Name: ______________________________________ Date: ___________________

ANOTHER LOOK AT LINEAR AND EXPONENTIAL MODELS
COMMON CORE ALGEBRA I

In this lesson we will be looking at linear and exponential models again and trying to understand when it makes more sense to use one, rather than the other.

***Exercise* #1:** A tank is being filled up with water. At $t = 0$, we know that the tank holds 150 gallons of water, and after one hour ($t = 1$), it holds 180 gallons of water.

(a) Assuming that the volume of water in the tank, *V*, is a linear function of time, *t*, in hours, find a formula for *V*.

(b) By what percent did the volume of water increase from $t = 0$ to $t = 1$?

(c) Based on (b), write an exponential function for *V* as a function of the time, *t*, that it has been filling.

(d) After the tank has been filling for 10 hours, the volume is now at 500 gallons. Which model, the linear or exponential, better fits this data point?

It is good to be able to look at a variety of different forms of functions and determine what type of function best fits the information. Let's take a look at that in the next exercise.

***Exercise* #2:** The area, *A*, of an oil spill is increasing and scientists are trying to model it as a function of time so that they can predict when it reaches certain critical sizes. They measure the data and find the following.

t (days)	0	1	2	3	4
A (square miles)	3.5	4.4	5.5	6.8	8.5

(a) Explain why a linear function would not fit this data well.

(b) An exponential function of the form $A = a(b)^t$ does model this data well. Select which of the following would be the most appropriate values for *a* and *b*:

a: 2.6 3.5 6.4 8.5

b: 0.92 1.18 1.25 1.48

We want to be very sure that we understand the various constants or **parameters** that come up in linear and exponential functions. Because these parameters **always** have a meaning in a physical situation.

***Exercise* #3:** Two scenarios are modeled using in (a) a linear function and in (b) an exponential function. In each case interpret the parameters that help define the functions.

(a) Plant managers at a local tire factory model the cost, *c*, in dollars of producing *n*-tires in a day by the equation:

$$c(n)=6.50n+1,245$$

Interpret the parameter values of 6.50 and 1,245. Include units in your answer.

(b) Biologists model the population, *p*, of lactic acid bacteria in yogurt as a function of the number of minutes, *m*, since they added the bacteria using the equation:

$$p(m)=135(1.28)^m$$

Interpret the parameter values of 135 and 1.28. Include units in your answer.

We can also work with approximate models based on **regression work** with **bivariate data sets**.

***Exercise* #4:** The rate that soil can absorb water during a rain storm decreases over time as the rain continues. The table below gives the rate *y*, in inches per hour, that water can be absorbed as a function of the number of hours that rain has been falling, *x*.

x (hours)	0	1	3	5	6	10
y (inches/hour)	12.3	9.4	5.9	3.5	2.7	1.1

(a) Find the linear correlation coefficient for this data set? Round to the nearest thousandth. Why is it negative? Does this indicate a strong negative correlation or a weak negative correlation? Explain.

(b) Produce a rough sketch of the residual plot for this data set based on (a). Does the residual plot indicate that a linear model is appropriate? Explain.

(c) Find the exponential regression equation for this data set. Round both parameters to the nearest hundredth.

(d) Produce a rough sketch of the residual plot for this data set based on (c). Does this plot indicate a more appropriate model?

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ANOTHER LOOK AT LINEAR AND EXPONENTIAL MODELS
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APPLICATIONS

1. For each of the following modeling scenarios, determine the equation asked for.

(a) Nate is driving away from Albany at a constant rate of 62 miles per hour. If he starts 22 miles from Albany at $t = 0$, determine an equation for Nate's distance, D, from Albany after t-hours.

(b) A bacteria culture is doubling in size every day. If the bacteria culture starts at 5,200, write an equation for its population size, p, as a function of the number of days, d, since it started.

2. The population of Arlington High School grew quickly at the turn of the millennium. The table below shows the population in 2000, 2001, and 2010.

Year	2000	2001	2010
t	0	1	10
Population	2600	2704	3610

(a) Based on the first two years, write a linear equation for the population, P, of Arlington High School t-years after the year 2000.

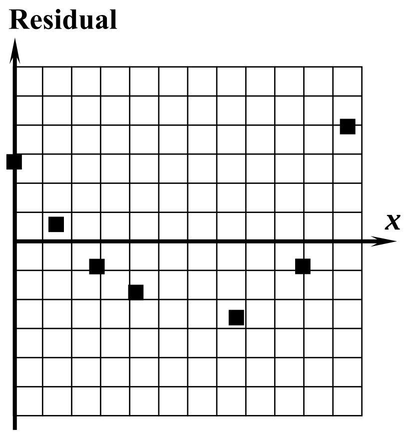
(b) Based on the first two years, write an exponential equation for the population, P, of Arlington High School t-years after the year 2000.

(c) Based on the population of Arlington in 2010, which model seems to be a better fit for the population trend? Justify your choice.

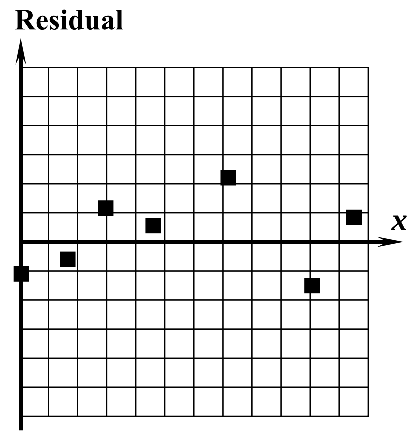
3. eMathInstruction is keeping track of the number of views on a newly released math lesson screencast. They record the total number of views as a function of the number of days since it launched, with the launch day being $x = 0$.

Days, x	0	3	5	8	13	17	20
Views, y	56	92	130	212	486	920	1,530

(a) The residual graph for the line of best fit is shown below. Indicate whether this statistic indicates that a linear function is appropriate to model the data.



(b) The residual graph created when doing an exponential fit for this data is shown below. Does this statistic indicate a better or worse fit than the linear model from (a)? Explain.



4. The regression equations for the two types of models were found using the data from Problem #3. They are as follows:

Linear:

$y = 68x - 157$

Exponential:

$y = 56(1.18)^x$

(a) How can you interpret the parameter 68 in the linear model in terms of the views of the website?

(b) How do you interpret the parameter 1.18 in the exponential model in terms of the views of the website?

(c) Why is the interpretation of the -157 in the linear model unreasonable or nonviable?