

Exponential Growth Problems

Remember! The exponential growth model is $n = a(1+r)^t$ where a is the initial amount, r is the rate (change percent to decimal) and t is the time. If the rate is giving per year, t should be in years. If the rate is given per hour, t should be in hours and so forth.

Frogs

- 1) A population of 100 frogs increases at an annual rate of 22%. How many frogs will there be in 5 years? Write your model!

$$y = 100(1 + .22)^5 \approx 270 \text{ frogs}$$

Using this same model for the exponential growth of the frogs, what will be the frog population in

a) 10 years $y = 100(1 + .22)^{10} \approx 730 \text{ Frogs}$

b) 25 years $y = 100(1 + .22)^{25} \approx 14,421 \text{ Frogs}$

- 2) A type of bacteria has a very high exponential growth rate at 80% every hour. If there are 10 bacteria, determine how many there will be in 5 hours, 1 day, and 1 week? Write your model!

a) 5 hours $y = 10(1 + .8)^5 \approx 189$

b) 1 day $y = 10(1 + .8)^{24} \approx 13,382,588$

c) 1 week $y = 10(1 + .8)^{(24 \times 7)} \approx 7.69 \times 10^{43}$

- 3) A species of extremely rare, deep water fish has an extremely rarely have children. If there are a 821 of this type of fish and their growth rate is 2% each month, how many will there be in half of a year, in 10 years and 100 years? Write your model!

a) Half a year (6 months) $y = 821(1 + .02)^6 \approx 924.6$

b) 1 year (12 months) $y = 821(1 + .02)^{12} \approx 1041.2$

c) 10 year $y = 821(1 + .02)^{120} \approx 8838.2$

$$y = 3,381,000 (1 + 0.018)^6$$

- 4) MULTIPLE CHOICE The population of Henderson City was 3,381,000 in 1994, and is growing at an annual rate of 1.8%. If this growth continues, what will the approximate population of Henderson City be in the year 2000.

a) 3,696,000 b) 3,798,000 c) 3,763,000 d) 3,831,000

- 5) MULTIPLE CHOICE A culture of bacteria contained 3,842,700 cells on one day and is growing at a daily rate of 6.8%. How many cells would be present 4 days later?

a) 4,999,442 b) 5,043,878 c) 5,339,404 d) 15,370,800

$$y = 3,842,700 (1 + 0.068)^4$$

6. Find a bank account balance if the account starts with \$100, has an annual rate of 4%, and the money left in the account for 12 years. Write your model!

$$y = 100 (1 + 0.04)^{12} \approx \$160.10$$

7. In 1985, there were 285 cell phone subscribers in the small town of Centerville. The number of subscribers increased by 75% per year after 1985. How many cell phone subscribers were in Centerville in 1994? Write your model!

$$y = 285 (1 + 0.75)^9 \approx 43,872$$

8. The population of Winnemucca, Nevada, can be modeled by $P = 6191(1.04)^t$, where t is the number of years since 1990. What was the population in 1990? By what percent did the population increase by each year? Write your model!

6191 (it's the "a" value)

the population increased by 4% each year

9. You have inherited land that was purchased for \$30,000 in 1960. The value of the land increased by approximately 5% per year. What is the approximate value of the land in the year 2011? Write your model!

$$y = 30,000 (1 + 0.05)^{51}$$

$$y \approx \$361,223.09$$

10. The equation $y = 2(1.162)^t$ models the growth of bacteria in a petri dish after t hours.

- A. How many bacteria are in the dish at the beginning of the experiment? 2
- B. What is the growth rate of the bacteria per hour? .162 or 16.2%
- C. How many bacteria will be present after 12 hours? ≈ 12
- D. How many bacteria will be present after 3 days? $\approx 99,054$

$$t = 3 \cdot 24 = 72$$

Modeling Exponential Growth Functions

Exponential growth can be modeled by the formula $y = a(1+r)^t$ where t is time

y = the final amount amount (also called balance)
 a = the start amount amount (also called principle)
 r = the interest/growth rate (must be written as a decimal)
 t = the time (typically in years, but depends on the problem)

Write a model and solve. Round answers appropriately.

EX 1: You deposit \$1500 into an account that pays 6.2% interest. What will the balance be after 5 years? After 10 years?

$a = 1500$ $r = .062$ *divide by 100*
 $y = 1500(1 + .062)^5 = \$2026.35$ *find y*
 $y = 1500(1 + .062)^{10} = \2737.39

EX 2: Eight students returned to school today with the flu virus. If the virus is expect to spread at a rate of 11% each day, how many students will be affected after one week? After 10 days?

per day
 $y = a(1+r)^t$
 $y = 8(1 + .11)^7 \approx 16 \text{ or } 17 \text{ students}$ *7 ← there are 7 days in one week!*
 $y = 8(1 + .11)^{10} \approx 22 \text{ or } 23$ $\frac{11}{100} = .11$

EX 3: Your grandparents purchased an acre of land in 1960 which has appreciated at a rate of 4.5% each year. What is the land worth today? they purchased for \$10,000

$y = 10,000(1 + .045)^{57} \approx \$122,921.70$ $r = .045$
 $\frac{2017}{-1960} = 57$

EX 4: How much would you need to deposit into an account that pays 6.25% annual interest in order to have saved \$10,000 by the year 2020?

\uparrow this is y. \uparrow you must find a
 $a = \$8337.06$ $\frac{10,000}{(1 + .0625)^3} = a$

EX 5: The equation $y = 6800(1.065)^t$ models the value of a piece of property since its purchase price in 1979.

- A. What was the purchase price? $\$6800$ *simplified*
 B. What is the rate of appreciation? $.065$ \uparrow starting price
 C. What is the value of the property today? $\frac{.065 \times 100}{6.5\%}$
- $y = 6800(1.065)^{38} = \$74,437.88$

EX 6: Today it was announced that 70 Emory University students were diagnosed with a serious intestinal virus. If the virus is spreading at a rate of 28% each day, approximately how many days would it take before the entire student population of 14,500 was sickened? (use the tables feature of your graphing calculator to estimate)

$y = 70(1 + .28)^t$

