Growth and Decay

1. A bacteria culture contains 1500 bacteria initially and doubles every hour.
   (a) Find a function that models the number of bacteria after *t* hours.
   (b) Find the number of bacteria after 24 hours.

2. A certain breed of mouse was introduced onto a small island with an initial population of 320 mice, and scientists estimate that the mouse population is doubling every year.
   (a) Find a function that models the number of mice after *t* years.
   (b) Estimate the mouse population after 8 years.

3. A 15-g sample of radioactive iodine decays in such a way that the mass remaining after *t* days is given by $m(t) = 15e^{-0.087t}$, where $m(t)$ is measured in grams. After how many days is there only 5 g remaining?

4. A grey squirrel population was introduced in a certain county of Great Britain 30 years ago. Biologists observe that the population doubles every 6 years, and now the population is 100,000.
   (a) What was the initial size of the squirrel population?
   (b) Estimate the squirrel population 10 years from now.

5. A certain species of bird was introduced in a certain county 25 years ago. Biologists observe that the population doubles every 10 years, and now the population is 13,000.
   (a) What was the initial size of the bird population?
   (b) Estimate the bird population 5 years from now.

6. The fox population in a certain region has a relative growth rate of 8% per year. It is estimated that the population in 2005 was 18,000.
   (a) Find a function that models the population t years after 2005.
   (b) Use the function from part (a) to estimate the fox population in the year 2013.

7. The population of a certain species of fish has a relative growth rate of 1.2% per year. It is estimated that the population in 2000 was 12 million.
   (a) Find an exponential model for the population *t* years after 2000.
   (b) Estimate the fish population in the year 2005.

8. The bat population in a certain Midwestern county was 350,000 in 2009, and the observed doubling time for the population is 25 years.
   (a) Find an exponential model for the population *t* years after 2006.
   (b) Estimate when the population will reach 2 million.

9. A culture starts with 8600 bacteria. After one hour the count is 10,000.
   (a) Find a function that models the number of bacteria after *t* hours.
   (b) Find the number of bacteria after 2 hours.
   (c) After how many hours will the number of bacteria double?

10. The count in a culture of bacteria was 400 after 2 hours and 25,600 after 6 hours.
    (a) What is the relative rate of growth of the bacteria population? Express your answer as a percentage.
    (b) What was the initial size of the culture?
    (c) Find a function that models the number of bacteria after *t* hours.
    (d) Find the number of bacteria after 4.5 hours.
    (e) When will the number of bacteria be 50,000?

11. The population of California was 29.76 million in 1990 and 33.87 million in 2000. Assume that the population grows exponentially.
    (a) Find a function that models the population t years after 1990.
    (b) Find the time required for the population to double.
    (c) Use the function from part (a) to predict the population of California in the year 2010..

Another Logistic Problem:

12. A small lake is stocked with a certain species of fish. The fish population is modeled by the function

$$P = \frac{10}{1 + 4e^{-0.8t}}$$

where P is the number of fish in thousands and t is measured in years since the lake was stocked.
    (a) Find the fish population after 3 years.
    (b) After how many years will the fish population reach 5000 fish?

Answers:

1. a. $y = 1500e^{(\ln 2)t}$
   b. 25,165,824,000
2. a. $y = 320e^{(\ln 2)t}$
   b. 81,920 mice
3. $y = 15e^{-0.087t}$, so t = 12.628 days
4. a. 3125
   b. 317,480
5. a. 2298
   b. 18,384
6. a. $y = 18{,}000e^{(\ln 1.08)t}$
   b. 33,316.744
7. a. $y = 12e^{(\ln 1.012)t}$
   b. 12,737,489 fish
8. a. $y = 322{,}065.678e^{0.0277t}$
   b. 65.864 years
9. a. $y = 8600e^{0.1508t}$
   b. 11627
   c. 4.596 hours
10. a. 104%
    b. 50
    c. $y = 50e^{1.04t}$
    d. 5388.5
    e. 6.64 hours
11. a. $y = 29.76e^{0.012936t}$
    b. 53.58 years
    c. 38.55 million
12. a. 7337
    b. 1.73 years