**b.** Use your equation to find the approximate consumption per person of whole milk in 2000.

$y = 16.5 \cdot 0.959^x$

$y = 16.5 \cdot 0.959^{20}$     **2000 is 20 years after 1980, so substitute 20 for x.**

$\approx 7.1$    **Use a calculator. Round to the nearest tenth of a gallon.**

● The average annual consumption of whole milk in 2000 was about 7 gal/person.

**✓ Check Understanding** **⑤ Statistics** In 1990, the population of Washington, D.C., was about 604,000 people. Since then the population has decreased about 1.8% per year.
a. What is the initial number of people?
b. What is the decay factor?
c. Write an equation to model the population of Washington, D.C., since 1990.
d. Suppose the current trend in population change continues. Predict the population of Washington, D.C., in 2010.

# EXERCISES

For more practice, see *Extra Practice.*

## Practice and Problem Solving

**Ⓐ Practice by Example**

**Example 1**
**(page 438)**

Identify the initial amount *a* and the growth factor *b* in each exponential function.

1. $g(x) = 20 \cdot 2^x$    2. $y = 200 \cdot 1.0875^x$    3. $y = 10,000 \cdot 1.01^x$    4. $f(t) = 1.5^t$

5. Suppose the population of a city is 50,000 and is growing 3% each year.
   a. The initial amount *a* is ▨.
   b. The growth factor *b* is 100% + 3%, which is $1 + ▨ = ▨$.
   c. To find the population after one year, you multiply 50,000 · ▨.
   d. Complete the equation $y = ▨ \cdot ▨^{▨}$ to find the population after *x* years.
   e. Use your equation to predict the population after 25 years.

**Examples 2, 3**
**(pages 438, 439)**

Each percent is an annual interest rate. In the formula $y = a \cdot b^x$, what value would you use for *b*?

6. 4%      7. 5%      8. 3.7%      9. 8.75%      10. 0.5%

Assume each interest rate below is an annual interest rate. Find the interest rate for an account that is compounded quarterly and monthly.

11. 3%      12. 4%      13. 4.5%      14. 7.6%      15. 6.25%

Find the balance in each account.

16. $4000 principal earning 6% compounded annually, after 5 years

17. $12,000 principal earning 4.8% compounded annually, after 7 years

18. $500 principal earning 4% compounded quarterly, after 6 years

19. $20,000 deposit earning 3.5% compounded quarterly, after 10 years

**Example 4**
**(page 440)**

20. **Chemistry** The half-life of iodine-124 is 4 days. A technician measures a 40-mCi sample of iodine-124.
   a. How many half-lives of iodine-124 occur in 16 days?
   b. How much iodine-124 is in the sample 16 days after the technician measures the original sample?

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**54. Data Collection** Complete the table at the right using any ball. The height 0 is the starting height. Record the maximum height after the first, second, and third bounce.
  **a.** Graph your data.
  **b.** Write an exponential decay function that models your data.

| Bounce | Height (centimeters) |
|---|---|
| 0 | ■ |
| 1 | ■ |
| 2 | ■ |
| 3 | ■ |

**55.** On January 1, 2000, Chessville had a population of 40,000 people. Its population increases 7% each year. On the same day, Checkersville had a population of 60,000 people. Its population decreases 4% each year. During what year will the population of Chessville exceed that of Checkersville?

## Standardized Test Prep

**Multiple Choice**

**56.** For which function will values of $y$ decrease as values of $x$ increase?
  **A.** $y = 12.5(1.325)^x$
  **B.** $y = 300(1.06)^x$
  **C.** $y = 5000(0.98)^x$
  **D.** $y = 1.02^x$

**57.** Suppose you deposit $1000 in an account earning 6% interest. You make no further deposits to the account and interest is compounded semi-annually. What is the balance after 5 years?
  **F.** $538.62     **G.** $1006.00     **H.** $1343.92     **I.** $1790.85
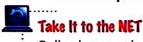
**Reading Comprehension**

**58.** Read the passage below and answer the following problem.

### Manhattan, Then and Now

In 1626, the Dutch landed on the island we now call Manhattan. They bought the island for $24 worth of merchandise. Today Manhattan is one of the most expensive places in the world to live. Rent for a one-bedroom apartment averages $2000 a month.

Suppose $24 had been invested in 1626 in an account paying 4.5% interest compounded annually. Which amount is closest to the balance in 2000?
  **A.** $339 million     **B.** $89 million     **C.** $9400     **D.** $8900

**Short Response**

**59.** Which is greater, the amount in an account that pays 5% interest compounded quarterly for 5 years or the amount in an account that pays 5.5% compounded annually for 5 years? Assume the accounts start with the same amount. Show your work.

## Mixed Review

**Lesson 8-7**

Graph each function.

**60.** $y = 2 \cdot 10^x$

**61.** $f(x) = 100 \cdot 0.9^x$

**62.** $g(x) = \frac{1}{10} \cdot 0.1^x$

**Lesson 8-3**

**63. Geography** In 2000, about $1.4 \times 10^4$ ships passed through the Panama Canal. About $5.2 \times 10^7$ gallons of water flow out of the canal with each ship. About how many gallons of water flowed out of the canal with ships in 2000? Write your answer in scientific notation.

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# Chapter Test

**Simplify each expression.**

1. $\dfrac{r^3t^{-7}}{t^5}$

2. $\left(\dfrac{a^3}{m}\right)^{-4}$

3. $\dfrac{t^{-8}m^2}{m^{-3}}$

4. $c^3v^9c^{-1}c^0$

5. $h^2k^{-5}d^3k^2$

6. $9y^4j^2y^{-9}$

7. $(w^2k^0p^{-5})^{-7}$

8. $2y^{-9}h^2(2y^0h^{-4})^{-6}$

9. $(1.2)^5(1.2)^{-2}$

10. $(-3q^{-1})^3\,q^2$

11. If $n = -3$, which expression has the least value?

   **A.** $n^2n^0$            **B.** $n^n$

   **C.** $n^8n^{-5}$         **D.** $-n^nn^{-4}$

**Write each number in scientific notation.**

12. **History** There were 44,909,000 votes cast for Bill Clinton in the 1992 presidential election.

13. **Pets** More than 450,000 households in the United States have reptiles as pets.

**Is each number written in scientific notation? If not, explain.**

14. $76 \times 10^{-9}$

15. $7.3 \times 10^5$

16. $4.05 \times 10 \times 10^{-8}$

17. $32.5 \times 10^{13}$

18. **a. Astronomy** The speed of light in a vacuum is about 186,300 mi/s. Use scientific notation to express how far light travels in one hour.

   **b.** At its farthest, Saturn is about $1.03 \times 10^9$ mi from Earth. About how many hours does it take for light to travel from Earth to Saturn?

19. Use the sequence $-32, 16, -8, 4, \ldots$

   **a.** What is the common ratio?

   **b.** What are the next three terms?

   **c.** Write a rule for the sequence.

   **d.** What is the ninth term of the sequence?

20. You drop a ball from a height of 12 ft. Each path has $\frac{3}{5}$ the height of the previous path.

   **a.** Write a rule for the sequence. The initial height is given by the term $n = 1$.

   **b.** What height will the ball reach at the top of the fourth path ($n = 4$)?

21. Find the fifth term of the sequence $A(n) = -3(-2)^{n+1}$.

**Evaluate each function for $x = 1, 2,$ and 3.**

22. $y = 3 \cdot 5^x$

23. $f(x) = \frac{1}{2} \cdot 4^x$

24. $f(x) = 4(0.95)^x$

25. $g(x) = 5\left(\frac{3}{4}\right)^x$

**Graph each function.**

26. $y = \frac{1}{2} \cdot 2^x$     27. $y = 2 \cdot \left(\frac{1}{2}\right)^x$     28. $f(x) = 3^x$

29. **Open-Ended** Write and solve a problem involving exponential decay.

30. **Writing** Explain when the function $y = a \cdot b^x$ shows exponential growth and when it shows exponential decay.

31. **Banking** A customer deposits $1000 in a savings account that pays 4% interest compounded quarterly. How much money will the customer have in the account after 2 years? After 5 years?

32. The function $y = 1.3 \cdot (1.07)^x$ models a city's annual electrical consumption for $x$ years since 1985, where $y$ is kilowatt-hours.

   **a.** Determine whether the function models exponential growth or decay, and find the growth or decay factor.

   **b.** According to the model, what will be the annual electrical usage in 2010?

   **c.** According to the model, what was the annual electrical usage in 1975?

   **d.** What value of $x$ should you substitute to find the value of $y$ now? Use this value for $x$ to find $y$.

33. **Automobiles** Suppose a new car is worth $20,000. You can use the function $y = 20,000(0.85)^x$ to estimate the car's value after $x$ years.

   **a.** What is the decay factor? What does it mean?

   **b.** Estimate the car's value after one year.

   **c.** Estimate the car's value after four years.

34. The function $y = 10 \cdot 1.08^x$ models the cost of annual tuition (in thousands of dollars) at a local college $x$ years after 1997.

   **a.** What is the annual percent increase?

   **b.** How much was tuition in 1997? In 2000?

   **c.** How much will the tuition be the year you plan to graduate from high school?