Anoka-Hennepin Secondary Curriculum Unit Plan

Department:	Mathematics	Course:	Intermediate Algebra	Unit 3 Title:	Exponential Functions	Grade Level(s):	9
Assessed Trimester:	Trimester A	Pacing:	7-8 Days	Date Created:	6/13/2013	Last Revision Date:	7/26/2014

Course Understandings: *Students will understand that:*

A. Relationships exist between real-world situations, mathematical equations, inequalities and graphs for linear, exponential, absolute value, radical, and polynomial functions.
B. Equations and inequalities can be categorized by form and that each form has specific processes to consider when solving and graphing.
E. The context of a problem is important in recognizing the reasonableness of a solution.
F. There are benefits and limitations in the use of calculators and other technology to solve mathematical situations.

DESIRED RESULTS (Stage 1) - WHAT WE WANT STUDENT TO KNOW AND BE ABLE TO DO?

Established Goals

Minnesota State/Local/Technology Standard(s) addressed (2007):

- **Standard (9.2.1.# - Modified):** Identify important features of exponential functions and other relations using symbolic, tabular and graphical methods where appropriate.
  Benchmark:
  9.2.1.3 Find the domain of a function defined symbolically, graphically or in a real-world context.
  9.2.1.6 Identify intercepts, zeros, maxima, minima and intervals of increase and decrease from the graph of a function.
  9.2.1.7 Understand the concept of an asymptote and identify asymptotes for exponential functions and reciprocals of linear functions, using symbolic and graphical methods.

- **Standard (9.2.2.# - Modified):** Recognize linear, exponential and other common functions in real-world and mathematical situations; represent these functions with tables, verbal descriptions, symbols and graphs; solve problems involving these functions, and explain results in the original context.
  Benchmark:
  9.2.2.2 Represent and solve problems in various contexts using exponential functions, such as investment growth, depreciation and population growth.
  9.2.2.3 Sketch graphs of linear, quadratic and exponential functions, and translate between graphs, tables and symbolic representations. Know how to use graphing technology to graph these functions.

- **Standard (9.2.4.# - Modified):** Represent real-world and mathematical situations using equations involving linear and exponential functions. Solve equations symbolically and graphically. Interpret solutions in the original context.
  Benchmark:
  9.2.4.2 Represent relationships in various contexts using equations involving exponential functions; solve these equations graphically or numerically. Know how to use calculators, graphing utilities or other technology to solve these equations.

Transfer

Students will be able to independently use their learning to: (product, high order reasoning)

- Analyze real world situations using the features of linear and exponential functions.

Meaning

Unit Understanding(s):	Essential Question(s):
Students will understand that: ● Rate of change can be used to discuss the difference between linear and exponential functions. ● Significant features of exponential graphs can be used to analyze real world situations and solve real world problems.	**Students will keep considering:** ● What characterizes exponential growth and decay? ● What are real world models of exponential growth and decay? ● How can one differentiate an exponential model from a linear model given a real world set of data? ● How do the skills and knowledge that we are learning influence the task of making decisions and understanding situations that can be modeled by linear and exponential functions?

Acquisition

Knowledge - Students will:

- Understand the definition of an exponential function and the vocabulary of the significant features of a graph.
- Understand the definition of a domain and range.

Reasoning - Students will:

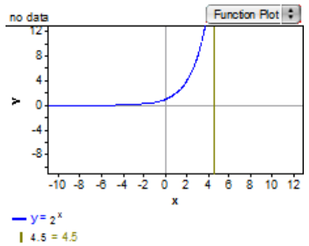
- Understand how real world situations relate to the significant features of a graph or table.
- Understand that certain functions have a restricted domain and/or range.
- Distinguish between linear and exponential functions given tables, graphs or symbols.
- Analyze graphs, tables and real life situations to identify and explain the domain.
- Interpret meaning of the graph in the context of the problems.
- Understand how rate of change differs between linear and exponential functions and how it relates to real world situations.

Skills - Students will:

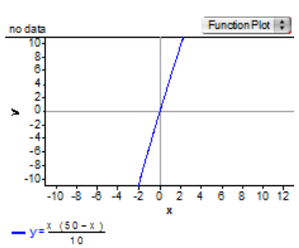
- Use tables and graphs to solve exponential equations, including real world situations, and translate between representations.
- Evaluate exponential functions in the form $y=ab^x$
- Identify the significant features of an exponential graph.
- Differentiate between linear and exponential representations.
- Identify significant features of a function represented as a graph, table or real-world situation (intercepts, rate of change, maximums and minimums, intervals of increase and decrease and asymptotes appropriate to the function).

Common Misunderstandings

- Students confuse the meaning of exponents and incorrectly calculate the value of exponential expressions (e.g., $2^{-3} = -8$, $2^0 = 0$, or $9^{1/2} = 4.5$)
- Students incorrectly state that graphs of exponential functions have vertical asymptotes.



- Students use end behaviors of a function within a specific graphing window to represent the maximum or minimum values of the function.
- Students may struggle with the concept of asymptotes, including what features of an equation lead to an asymptote in the graph of the function. Students may not realize the effect of the graphing window in viewing asymptotes.
- Students will incorrectly state that the maximum value of the function $y = -3(x - 11)^2 + 7$ is 11. Students confuse which variable, the independent or dependent, is being maximized or minimized and which variable determines where this occurs.
- Students incorrectly identify the features of a function based on limited information. For example, a student might incorrectly explain that the graph of the function $y = \frac{1}{10}x\,(50 - x)$ is a linear function because when the function is entered into a graphing calculator using the default settings the graph looks like a line.



Essential new vocabulary

- Exponential decay
- Exponential growth
- Exponential functions

- Students sometimes only focus on the additive rate of change of the dependent variable to determine the rate of change of a function.
- Students often struggle to create a mathematical model for a real-world situation.

table	students say	students should say
x | *0* | *1* | *2* | *31* **y** | 3 | 3 | 7 | 9	"The slope is two since the values in the y-column are going up by two."	This response is correct but the rate of change of a function relies on coordinating the change in both variables. A statement that highlights this coordination would be: "The values of the *y*-variable are increasing by two for each change of one in the *x*-variable.
x | *0* | *5* | *10* | *15* ***y*** | 7 | 10 | 13 | 16	"The relationship is linear and it has a slope of three."	"The relationship is linear and the value of the *y*-variable increases by three for every increase of five of the *x*-variable. The rate of change is three-fifths."
x | *0* | *3* | *-2* | *11* ***y*** | 3 | 9 | -1 | 25	"This relationship is not linear since the rate of change in the y-variable is not constant."	"The relationship is linear with a rate of change of two." The correct rate of change could be determined symbolically using pairs of points. Some students may find the rate of change by making a graph.
x | *0* | *1* | *4* | *9* ***y*** | 10 | 15 | 20 | 25	"This relationship is linear because the *y*-variable goes up by 5 each time."	"The relationship is not linear." If you look at the graph of the function it looks like a curve. My guess is that the function is a translation of a square root function. I used my calculator to guess and check and came up with $f(x) = 5\sqrt{x} + 10$.