* #3:** Consider the two points $(0,12)$ and $(1,3)$. Create a linear equation that passes through these points in $y = mx + b$ form and an exponential equation in $y = a(b)^x$ form that also passes through them. Then, using your calculator, graph both using a **WINDOW** of $-2 \le x \le 2$ and $-5 \le y \le 15$.



☐ (2) Linear vs Exponential Growth

Recall that linear functions have a constant **average rate of change (slope)**. That's, of course, why they have a constant amount added for every constant change in *x*. Let's examine the average rate of change for an increasing exponential.

***Exercise* #4:** The exponential function $f(x)=4(2)^x$ is shown partially in the table below. Find the average rate of change over the various intervals given. This should be relatively simple because $\Delta x=1$.

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

(a) $0 \le x \le 1$

(b) $1 \le x \le 2$

(c) $2 \le x \le 3$

(d) $3 \le x \le 4$

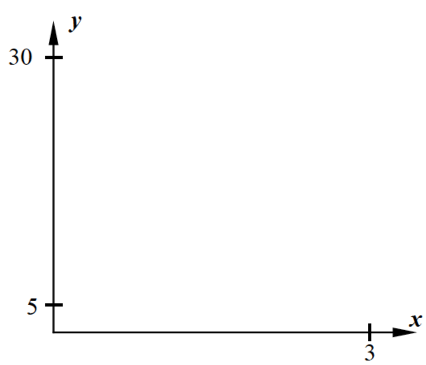
(e) What is clearly happening to the average rate of change as *x* gets larger?

☐ (3) Linear vs Exponential Growth

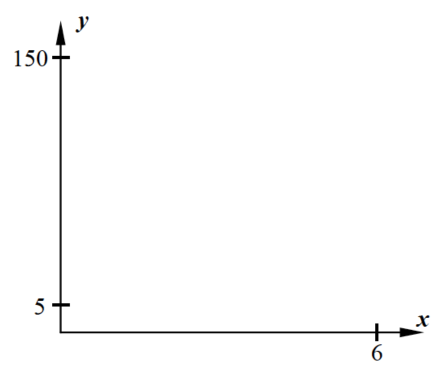
The fact that the **slope** of an **increasing exponential** is **always increasing** has an interesting consequence.

***Exercise* #5:** Consider the linear function $y=20x+5$ and the exponential function $y=5(2)^x$. Both of these functions have a *y*-intercept of 5, so "start" in the same location.

(a) Using your calculator, sketch these two curves on the axes below for the indicated window. Label each with its equation.



(b) Again, using your calculator, sketch these two curves on the axes below for the indicated window. Label each with its equation.



(c) Although the line appears to rise more quickly than the exponential, at first, the exponential eventually catches up and surpasses the linear. Why will an **increasing exponential function** always catch up with an **increasing linear function**?

☐ (4) Linear vs Exponential Growth

APPLICATIONS

3. Wildlife biologists are tracking the population of albino deer in an upstate New York forest preserve. They record the population every year since 2005, which they consider to be $t=0$. Their data is shown in the table below.

Year	2005	2006	2007	2008	2009	2010
t	0	1	2	3	4	5
Population	86	98	111	128	147	168

(a) Although neither a linear nor an exponential function would model this data perfectly, justify why an exponential function would be a much better fit. Specifically, explain both why a linear function would *not* be a good fit while an exponential would be reasonable.

(b) Determine an equation for an exponential that models this data set in the form $P=a(b)^t$.

(c) Use your model to predict the population of deer in the year 2014.

☐ (5) Exponential Models of Percent Growth

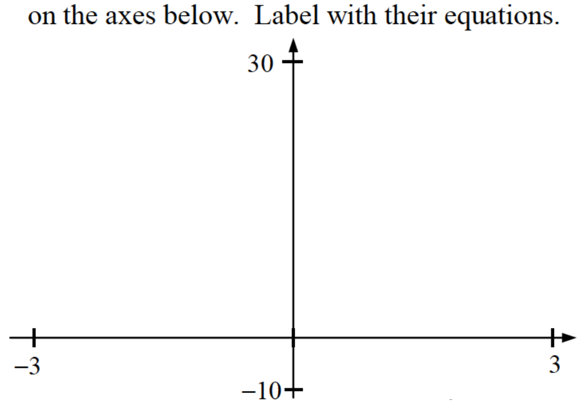
REASONING

4. You can determine the equation of a line or the equation of an exponential given any two points that lie on these curves. In this exercise we will pick two special points. Consider the points $(0,5)$ and $(1,15)$.

(a) Write the equation of the line that passes between these two points in $y=mx+b$ form.

(b) Write the equation of the exponential that passes between these two points in $y=a(b)^x$ form.

(c) Using your calculator, sketch the two curves on the axes below. Label with their equations.



LESSON SUMMARY

Linear Function	Exponential Function
$f(x) = mx + b$	$f(x) = a \cdot b^x$
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 *growth rate*. $b > 1$ for growth, $0 < b < 1$ for decay.
If the growth or decay involves increasing or decreasing by a fixed number (constant difference), use a **linear** function	If the growth or decay is expressed using multiplication (including words like “doubling” or “halving”) use an **exponential** function.

☐ (6) **Exit Ticket**

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☐ (7) **Homework**
cont.

FLUENCY

1. For each of the following problems a table of values is given where $\Delta x = 1$. For each, first determine if the table represents a linear function, of the form $y = mx + b$, or an exponential function, of the form $y = a(b)^x$. Then, write its equation.

(a)

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

Type: ______________________________

Equation: ___________________________

(b)

x	0	1	2	3	4
y	2	6	18	54	162

Type: ______________________________

Equation: ___________________________

(c)

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

Type: ______________________________

Equation: ___________________________

(d)

x	-2	-1	0	1	2
y	32	16	0	-16	-32

Type: ______________________________

Equation: ___________________________

(e)

x	0	1	2	3	4
y	16	20	25	$31\frac{1}{4}$	$39\frac{1}{16}$

Type: ______________________________

Equation: ___________________________

(f)

x	0	1	2	3	4
y	180	160	140	120	100

Type: ______________________________

Equation: ___________________________

2. The data shown in the table below represents either a linear or an exponential function. Which of the equations below best models this data set?

(1) $y = 5(2)^x$ $\qquad$ $y = 2x + 10$

(2) $y = 10(2)^x$ $\qquad$ (4) $y = 10x + 5$

x	1	2	3	4
y	10	20	40	80

Exit Ticket **Name**_______________________________ **Date** ______ _____ **Per**_ _____ **5.6L**

The LO (Learning Outcomes) are written below your name on the front of this packet. Demonstrate your achievement of these outcomes by doing the following:

(1) For each problem below, decide whether the word problem represents a linear or exponential function. Circle either linear or exponential. Then, write the function formula.

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

Linear or exponential?

f(x) =

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

Linear or exponential?

f(x) =

DO NOW Name_________________________________ Date ___________ Per______ 5.6L

(1) Translation to algebra progress. Write one or more algebraic statement(s) to represent this situation. Be sure to write at least one “Let” statement to define any variables.

A radio station is giving away tickets to a play. They plan to give away tickets for seats that cost \$10 and \$20. They want to give away at least 20 tickets. The total cost of all the tickets they give away can be no more than \$280.