Objectives for Exponential and Logarithmic Functions Activity

* Build models using exponential functions and logarithmic functions
* Analyze models using characteristics of exponential and logarithmic functions

1. You place $1000 into an account paying a nominal rate of 5.5% compounded quarterly (4 times per year).
   1. Find an equation for the balance *B*, after *t* years.
   2. What is the **annual** **growth rate** (to four decimal places).
   3. How much money will be in the account after 10 years?
   4. How long will it take for the amount of money to double (round your answer to two decimal places)?
2. Find a formula for an exponential function, *f*, with *f*(1) = 10 and *f*(3) = 14.4. Do this problem algebraically and check your answer using regression. Write your exponential function in both forms (i.e.  and )
3. The half-life of carbon-14 is approximately 5728 years. If a fossil is found with 20% of its initial amount of carbon-14 remaining, how old is it?
4. A population of bacteria decays at a continuous rate of 10% per hour.
   1. What is the half-life of these bacteria?
   2. If the population starts out with 100,000 bacteria, create a function to represent the number of bacteria, *N*, after *t* hours.
   3. Use your function found in part b. to find out how many bacteria would remain after 1 day (24 hours).
   4. What is the decay rate of the bacteria (i.e. by what percentage does the bacteria decrease each hour)?
5. A population of bacteria is measured to be at 1,000 after 10 minutes since it appeared. 25 minutes after it appeared, it is measured to be 10,000.
   1. What is the initial size of the population?
   2. What is the doubling time of the population?
   3. When will the population reach 1,000,000?
6. The population of a town is given by the following table:

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
| Population in thousands | 100 | 108 | 117 | 127 | 138 | 149 | 162 | 175 | 190 | 205 |

* 1. Use your calculator to find an exponential model to fit the data.
  2. What is the annual growth rate of the city? What is the continuous growth rate?
  3. What is the doubling time of the city?
  4. According to the model, when will the population of the city be 1,000,000?

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| **Historical U.S. Population Growth** by year 1966-1998   |  |  | | --- | --- | | **Date** | **National Population**  The table to the left gives the US population between 1966 and 1998.   1. Find an exponential model to fit this data. 2. According to your model, what should the US population have been on July 1, 2011? 3. In July of 2011, the US census buereau estimated the population at 313,232,044 (from http://www.indexmundi.com/united\_states/population.html) . According to the model from part a, when should the US population have reached 313,232,044? To what do you attribute the difference in your answers? | | July 1, 1998 | 270,298,524 | | July 1, 1997 | 267,743,595 | | July 1, 1996 | 265,189,794 | | July 1, 1995 | 262,764,948 | | July 1, 1994 | 260,289,237 | | July 1, 1993 | 257,746,103 | | July 1, 1992 | 254,994,517 | | July 1, 1991 | 252,127,402 | | July 1, 1990 | 249,438,712 | | July 1, 1989 | 246,819,230 | | July 1, 1988 | 244,498,982 | | July 1, 1987 | 242,288,918 | | July 1, 1986 | 240,132,887 | | July 1, 1985 | 237,923,795 | | July 1, 1984 | 235,824,902 | | July 1, 1983 | 233,791,994 | | July 1, 1982 | 231,664,458 | | July 1, 1981 | 229,465,714 | | July 1, 1980 | 227,224,681 | | July 1, 1979 | 225,055,487 | | July 1, 1978 | 222,584,545 | | July 1, 1977 | 220,239,425 | | July 1, 1976 | 218,035,164 | | July 1, 1975 | 215,973,199 | | July 1, 1974 | 213,853,928 | | July 1, 1973 | 211,908,788 | | July 1, 1972 | 209,896,021 | | July 1, 1971 | 207,660,677 | | July 1, 1970 | 205,052,174 | | July 1, 1969 | 202,676,946 | | July 1, 1968 | 200,706,052 | | July 1, 1967 | 198,712,056 | | July 1, 1966 | 196,560,338 | |

Table from <http://www.npg.org/facts/us_historical_pops.htm>

8. Using the population clock (<http://www.census.gov/main/www/popclock.html>) record the population for the US and the World at 4-5 intervals (say every half hour). Use this data to build exponential functions to model the US and World Population. Then use the models to predict what the population will be at the start of class next week.