

Applications

- In parts of the United States, wolves are being reintroduced to wilderness areas where they had become extinct. Suppose 20 wolves are released in northern Michigan, and the yearly growth factor for this population is expected to be 1.2.
 - Make a table showing the projected number of wolves at the end of each of the first 6 years.
 - Write an equation that models the growth of the wolf population.
 - How long will it take for the new wolf population to exceed 100?
- The table shows that the elk population in a state forest is growing exponentially. What is the growth factor? Explain.



**Growth of
Elk Population**

Time (yr)	Population
0	30
1	57
2	108
3	206
4	391
5	743

- Suppose this growth pattern continues. How many elk will there be after 10 years? How many elk will there be after 15 years?
- Write an equation you could use to predict the elk population p for any year n after the elk were first counted.
- In how many years will the population exceed one million?

3. Suppose there are 100 trout in a lake and the yearly growth factor for the population is 1.5. How long will it take for the number of trout to double?
4. Suppose there are 500,000 squirrels in a forest and the growth factor for the population is 1.6 per year. Write an equation you could use to find the squirrel population p in n years.
5. **Multiple Choice** The equation $p = 200(1.1)^t$ models the growth of a population. The variable p is the population in millions and t is the time in years. How long will it take this population to double?
A. 4 to 5 years **B.** 5 to 6 years **C.** 6 to 7 years **D.** 7 to 8 years

In Exercises 6 and 7, the equation models the growth of a population, where p is the population in millions and t is the time in years. Tell how much time it would take the population to double.

6. $p = 135(1.7)^t$

7. $p = 1,000(1.2)^t$

8. **a.** Fill in the table for each equation.

$$y = 50(2.2)^x$$

x	0	1	2	3	4	5
y	■	■	■	■	■	■

$$y = 350(1.7)^x$$

x	0	1	2	3	4	5
y	■	■	■	■	■	■

- b.** What is the growth factor for each equation?
- c.** Predict whether the graphs of these equations will ever cross.
- d.** Estimate any points at which you think the graphs will cross.
9. Maya's grandfather opened a savings account for her when she was born. He opened the account with \$100 and did not add or take out any money after that. The money in the account grows at a rate of 4% per year.
- a.** Make a table to show the amount in the account from the time Maya was born until she turned 10.
- b.** What is the growth factor for the account?
- c.** Write an equation for the value of the account after any number of years.



For: Help with Exercise 9
 Web Code: ape-3309

Find the growth rate associated with the given growth factor.

10. 1.4

11. 1.9

12. 1.75

For Exercises 13–15, find the growth factor associated with the given growth rate.

13. 45%

14. 90%

15. 31%

16. Suppose the price of an item increases by 25% per year. What is the growth factor for the price from year to year?

17. Currently, 1,000 students attend Greenville Middle School. The school can accommodate 1,300 students. The school board estimates that the student population will grow by 5% per year for the next several years.

- a. In how many years will the population outgrow the present building?
- b. Suppose the school limits its growth to 50 students per year. How many years will it take for the population to outgrow the school?



18. Suppose that, for several years, the number of radios sold in the United States increased by 3% each year.

- a. Suppose one million radios sold in the first year of this time period. About how many radios sold in each of the next 6 years?
- b. Suppose only 100,000 radios sold in the first year. About how many radios sold in each of the next 6 years?

19. Suppose a movie ticket costs about \$7, and inflation causes ticket prices to increase by 4.5% a year for the next several years.

- a. At this rate, how much will a ticket cost 5 years from now?
- b. How much will a ticket cost 10 years from now?
- c. How much will a ticket cost 30 years from now?

20. Find the growth rate (percent growth) for a relationship with the equation $y = 30(2^x)$.
21. **Multiple Choice** Ms. Diaz wants to invest \$500 in a savings bond. At which bank would her investment grow the most over 8 years?
- F. Bank 1: 7% interest for 8 years.
 - G. Bank 2: 2% interest for the first 4 years and 12% interest for the next four years.
 - H. Bank 3: 12% interest for the first 4 years and 2% interest for the next four years.
 - J. All three result in the same growth.
22. Oscar made the following calculation to predict the value of his baseball card collection several years from now:
- $$\text{Value} = \$130 \times 1.07 \times 1.07 \times 1.07 \times 1.07 \times 1.07$$
- a. What initial value, growth rate, growth factor, and number of years is Oscar assuming?
 - b. If the value continues to increase at this rate, how much would the collection be worth in three more years?
23. Carlos, Latanya, and Mila work in a biology laboratory. Each of them is responsible for a population of mice.
- The growth factor for Carlos's population of mice is $\frac{8}{7}$.
 - The growth factor for Latanya's population of mice is 3.
 - The growth factor for Mila's population of mice is 125%.
- a. Whose mice are reproducing fastest?
 - b. Whose mice are reproducing slowest?



Connections

Calculate each percent.

24. 120% of \$3,000

25. 150% of \$200

26. 133% of \$2,500

For Exercises 27–30, tell whether the sequence of numbers could represent an exponential growth pattern. Explain your reasoning. If the pattern is exponential, give the growth factor.

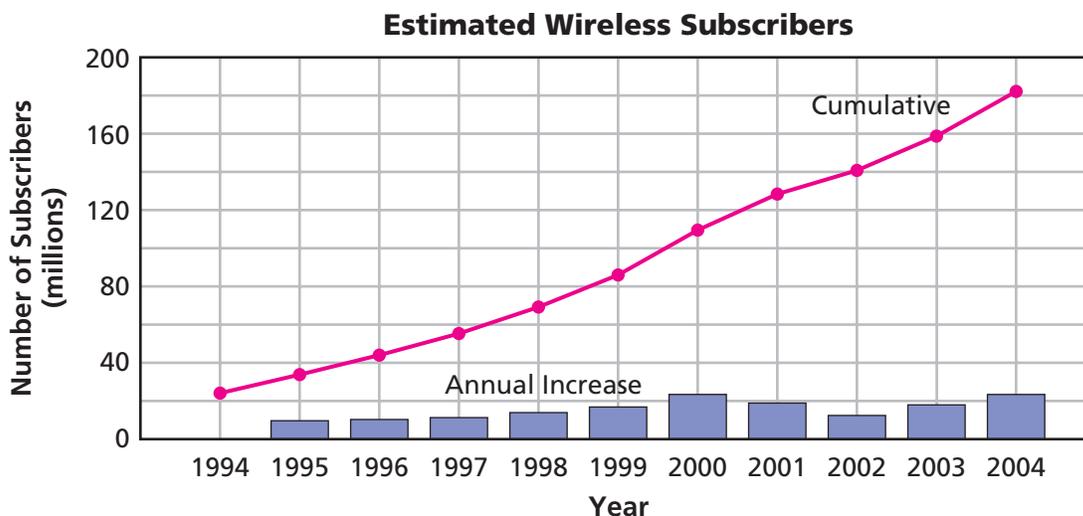
27. 1 1.1 1.21 1.331 1.4641 1.61051 1.771561

28. 3 5 $8\frac{1}{3}$ $13\frac{8}{9}$ $23\frac{4}{27}$

29. 3 $4\frac{2}{3}$ $6\frac{1}{3}$ 8 $9\frac{2}{3}$ $11\frac{1}{3}$

30. 2 6.4 20.5 66 210

31. The graph shows the growth in the number of wireless subscribers in the United States from 1994 to 2004.

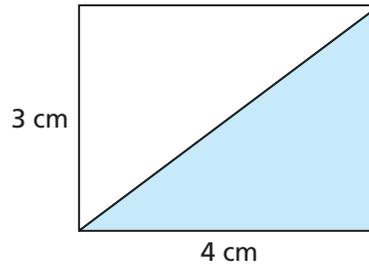


SOURCE: CTIA-The Wireless Association™

- What do the bars in the graph represent?
- What does the curve represent?
- Describe the pattern of change in the total number of subscribers from 1994 to 2004. Could the pattern be exponential? Explain.
- The number of subscribers in 2001 was 128,375,000 and in 2002 the number was 140,455,000. Do these numbers fit the pattern you described in part (c)? Explain.

- 32.** A worker currently receives a yearly salary of \$20,000.
- Find the dollar values of a 3%, 4%, and 6% raise for this worker.
 - Find the worker's new annual salary for each raise in part (a).
 - You can find the new salary after a 3% raise in two ways:
 $\$20,000 + 3\%$ of $(\$20,000)$ *or* 103% of $\$20,000$
 Explain why these two methods give the same result.

- 33.** Arturo enlarges this drawing to 110% of this size. Make a copy of the drawing on grid paper and use it as you answer the following questions.



- What is the length of the diagonal in the original drawing? What is the area of the shaded region?
- What is the length of the diagonal in the enlarged drawing? What is the area of the shaded region?
- Arturo enlarges the enlargement to 110% of its size. He continues this process, enlarging each new drawing to 110% of its size. After five enlargements, what will the length of the diagonal and the area of the shaded region be?
- Is each enlargement similar to the original figure? Explain.
 (**Hint:** Compare the ratio of the length to the width for each enlargement with the ratio of the length to the width for the original.)

- 34.** Kwan cuts lawns every summer to make money. One of her customers offers to give her a 3% raise next summer and a 4% raise the summer after that.

Kwan says she would prefer to get a 4% raise next summer and a 3% raise the summer after that. She claims she will earn more money this way. Is she correct? Explain.



35. After graduating from high school, Kim accepts a job with a package delivery service, earning \$9 per hour.

a. How much will Kim earn in a year if she works 40 hours per week for 50 weeks and gets 2 weeks of paid vacation time?

b. Write an equation showing the relationship between the number of weeks Kim works w and the amount she earns a .

c. Kim writes the following equation: $9,000 = 360w$. What question is she trying to answer? What is the answer to that question?

d. Suppose Kim works for the company for 10 years, receiving a 3% raise each year. Make a table showing how her annual income grows over this time period.

e. When Kim was hired, her manager told her that instead of a 3% annual raise, she could choose to receive a \$600 raise each year. How do the two raise plans compare over a 10-year period? Which plan do you think is better? Explain your answer.



36. Which represents faster growth, a growth factor of 2.5 or a growth rate of 25%?

37. Order these scale factors from least to greatest.

130% $\frac{3}{2}$ 2 1.475

38. Christopher made a drawing that measures $8\frac{1}{2}$ by 11 inches. He needs to reduce it so it will fit into a space that measures $7\frac{1}{2}$ by 10 inches. What scale factor should he use to get a similar drawing that is small enough to fit? (Do not worry about getting it to fit perfectly.)

39. a. Match each growth rate from List 1 with the equivalent growth factor in List 2 if possible.

List 1: 20%, 120%, 50%, 200%, 400%, 2%

List 2: 1.5, 5, 1.2, 2.2, 4, 2, 1.02

b. Order the growth rates from List 1 from least to greatest.

c. Order the growth factors from List 2 from least to greatest.

Extensions

- 40.** In Russia, shortly after the breakup of the Soviet Union, the yearly growth factor for inflation was 26. What growth rate (percent increase) is associated with this growth factor? We call this percent increase the *inflation rate*.
- 41.** In 1990, the population of the United States was about 250 million and was growing exponentially at a rate of about 1% per year.
- At this growth rate, what will the population of the United States be in the year 2010?
 - At this rate, how long will it take the population to double?
 - Do you think the predictions in parts (a) and (b) are accurate? Explain.
 - The population in 2000 was about 282 million. How accurate was the growth rate?

42. Use the table to answer parts (a)–(d).

- One model of world population growth assumes the population grows exponentially. Based on the data in this table, what would be a reasonable growth factor for this model?
- Use your growth factor from part (a) to write an equation for the growth of the population at 5-year intervals beginning in 1955.
- Use your equation from part (b) to estimate the year in which the population was double the 1955 population.
- Use your equation to predict when the population will be double the 2000 population.

World Population Growth

Year	Population (billions)
1955	2.76
1960	3.02
1965	3.33
1970	3.69
1975	4.07
1980	4.43
1985	4.83
1990	5.26
1995	5.67
2000	6.07

Write an exponential growth equation that matches each description.

- 43.** A population is initially 300. After 1 year, the population is 360.
- 44.** A population has a yearly growth factor of 1.2. After 3 years, the population is 1,000.
- 45.** The growth rate for an investment is 3% per year. After 2 years, the value of the investment is \$2,560.

- 46.** Suppose your calculator did not have an exponent key. You could find 1.5^{12} by entering:
 $1.5 \times 1.5 \times 1.5$
- How could you evaluate 1.5^{12} with fewer keystrokes?
 - What is the fewest number of times you could press $\boxed{\times}$ to evaluate 1.5^{12} ?

- 47.** Mr. Watson sold his boat for \$10,000. He wants to invest the money.
- How much money will he have after 1 year if he invests the \$10,000 in an account that pays 4% interest per year?
 - Mr. Watson sees an advertisement for another type of savings account:

“4% interest per year compounded quarterly.”

He asks the bank teller what “compounded quarterly” means. She explains that instead of giving him 4% of \$10,000 at the end of one year, the bank will give him 1% at the end of each 3-month period (each quarter of a year).

**Growth of \$10,000
Investment at 4% Interest
Compounded Quarterly**

Time (mo)	Money in Account
0	\$10,000
3	\$10,100
6	\$10,201
9	\$10,303.01

If Mr. Watson invests his money at this bank, how much will be in his account at the end of one year?

- Mr. Watson sees an advertisement for a different bank that offers 4% interest per year *compounded monthly*. (This means he will get $\frac{1}{12}$ of 4% interest every month.) How much money will he have at the end of the year if he invests his money at this bank?
- Which account would have the most money at the end of one year? Explain.