Lesson Title: Exponential Growth Date:___________________

Subject: Algebra I or Algebra II **Grade:** 8 - 11	**Topic:** Exponential Functions **Designer:** Jessica Ulcickas

Stage 1 – Desired Results

Lesson Overview: This activity teaches students about exponential growth in real life situations. The activity walks students through identifying various exponential growth equations for situations involving compound interest and population growth. By the end of the activity, students will have had exposure to three different types of exponential growth equations: the general exponential growth equation, the compound interest equation, and the equation for continuously compounded interest. When the activity is completed, students will be able to identify the equation for various exponential growth situations and read and identify important pieces of the graphs of exponential functions.

Standards Addressed:

CCSS.MATH.CONTENT.HSF.IF.C.7.E
Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

CCSS.MATH.CONTENT.HSF.IF.C.8.B
Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)12^t$, $y = (1.2)^t/10$, and classify them as representing exponential growth or decay.

CCSS.Math.Content.HSF-BF.B.3 Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

Enduring Understanding:	**Essential Questions**:
Exponential growth functions can be used to model various everyday life situations. One use of exponential growth models is to model population growth. The population growth model used the equation $A = P(1 + r)^t$, where A is the final population, P is the initial population, r is the growth rate written in decimal form, and t is the amount of time passed. Exponential growth can also model the growth of money based on compound	What types of situations can be modeled using exponential growth? How can you use graphs of exponential functions to predict information about the future? Why when using exponential functions is the y-intercept so important?

interest. There are two formulas for compound interest. The first formula for compound interest is the general formula: $A = P\left(1 + \frac{r}{n}\right)^{nt}$. In this formula, n stands for the number of times the interest is compounded in a given year. The second formula is the continuously compounded interest formula: $A = Pe^{rt}$, where e is the number 2.71828… These formulas can all be used to identify important information about a given situation. For example, how long will it take the money in my savings account to double just based on interest?	
Students will need to know: Students will need to have basic knowledge of functions and what their graphical representations are. Students should also be familiar with function transformations and how the graphical representation of a function changes when the equation is changed. Students should also be familiarized with the formulas $A = P(1 + r)^t, A = P\left(1 + \frac{r}{n}\right)^{nt}$, and $A = Pe^{rt}$. Students should already be familiar with the number e.	**Students will be able to**: • Identify the mathematical model to be used given a specific exponential growth situation. • Identify how much money someone will have at a given time using graphs of compound interest functions. • Identify how long it will take someone to have a certain amount of money using graphs of compound interest functions. • Identify the predicted population at a given time using graphs of population growth functions. • Identify how long it will take a population to reach a certain number using graphs of population growth functions.
Stage 2 – Assessment Evidence	
Performance Tasks: In this activity: • Asking students to identify the mathematical model to be used given a specific exponential growth situation. • Asking students to identify how much money someone will have at a given time using graphs of compound interest functions. • Asking students to identify how long it will take someone to have a certain	**Other Evidence**: • To be decided by the teacher.

<table>
<tr><td>amount of money using graphs of compound interest functions.
• Asking students to identify the predicted population at a given time using graphs of population growth functions.
• Asking students to identify how long it will take a population to reach a certain number using graphs of population growth functions.</td><td></td></tr>
<tr><td colspan="2" align="center">Stage 3 – Learning Plan</td></tr>
<tr><td>Lesson Procedure:

<u>Many Days Before</u>:

Students will be introduced to the topic of exponential functions and their graphs. Students will also be introduced to the number e, the topic of compound interest, and the three exponential growth formulas ($A = P(1+r)^t, A = P\left(1+\frac{r}{n}\right)^{nt}$, and $A = Pe^{rt}$.)

<u>Day Of</u>:
Students will go to the computer lab in order to complete this activity. For the duration of the activity, the teacher will monitor student progress to ensure that students complete the activity properly and do not simply click to complete. It is recommended that students take notes during the activity to help with their enduring understanding of the topic. The activity will not take all class period, so the remainder of the class period will be at the discretion of the classroom teacher.</td><td>Required Materials:

• Computers for each student.
• Notebooks for each student.</td></tr>
<tr><td>Possible Discussion Questions for Students:

• What types of practical uses do you think exponential decay functions may have?

• You identified how long it takes money</td><td>Sample Answers to Discussion Questions:

• Answers may vary. Sample answers: radioactive decay, car value deprecation, etc…

• No, the doubling time will be the same</td></tr>
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to double given a certain situation. Does this time change if you change the initial amount of money you put in an account? • What is the best way to increase the amount of money you make in account: increasing the number of times you compound your money in a given year, increasing the amount of money you initial put in to your account, or increasing the amount of time you leave money in an account for? Does this make sense to do realistically?	no matter how much money you start with in your account. • Answers may vary. Sample answer: The best way is to put more money into the account initially. Then interest will also grow based on the extra money. However it is not always realistic to think that you will have extra money to leave in an account for an extended period of time.