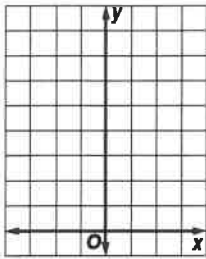


# 7-1 Skills Practice

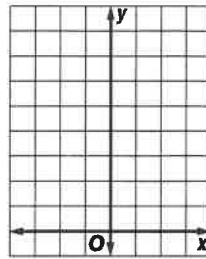
## Graphing Exponential Functions

Graph each function. State the function's domain and range.

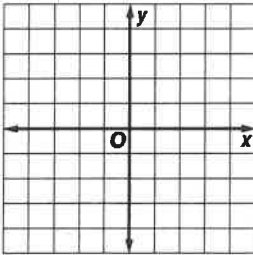
1.  $y = 3(2)^x$



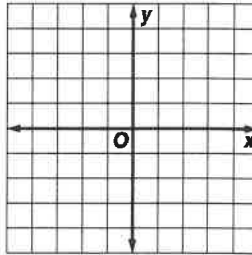
2.  $y = 2\left(\frac{1}{2}\right)^x$



3.  $y = -\frac{3}{2}(1.5)^x$

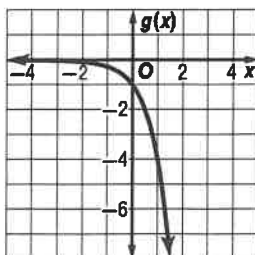


4.  $y = 3\left(\frac{1}{3}\right)^x$

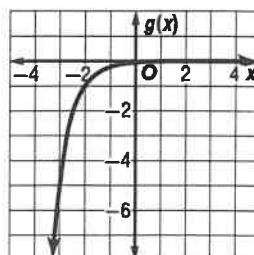


For each graph  $f(x)$  is the parent function and  $g(x)$  is a transformation of  $f(x)$ . Use the graph to determine  $g(x)$ .

5.  $f(x) = 4^x$



6.  $f(x) = \left(\frac{1}{5}\right)^x$

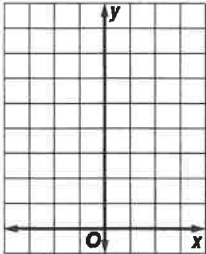


# 7-1 Practice

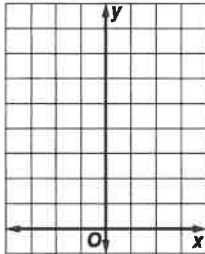
## Graphing Exponential Functions

Graph each function. State the domain and range.

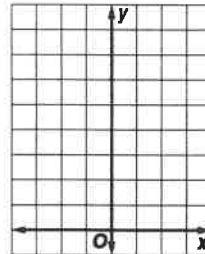
1.  $y = 1.5(2)^x$



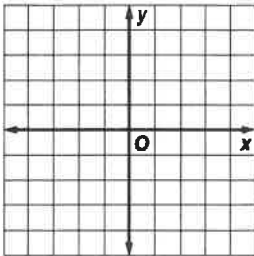
2.  $y = 4(3)^x$



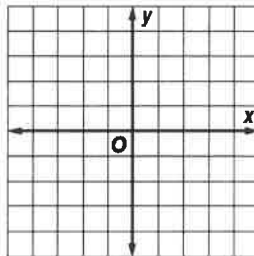
3.  $y = 3(0.5)^x$



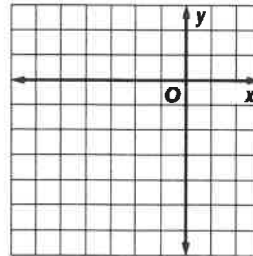
4.  $y = 5\left(\frac{1}{2}\right)^x - 8$



5.  $y = -2\left(\frac{1}{4}\right)^{x-3}$



6.  $y = \frac{1}{2}(3)^{x+4} - 5$



7. **BIOLOGY** The initial number of bacteria in a culture is 12,000. The culture doubles each day.

a. Write an exponential function to model the population  $y$  of bacteria after  $x$  days.

b. How many bacteria are there after 6 days?

8. **EDUCATION** A college with a graduating class of 4000 students in the year 2008 predicts that its graduating class will grow 5% per year. Write an exponential function to model the number of students  $y$  in the graduating class  $t$  years after

## 7-2 Skills Practice

### Solving Exponential Equations and Inequalities

Solve each equation.

1.  $25^{2x+3} = 25^{5x-9}$

2.  $9^{8x-4} = 81^{3x+6}$

3.  $4^{x-5} = 16^{2x-31}$

4.  $4^{3x-3} = 8^{4x-4}$

5.  $9^{-x+5} = 27^{6x-10}$

6.  $125^{3x-4} = 25^{4x+2}$

Solve each inequality.

7.  $\left(\frac{1}{36}\right)^{6x-3} > 6^{3x-9}$

8.  $64^{4x-8} < 256^{2x+6}$

9.  $\left(\frac{1}{27}\right)^{3x+13} < 9^{5x-\frac{1}{2}}$

10.  $\left(\frac{1}{9}\right)^{2x+7} \leq 27^{6x-12}$

11.  $\left(\frac{1}{8}\right)^{-2x-6} > \left(\frac{1}{32}\right)^{-x+11}$

12.  $9^{9x+1} < \left(\frac{1}{243}\right)^{-3x+5}$

Write an exponential function whose graph passes through the given points.

13.  $(0, 3)$  and  $(3, 375)$

14.  $(0, -1)$  and  $(6, -64)$

15.  $(0, 7)$  and  $(-2, 28)$

16.  $\left(0, \frac{1}{2}\right)$  and  $(2, 40.5)$

17.  $(0, 15)$  and  $(1, 12)$

18.  $(0, -6)$  and  $(-4, -1536)$

19.  $\left(0, \frac{1}{3}\right)$  and  $(3, 9)$

20.  $(0, 1)$  and  $(6, 4096)$

21.  $(0, -2)$  and  $(-1, -4)$

## 7-2 Practice

### Solving Exponential Equations and Inequalities

Solve each equation.

1.  $4^x + 35 = 64^{x-3}$

2.  $\left(\frac{1}{64}\right)^{0.5x-3} = 8^{9x-2}$

3.  $3^x - 4 = 9^x + 28$

4.  $\left(\frac{1}{4}\right)^{2x+2} = 64^{x-1}$

5.  $\left(\frac{1}{2}\right)^{x-3} = 16^{3x+1}$

6.  $3^{6x-2} = \left(\frac{1}{9}\right)^{x+1}$

Write an exponential function for the graph that passes through the given points.

7. (0, 5) and (4, 3125)

8. (0, 8) and (4, 2048)

9.  $\left(0, \frac{3}{4}\right)$  and (2, 36.75)

10. (0, -0.2) and (-3, -3.125)

11. (0, 15) and  $\left(2, \frac{15}{16}\right)$

12. (0, 0.7) and  $\left(\frac{1}{2}, 3.5\right)$

Solve each inequality.

13.  $400 > \left(\frac{1}{20}\right)^{7x+8}$

14.  $10^{2x+7} \geq 1000^x$

15.  $\left(\frac{1}{16}\right)^{3x-4} \leq 64^{x-1}$

16.  $\left(\frac{1}{8}\right)^{x-6} < 4^{4x+5}$

17.  $\left(\frac{1}{36}\right)^{x+8} \leq 216^{x-3}$

18.  $128^{x+3} < \left(\frac{1}{1024}\right)^{2x}$

19. At time  $t$ , there are  $216^{t+18}$  bacteria of type A and  $36^{2t+8}$  bacteria of type B organisms in a sample. When will the number of each type of bacteria be equal?

# 7-3 Skills Practice

## Logarithms and Logarithmic Functions

Write each equation in exponential form.

1.  $\log_3 243 = 5$

2.  $\log_4 64 = 3$

3.  $\log_9 3 = \frac{1}{2}$

4.  $\log_5 \frac{1}{25} = -2$

Write each equation in logarithmic form.

5.  $2^3 = 8$

6.  $3^2 = 9$

7.  $8^{-2} = \frac{1}{64}$

8.  $\left(\frac{1}{3}\right)^2 = \frac{1}{9}$

Evaluate each expression.

9.  $\log_5 25$

10.  $\log_9 3$

11.  $\log_{10} 1000$

12.  $\log_{125} 5$

13.  $\log_4 \frac{1}{64}$

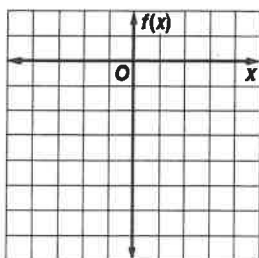
14.  $\log_5 \frac{1}{625}$

15.  $\log_8 512$

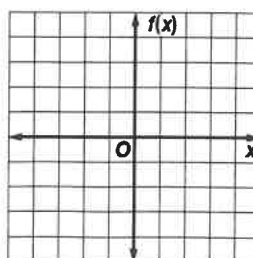
16.  $\log_{27} \frac{1}{3}$

Graph each function.

17.  $f(x) = \log_3 (x + 1) - 4$



18.  $f(x) = -\log_5 x + 2.5$



Lesson 7-3

## 7-3 Practice

### Logarithms and Logarithmic Functions

Write each equation in exponential form.

1.  $\log_6 216 = 3$

2.  $\log_2 64 = 6$

3.  $\log_3 \frac{1}{81} = -4$

4.  $\log_{10} 0.00001 = -5$

5.  $\log_{25} 5 = \frac{1}{2}$

6.  $\log_{32} 8 = \frac{3}{5}$

Write each equation in logarithmic form.

7.  $5^3 = 125$

8.  $7^0 = 1$

9.  $3^4 = 81$

10.  $3^{-4} = \frac{1}{81}$

11.  $\left(\frac{1}{4}\right)^8 = \frac{1}{64}$

12.  $7776^{\frac{1}{5}} = 6$

Evaluate each expression.

13.  $\log_3 81$

14.  $\log_{10} 0.0001$

15.  $\log_2 \frac{1}{16}$

16.  $\log_{\frac{1}{3}} 27$

17.  $\log_9 1$

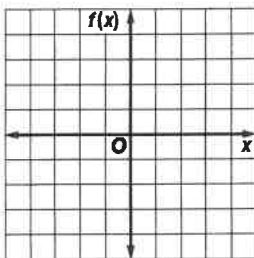
18.  $\log_8 4$

19.  $\log_7 \frac{1}{49}$

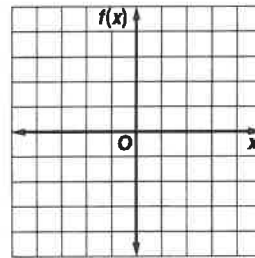
20.  $\log_6 6^4$

Graph each function.

21.  $f(x) = \log_2 (x - 2)$



22.  $f(x) = -2 \log_4 x$



23. **SOUND** An equation for loudness, in decibels, is  $L = 10 \log_{10} R$ , where  $R$  is the relative intensity of the sound. Sounds that reach levels of 120 decibels or more are painful to humans. What is the relative intensity of 120 decibels?

24. **INVESTING** Maria invests \$1000 in a savings account that pays 4% interest compounded annually. The value of the account  $A$  at the end of five years can be determined from the equation  $\log_{10} A = \log_{10} [1000(1 + 0.04)^5]$ . Write this equation in exponential form.

## 7-4 Skills Practice

### Solving Logarithmic Equations and Inequalities

Solve each equation.

1.  $3x = \log_6 216$

2.  $x - 4 = \log_3 243$

3.  $\log_4 (4x - 20) = 5$

4.  $\log_9 (3 - x) = \log_9 (5x - 15)$

5.  $\log_{81} (x + 20) = \log_{81} (6x)$

6.  $\log_9 (3x^2) = \log_9 (2x + 1)$

7.  $\log_4 (x - 1) = \log_4 (12)$

8.  $\log_7 (5 - x) = \log_7 (5)$

9.  $\log_x (5x) = 2$

Solve each inequality.

10.  $\log_5 (-3x) < 1$

11.  $\log_6 x > \log_6 (4 - x)$

12.  $\log_{10} (x - 3) < 2$

13.  $\log_2 (x - 5) > \log_2 (3)$

14.  $\log_7 (8x + 5) > \log_7 (6x - 18)$

15.  $\log_9 (3x - 3) < 1.5$

16.  $\log_{10} (2x - 2) < \log_{10} (7 - x)$

17.  $\log_9 (x - 1) > \log_9 (2x)$

18.  $\log_{16} x \geq 0.5$

19.  $\log_3 \left( \frac{x - 3}{4} + 5 \right) > \log_3 (x + 2)$

20.  $\log_5 (3x) < \log_5 (2x - 1)$

21.  $\log_3 (7 - x) \leq \log_3 (x + 19)$

**7-4 Practice****Solving Logarithmic Equations and Inequalities****Solve each equation.**

1.  $x + 5 = \log_4 256$

2.  $3x - 5 = \log_2 1024$

3.  $\log_3 (4x - 17) = 5$

4.  $\log_5 (3 - x) = 5$

5.  $\log_{13} (x^2 - 4) = \log_{13} 3x$

6.  $\log_3 (x - 5) = \log_3 (3x - 25)$

**Solve each inequality.**

7.  $\log_3 (-6x) < 1$

8.  $\log_9 (x + 2) > \log_9 (6 - 3x)$

9.  $\log_{11} (x + 7) < 1$

10.  $\log_{81} x \leq 0.75$

11.  $\log_2 (x + 6) < \log_2 17$

12.  $\log_{12} (2x - 1) > \log_{12} (5x - 16)$

13.  $\log_9 (2x - 1) < 0.5$

14.  $\log_{10} (x - 5) > \log_{10} 2x$

15.  $\log_3 (x + 12) > \log_3 2x$

16.  $\log_3 (0.3x + 5) > \log_3 (x - 2)$

17.  $\log_2 (x + 3) < \log_2 (1 - 3x)$

18.  $\log_6 (3 - x) \leq \log_6 (x - 1)$

- 19. WILDLIFE** An ecologist discovered that the population of a certain endangered species has been doubling every 12 years. When the population reaches 20 times the current level, it may no longer be endangered. Write the logarithmic expression that gives the number of years it will take for the population to reach that level.



NAME \_\_\_\_\_

DATE \_\_\_\_\_ PERIOD \_\_\_\_\_

## 7-1 Study Guide and Intervention

### Graphing Exponential Functions

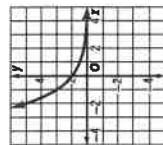
(continued)

**Exponential Decay** The following table summarizes the characteristics of exponential decay functions.

- The function is continuous, one-to-one, and decreasing.
- The domain is the set of all real numbers.
- The x-axis is the asymptote of the graph.
- The range is the set of all positive real numbers.
- The graph contains the point (0, 1).

**Example** Graph  $y = \left(\frac{1}{2}\right)^x$ . State the domain and range. Make a table of values. Connect the points to form a smooth curve. The domain is all real numbers and the range is the set of all positive real numbers.

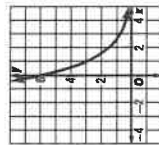
x	-2	-1	0	1	2
y	4	2	1	0.5	0.25



### Exercises

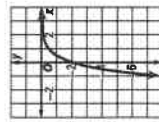
Graph each function. State the domain and range.

1.  $y = 6\left(\frac{1}{2}\right)^x$



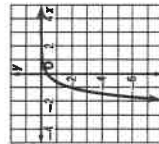
D = {all real numbers};  
R = {y | y > 0}

2.  $y = -2\left(\frac{1}{4}\right)^x$



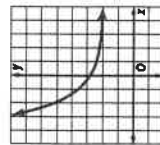
D = {all real numbers};  
R = {y | y < 0}

3.  $y = -0.4(0.2)^x$



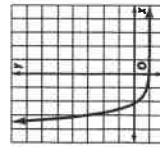
D = {all real numbers};  
R = {y | y < 0}

4.  $y = \left(\frac{2}{5}\right)\left(\frac{1}{2}\right)^{x-1} + 2$



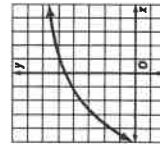
D = {all real numbers};  
R = {y | y > 2}

5.  $y = 4\left(\frac{1}{5}\right)^{x+8} - 1$



D = {all real numbers};  
R = {y | y > -1}

6.  $y = \left(-\frac{1}{3}\right)\left(\frac{3}{4}\right)^{x-6} + 6$



D = {all real numbers};  
R = {y | y < 6}

NAME \_\_\_\_\_

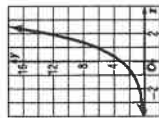
DATE \_\_\_\_\_ PERIOD \_\_\_\_\_

## 7-1 Skills Practice

### Graphing Exponential Functions

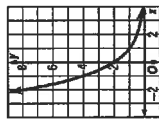
Graph each function. State the function's domain and range.

1.  $y = 3(2)^x$



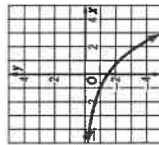
D = {all real numbers};  
R = {y | y > 0}

2.  $y = 2\left(\frac{1}{2}\right)^x$



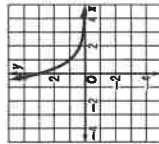
D = {all real numbers};  
R = {y | y > 0}

3.  $y = -\frac{3}{2}(1.5)^x$



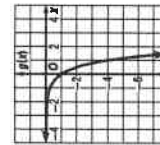
D = {all real numbers};  
R = {y | y < 0}

4.  $y = 3\left(\frac{1}{5}\right)^x$



D = {all real numbers};  
R = {y | y > 0}

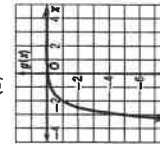
5.  $f(x) = 4^x$



$g(x) = -4^x$

For each graph  $f(x)$  is the parent function and  $g(x)$  is a transformation of  $f(x)$ . Use the graph to determine  $g(x)$ .

6.  $f(x) = \left(\frac{1}{5}\right)^x$



$g(x) = -\left(\frac{1}{5}\right)^{x+2}$

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Chapter 7

6

Glencoe Algebra 2

7

Glencoe Algebra 2

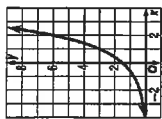
NAME \_\_\_\_\_ DATE \_\_\_\_\_ PERIOD \_\_\_\_\_

### 7-1 Practice

#### Graphing Exponential Functions

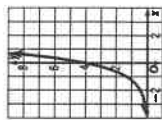
Graph each function. State the domain and range.

1.  $y = 1.5(2)^x$



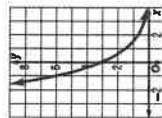
$D = \{\text{all real numbers}\}$   
 $R = \{y | y > 0\}$

2.  $y = 4(3)^x$



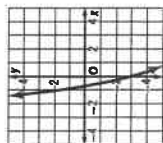
$D = \{\text{all real numbers}\}$   
 $R = \{y | y > 0\}$

3.  $y = 3(0.5)^x$



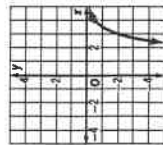
$D = \{\text{all real numbers}\}$   
 $R = \{y | y > 0\}$

4.  $y = 5\left(\frac{1}{2}\right)^x - 8$



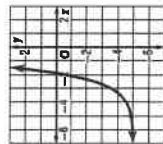
$D = \{\text{all real numbers}\}$   
 $R = \{y | y > -8\}$

5.  $y = -2\left(\frac{1}{4}\right)^{x-3}$



$D = \{\text{all real numbers}\}$   
 $R = \{y | y < 0\}$

6.  $y = \frac{1}{2}(3)^{x+4} - 5$



$D = \{\text{all real numbers}\}$   
 $R = \{y | y > -5\}$

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## Answers (Lesson 7-1)

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PERIOD \_\_\_\_\_

### 7-1 Word Problem Practice

#### Graphing Exponential Functions

**1. GOLF BALLS** A golf ball manufacturer packs 3 golf balls into a single package. Three of these packages make a gift box. Three gift boxes make a value pack. The display shelf is high enough to stack 3 value packs one on top of the other. Three such columns of value packs make up a display front. Three display fronts can be packed in a single shipping box and shipped to various retail stores. How many golf balls are in a single shipping box?  
**729**

**4. TENNIS SHOES** The cost of a pair of tennis shoes increases about 5.1% every year. About how much would a \$50 pair of tennis shoes cost 25 years from now?  
**\$173.40**

**5. MONEY** Sam opened a savings account that compounds interest at a rate of 3% annually. Let  $P$  be the initial amount Sam deposited and let  $t$  be the number of years the account has been open.

a. Write an equation to find  $A$ , the amount of money in the account after  $t$  years. Assume that Sam made no more additional deposits and no withdrawals.  **$A = P(1.03)^t$**

b. If Sam opened the account with \$500 and made no deposits or withdrawals, how much is in the account 10 years later? **\$671.96**

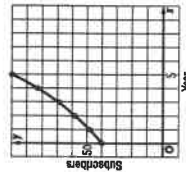
c. What is the least number of years it would take for such an account to double in value?  
**24 yr**

**2. FOLDING** Paper thickness ranges from 0.0032 inch to 0.0175 inch. Kay folds a piece of paper 0.01 inch thick in half over and over until it is at least 25 layers thick. How many times does she fold the paper in half and how many layers are there? How thick is the folded paper?  
**5 folds; 32 layers; 0.32 in.**

**3. SUBSCRIPTIONS** Subscriptions to an online arts and crafts club have been increasing by 20% every year. The club began with 40 members.

Year	0	1	2	3	4
Subscriptions	40	48			

Make a graph of the number of subscribers over the first 5 years of the club's existence.



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NAME \_\_\_\_\_ DATE \_\_\_\_\_ PERIOD \_\_\_\_\_

### 7-2 Skills Practice

#### Solving Exponential Equations and Inequalities

Solve each equation.

1.  $25^{3x+2} = 25^{5x-9}$       2.  $9^{3x-4} = 81^{3x+6}$       3.  $4^{x-5} = 16^{2x-31}$   
 4      8      19

4.  $4^{3x-9} = 8^{6x-4}$       5.  $9^{-x+5} = 27^{6x-10}$       6.  $125^{3x-4} = 25^{4x+2}$   
 1      2      16

Solve each inequality.

7.  $\left(\frac{1}{36}\right)^{6x-3} > 6^{3x-9}$       8.  $64^{4x-8} < 256^{2x+4}$       9.  $\left(\frac{1}{27}\right)^{3x+13} \leq 9^{6x-1}$   
 $x < 1$        $x < 12$        $x \geq -2$

10.  $\left(\frac{1}{9}\right)^{2x+7} \leq 27^{3x-13}$       11.  $\left(\frac{1}{6}\right)^{-3x-6} > \left(\frac{1}{32}\right)^{-x+11}$       12.  $9^{3x+1} < \left(\frac{1}{243}\right)^{-2x+5}$   
 $x \geq 1$        $x > -73$        $x < -9$

Write an exponential function whose graph passes through the given points.

13. (0, 3) and (3, 375)      14. (0, -1) and (6, -64)      15. (0, 7) and (-2, 28)  
 $y = 3(6)^x$        $y = -1(2)^x$        $y = 7\left(\frac{1}{2}\right)^x$

16.  $\left(0, \frac{1}{2}\right)$  and (2, 40.5)      17. (0, 15) and (1, 12)      18. (0, -6) and (-4, -1586)  
 $y = \frac{1}{2}(9)^x$        $y = 15(0.8)^x$        $y = -6\left(\frac{1}{4}\right)^x$

19.  $\left(0, \frac{1}{3}\right)$  and (3, 9)      20. (0, 1) and (6, 4096)      21. (0, -2) and (-1, -4)  
 $y = \frac{1}{3}(3)^x$        $y = (4)^x$        $y = -2\left(\frac{1}{2}\right)^x$

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### 7-2 Practice

#### Solving Exponential Equations and Inequalities

Solve each equation.

1.  $4^{x+15} = 64^{x-3}$       2.  $\left(\frac{1}{64}\right)^{5x-3} = 8^{3x-2}$   
 $x = 22$        $x = 0.8$

3.  $3^{2x-4} = 9^{x+28}$       4.  $\left(\frac{1}{4}\right)^{2x+2} = 64^{x-1}$   
 $x = -60$        $x = \frac{1}{5}$

5.  $\left(\frac{1}{2}\right)^{x-8} = 16^{2x+1}$       6.  $3^{6x-2} = \left(\frac{1}{5}\right)^{x+1}$   
 $x = -\frac{1}{13}$        $x = 0$

Write an exponential function for the graph that passes through the given points.

7. (0, 5) and (4, 3125)      8. (0, 8) and (4, 2048)      9.  $\left(0, \frac{3}{4}\right)$  and  $\left(2, 36.75\right)$   
 $y = 5(5)^x$        $y = 8(4)^x$        $y = 0.75(7)^x$

10. (0, -0.2) and (-3, -3.125)      11. (0, 15) and  $\left(2, \frac{15}{16}\right)$       12. (0, 0.7) and  $\left(\frac{1}{2}, 3.5\right)$   
 $y = -0.2(0.4)^x$        $y = 15\left(\frac{1}{4}\right)^x$        $y = 0.7(25)^x$

Solve each inequality.

13.  $400 > \left(\frac{1}{20}\right)^{7x+8}$       14.  $10^{2x+7} \geq 1000^x$       15.  $\left(\frac{1}{16}\right)^{3x-4} \leq 64^x - 1$   
 $x > -\frac{10}{7}$        $x \leq 7$        $x \geq \frac{11}{9}$

16.  $\left(\frac{1}{8}\right)^{x-6} < 4^{4x+5}$       17.  $\left(\frac{1}{36}\right)^{x+8} \leq 216^{x-8}$       18.  $126^{x+3} < \left(\frac{1}{1024}\right)^{2x}$   
 $x > \frac{8}{11}$        $x \geq -\frac{7}{5}$        $x < \frac{7}{9}$

19. At time  $t$ , there are  $216^{t+13}$  bacteria of type A and  $36^{2t+8}$  bacteria of type B organisms in a sample. When will the number of each type of bacteria be equal?  
 $t = 36$

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**7-3**

**Study Guide and Intervention** *(continued)*

**Logarithms and Logarithmic Functions**

**Graphing Logarithmic Functions** The function  $y = \log_b x$ , where  $b \neq 1$ , is called a logarithmic function. The graph of  $f(x) = \log_b x$  represents a parent graph of the logarithmic functions. Properties of the parent function are described in the following table.

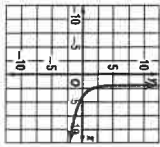
Parent function of Logarithmic Functions, $f(x) = \log_b x$	1. The function is continuous and one-to-one.
	2. The domain is the set of all positive real numbers.
	3. The y-axis is an asymptote of the graph.
	4. The range is the set of all real numbers.
	5. The graph contains the point (1, 0).

The graphs of logarithmic functions can be transformed by changing the value of the constants  $a$ ,  $h$ , and  $k$  in the equation  $f(x) = a \log_b (x - h) + k$ .

**Example** Graph  $f(x) = -8 \log_6 (x - 2) + 1$ .

This is a transformation of the graph of  $f(x) = \log_6 x$ .

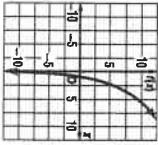
- $|a| = 8$ : The graph expands vertically.
- $a < 0$ : The graph is reflected across the x-axis.
- $h = 2$ : The graph is translated 2 units to the right.
- $k = 1$ : The graph is translated 1 unit up.



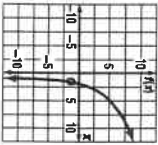
**Exercises**

Graph each function.

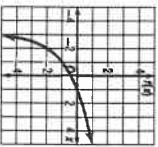
1.  $f(x) = 4 \log_3 x$



2.  $f(x) = 4 \log_3 (x - 1)$



3.  $f(x) = 2 \log_4 (x + 3) - 2$



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**7-3**

**Skills Practice**

**Logarithms and Logarithmic Functions**

Write each equation in exponential form.

1.  $\log_3 243 = 5$      $3^5 = 243$

2.  $\log_4 64 = 3$      $4^3 = 64$

3.  $\log_5 3 = \frac{1}{2}$      $9^{\frac{1}{2}} = 3$

4.  $\log_6 \frac{1}{25} = -2$      $5^{-2} = \frac{1}{25}$

Write each equation in logarithmic form.

5.  $2^3 = 8$      $\log_2 8 = 3$

6.  $3^2 = 9$      $\log_3 9 = 2$

7.  $8^{-2} = \frac{1}{64}$      $\log_8 \frac{1}{64} = -2$

8.  $(\frac{1}{3})^2 = \frac{1}{9}$      $\log_3 \frac{1}{9} = 2$

Evaluate each expression.

9.  $\log_6 25$     2

10.  $\log_5 3$      $\frac{1}{2}$

11.  $\log_6 1000$     3

12.  $\log_{10} 5$      $\frac{1}{3}$

13.  $\log_4 \frac{1}{64}$     -3

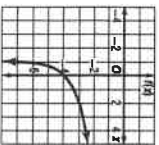
14.  $\log_5 \frac{1}{625}$     -4

15.  $\log_3 512$     3

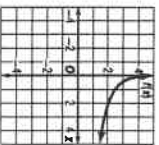
16.  $\log_{27} \frac{1}{3}$      $-\frac{1}{3}$

Graph each function.

17.  $f(x) = \log_3 (x + 1) - 4$



18.  $f(x) = -\log_6 x + 2.5$



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**7-3 Practice**

**Logarithms and Logarithmic Functions**

Write each equation in exponential form.

- 1.  $\log_6 216 = 3$     $6^3 = 216$       2.  $\log_5 64 = 6$     $2^6 = 64$       3.  $\log_8 \frac{1}{81} = -4$     $3^{-4} = \frac{1}{81}$
- 4.  $\log_{10} 0.00001 = -5$       5.  $\log_8 5 = \frac{1}{2}$       6.  $\log_8 8 = \frac{5}{5}$
- $10^{-5} = 0.00001$        $25^{\frac{1}{2}} = 5$        $32^{\frac{2}{5}} = 8$

Write each equation in logarithmic form.

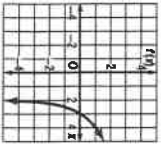
- 7.  $5^3 = 125$     $\log_5 125 = 3$       8.  $7^0 = 1$     $\log_7 1 = 0$       9.  $3^4 = 81$     $\log_3 81 = 4$
- 10.  $3^{-4} = \frac{1}{81}$     $\log_3 \frac{1}{81} = -4$       11.  $(\frac{1}{4})^3 = \frac{1}{64}$     $\log_4 \frac{1}{64} = 3$       12.  $7776^{\frac{1}{6}} = 6$     $\log_{7776} 6 = \frac{1}{6}$

Evaluate each expression.

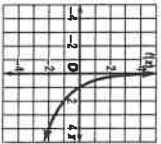
- 13.  $\log_5 81$    4      14.  $\log_{10} 0.0001$    -4      15.  $\log_2 \frac{1}{16}$    -4      16.  $\log_5 27$    -3
- 17.  $\log_5 1$    0      18.  $\log_4 4$    2      19.  $\log_7 \frac{1}{49}$    -2      20.  $\log_6 6^4$    4

Graph each function.

21.  $f(x) = \log_5 (x - 2)$



22.  $f(x) = -2 \log_4 x$



**23. SOUND** An equation for loudness, in decibels, is  $L = 10 \log_{10} R$ , where  $R$  is the relative intensity of the sound. Sounds that reach levels of 120 decibels or more are painful to humans. What is the relative intensity of 120 decibels? **10<sup>12</sup>**

**24. INVESTING** Maria invests \$1000 in a savings account that pays 4% interest compounded annually. The value of the account  $A$  at the end of five years can be determined from the equation  $\log_{10} A = \log_{10} [1000(1 + 0.04)^5]$ . Write this equation in exponential form.  
 **$A = 1000(1 + 0.04)^5$**

**7-3 Word Problem Practice**

**Logarithms and Logarithmic Functions**

**1. CHEMISTRY** The pH of a solution is found by the formula  $\text{pH} = -\log H$ , where  $H$  stands for the hydrogen ion concentration in the formula. What is the pH of a solution to the nearest hundredth when  $H$  is 1356?  
**-3.13**

**2. FIND THE ERROR** Michio wanted to find the value of  $x$  in the equation  $2(3)^x = 34$ . He first converted the equation to  $\log 2x = 17$ . Next he wrote  $2x = 9^x$  and used a calculator to find  $x = 64.670,081$ . Was his answer correct? If not, what was his mistake and what is the right answer?  
**No; he should have converted to  $x = \log_2 17$ ;  $x = 2.58$ .**

**3. SOUND** The decibel level  $L$  of a sound is determined by the formula  $L = 10 \log_{10} \frac{I}{I_0}$ . Find  $I$  in terms of  $M$  for a noise with a decibel level of 120.  
 **$I = 1,000,000,000,000 M$  or  $10^{12} M$**

**4. EARTHQUAKES** The intensity of an earthquake can be measured on the Richter scale using the formula  $y = 10^{x-1}$ , where  $y$  is the absolute intensity of the earthquake and  $R$  is its Richter scale measurement.

Richter Scale Number	Absolute Intensity
1	1
2	10
3	100
4	1000
5	10,000

An earthquake in San Francisco in 1906 had an absolute intensity of 6,000,000. What was that earthquake's measurement on the Richter scale?  
**7.8**

**5. GAMES** Julio and Natalia decided to play a game in which they each selected a logarithmic function and compare their functions to see which gave larger values. Julio selected the function  $f(x) = 10 \log_2 x$  and Natalia selected the function  $g(x) = 2 \log_{10} x$ .

- a. Which of the functions has a larger value when  $x = 77$ ?  
**Julio's; Julio's is 28.07 and Natalia's is 1.69.**
- b. Which of their functions has a larger value when  $x = 17$ ?  
**Neither; both equal 0.**
- c. Do you think the base or the multiplier is more important in determining the value of a logarithmic function?  
**Answers will vary.**

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PERIOD \_\_\_\_\_  
**7-4 Skills Practice**  
**Solving Logarithmic Equations and Inequalities**

Solve each equation.

1.  $3x = \log_6 216$       2.  $x - 4 = \log_2 243$       3.  $\log_2 (4x - 20) = 5$   
**1**      **9**      **261**

4.  $\log_3 (3 - x) = \log_3 (5x - 15)$     5.  $\log_{10} (x + 20) = \log_{10} (6x)$     6.  $\log_2 (3x^2) = \log_2 (2x + 1)$   
**no solution**      **4**       **$-\frac{1}{3}$  or 1**

7.  $\log_2 (x - 1) = \log_2 (12)$       8.  $\log_2 (5 - x) = \log_2 (5)$       9.  $\log_2 (3x) = 2$   
**13**      **0**      **5**

Solve each inequality.

10.  $\log_2 (-3x) < 1$       11.  $\log_2 x > \log_2 (4 - x)$   
 **$\{x | -\frac{5}{3} < x < 0\}$**        **$\{x | 2 < x < 4\}$**

12.  $\log_{10} (x - 3) < 2$       13.  $\log_2 (x - 5) > \log_2 (3)$   
 **$\{x | 3 < x < 103\}$**        **$\{x | x > 8\}$**

14.  $\log_2 (8x + 5) > \log_2 (6x - 18)$     15.  $\log_2 (3x - 3) < 1.5$   
 **$\{x | x > 3\}$**        **$\{x | 1 < x < 10\}$**

16.  $\log_{10} (2x - 2) < \log_{10} (7 - x)$   
 **$\{x | 1 < x < 3\}$**       17.  $\log_2 (x - 1) > \log_2 (2x)$   
**no solution**

18.  $\log_{10} x \geq 0.5$       19.  $\log_2 \left(\frac{x-3}{4} + 5\right) > \log_2 (x + 2)$   
 **$\{x | x \geq 4\}$**        **$\{x | -2 < x < 3\}$**

20.  $\log_2 (3x) < \log_2 (2x - 1)$     21.  $\log_2 (7 - x) \leq \log_2 (x + 19)$   
**no solution**       **$\{x | -6 \leq x \leq 7\}$**

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PERIOD \_\_\_\_\_  
**7-4 Practice**  
**Solving Logarithmic Equations and Inequalities**

Solve each equation.

1.  $x + 5 = \log_4 256$   
 **$x = -1$**

3.  $\log_2 (4x - 17) = 5$   
 **$x = 65$**

5.  $\log_{10} (x^2 - 4) = \log_{10} 3x$   
 **$x = 4$**

4.  $\log_2 (3 - x) = 5$   
 **$x = -3122$**

6.  $\log_2 (x - 5) = \log_2 (3x - 25)$   
 **$x = 10$**

Solve each inequality.

7.  $\log_2 (-6x) < 1$   
 **$\{x | 0 > x > -\frac{4}{3}\}$**

9.  $\log_{10} (x + 7) < 1$   
 **$\{x | -7 < x < 4\}$**

11.  $\log_2 (x + 6) < \log_2 17$   
 **$\{x | 11 > x > -6\}$**

13.  $\log_2 (2x - 1) < 0.5$   
 **$\{x | 0.5 < x < 2\}$**

15.  $\log_2 (x + 12) > \log_2 2x$   
 **$\{x | 12 > x > 0\}$**

17.  $\log_2 (x + 3) < \log_2 (1 - 3x)$   
 **$\{x | -3 < x < -\frac{1}{2}\}$**

8.  $\log_2 (x + 2) > \log_2 (6 - 3x)$   
 **$\{x | 1 < x < 2\}$**

10.  $\log_{10} x \leq 0.75$   
 **$\{x | 27 \geq x > 0\}$**

12.  $\log_{10} (2x - 1) > \log_{10} (5x - 16)$   
 **$\{x | 3 \frac{1}{5} < x < 5\}$**

14.  $\log_{10} (x - 5) > \log_{10} 2x$   
**no solution**

16.  $\log_2 (0.3x + 5) > \log_2 (x - 2)$   
 **$\{x | 2 < x < 10\}$**

18.  $\log_2 (3 - x) \leq \log_2 (x - 1)$   
 **$\{x | 3 > x \geq 2\}$**

**19. WILDLIFE** An ecologist discovered that the population of a certain endangered species has been doubling every 12 years. When the population reaches 20 times the current level, it may no longer be endangered. Write the logarithmic expression that gives the number of years it will take for the population to reach that level.  
 **$12 \log_2 20$**