



## Problem Set

Write a formula for the balance of each savings account at the end of  $t$  years, compounded annually.

1.  $P = \$3000, r = 3\%$

$$P_t = 3000(1 + 0.03)^t$$

2.  $P = \$4000, r = 6\%$

3.  $P = \$17,500, r = 10\%$

4.  $P = \$25,000, r = 12\%$

5.  $P = \$135,000, r = 3.6\%$

6.  $P = \$275,000, r = 2.7\%$

7.  $P = \$15,000, r = 0.52\%$

8.  $P = \$53,000, r = 0.13\%$

Calculate the balance of each savings account if interest is compounded annually. Assume that no withdrawals are made from the account.

9.  $P = \$2000, r = 3\%, t = 4$

$$P = P_0(1 + r)^t$$

$$P = 2000(1 + 0.03)^4$$

$$2000(1.03)^4 = \$2251.02$$

10.  $P = \$3000, r = 4\%, t = 5$

11.  $P = \$1500, r = 2.5\%, t = 6$

12.  $P = \$25,000, r = 4.2\%, t = 10$

13.  $P = \$1,500,000, r = 2.7\%, t = 3$

14.  $P = \$20,000,000, r = 3.5\%, t = 5$

**Use the information provided to answer each question.**

15. A savings bond costs \$1000 and has an interest rate of 4% compounded monthly. Calculate the value of the savings bond after 10 years.

$$P = P_0 \left(1 + \frac{r}{n}\right)^{nt} = 1000 \left(1 + \frac{0.04}{12}\right)^{12(10)} = \$1490.83$$

16. You deposit \$12,500 into an account with an interest rate of 6% compounded monthly. Calculate the balance after 4 years.
17. You invest \$125,000 into an account with an interest rate of 3.75% compounded monthly. Calculate the balance after 15 years.
18. You invest \$50,000, and have a rate of return of 6.15% compounded monthly. Calculate the balance after 12 years.
19. To buy a car, you save \$15,000 in an account with an interest rate of 8.45% compounded twice a year. Calculate the balance after 5 years.
20. You deposit \$500 in a certificate of deposit (CD) that earns 1.25% compounded four times a year. Calculate the balance after 8 years.



Name \_\_\_\_\_

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## A Review Properties of Whole Number Exponents

### Vocabulary

Identify each term using the given expression.

$$2^3$$

1. power
2. base
3. exponent

### Problem Set

Use the definition of a power to simplify each expression.

1.  $2 \cdot x \cdot x \cdot x$

$$2x^3$$

2.  $7 \cdot x \cdot x \cdot x \cdot x \cdot x$

3.  $14 \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y$

4.  $13 \cdot x \cdot x \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y$

5.  $150 \cdot A \cdot A \cdot B \cdot B \cdot B \cdot B \cdot B \cdot C \cdot C \cdot C \cdot C$

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6.  $125 \cdot A \cdot B \cdot B \cdot B \cdot B \cdot B \cdot B \cdot C \cdot C$

7.  $32 \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y \cdot z \cdot z \cdot z$

8.  $47 \cdot x \cdot x \cdot y \cdot y \cdot y \cdot z \cdot z \cdot z \cdot z \cdot z$

**Multiply the powers and simplify completely.**

9.  $2^3 \cdot 2^5$

$2^8 = 256$

10.  $3^2 \cdot 3^3$

11.  $4x^3 \cdot 5x^2$

12.  $7x^2 \cdot 3x^6$

13.  $6x^3 \cdot 8y^5$

14.  $2x^5 \cdot -12y^3$

15.  $-3x^3 \cdot 5y^2 \cdot 6x^4 \cdot 3y^5$

16.  $4x^5 \cdot 10y^4 \cdot 2x^8 \cdot 3y^3$

**Divide the powers and simplify completely.**

17.  $\frac{x^7}{x^3}$   
 $x^4$

18.  $\frac{x^{10}}{x^4}$

19.  $\frac{5^6}{5^4}$

20.  $\frac{3^6}{3^8}$

21.  $\frac{10x^8}{5x^5}$

22.  $\frac{24x^{11}}{-6x^5}$

23.  $\frac{5x^7 \cdot 3x^2}{10x^3 \cdot -2x^4}$

24.  $\frac{9x^4 \cdot 2y^2}{3x \cdot 12y^6}$

25.  $\frac{x^5}{x^8}$

26.  $\frac{x^8}{x^{12}}$

**Raise each power to a power and simplify completely.**

27.  $(x^3)^4$   
 $x^{12}$

28.  $(x^5)^3$

29.  $(2^3)^3$

30.  $(2^5)^2$

**Raise each product to a power and simplify completely.**

31.  $(x^3y^4)^4$   
 $x^{12}y^{16}$

32.  $(x^2y^5)^3$

33.  $(-3x^3)^2$

34.  $(10x^4y)^3$

35.  $(4x^2y^3)^4 \cdot (2x^3y^5)^5$

36.  $(10xy)^3 \cdot (2x^3y^4)^2 \cdot (4x^2y^2)^4 \cdot (-3x^3y^4)^3$

**Raise each quotient to a power and simplify completely.**

37.  $\left(\frac{3}{4}\right)^3$   
 $\frac{27}{64}$

38.  $\left(\frac{10}{3}\right)^5$

39.  $\left(\frac{x}{y}\right)^4$

40.  $\left(\frac{2y^3}{x^5}\right)^5$

41.  $\left(\frac{12x^3}{y^{10}}\right)^2$

42.  $\left(\frac{-3x^3y^4}{4x^5y^{10}}\right)^3$

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

44.  $\left(\frac{10x^3y^{10}}{3x^4y^7}\right)^3$

45.  $\left(\frac{3x^2}{y^4}\right)^3 \cdot \left(\frac{y^3}{x^4}\right)^2$

46.  $\left(\frac{2x^3}{y^5}\right)^2 \cdot \left(\frac{y^4}{x^3}\right)^4$

Simplify each expression completely.

47.  $\frac{x^3}{x^3}$

48.  $\frac{y^{10}}{y^{10}}$

1

49.  $(3x)^3$

50.  $\frac{(4x^2)^2}{8x^4}$

51.  $\frac{(x^2y^3)^2}{(3x^2y^2)^3}$

52.  $\frac{(2xy^4)^3}{(x^2y^3)^4}$

53.  $\left(\frac{-3x^2y^3}{2y^5}\right)^3 \cdot \left(\frac{4x^3y^3}{9x^2}\right)^2 \cdot \frac{-(3x^3y^2)^2}{(8xy)^3}$

54.  $\left(\frac{5x^3y^4}{3xy^2}\right)^2 \cdot \left(\frac{9x^2y^4}{10y^3}\right)^3 \cdot \frac{-(20x^2y^3)^3}{9x^2y^3}$

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## Exponents, Reciprocals, and Roots Integral and Rational Exponents

### Vocabulary

Give an example of each type of exponent.

1. negative exponent
  
2. rational exponent

### Problem Set

Rewrite each expression without negative exponents. Then simplify completely.

1.  $x^{-3}$   
 $\frac{1}{x^3}$

2.  $x^{-8}$

3.  $3x^{-5}y^2 \cdot 5x^{-3}y^3$

4.  $11x^4y^{-3} \cdot 2x^{-5}y$

5.  $\frac{x^{-5}y^3}{x^{-2}y^4}$

6.  $\frac{x^3 \cdot y^{-5}}{x^{-4} \cdot y^2}$

7.  $(2x^{-2}y^3)^{-2}$

8.  $(3x^3y^{-4})^{-3} \cdot (-4x^2y^{-5})^2$

$$9. \left(\frac{2x^5y^4}{5x^{-2}}\right)^3 \cdot \left(\frac{5x^{-5}}{2y^6}\right)^2 \cdot \left(\frac{10y^{-3}}{8x^4}\right)^2$$

$$10. \left(\frac{6x^{-5}y}{x^4y^{-2}}\right)^2 \cdot \left(\frac{4x^2}{9y^{-3}}\right)^3 \cdot \left(\frac{3x^4y^2}{8x^{-3}}\right)^2$$

Solve each equation for  $a$ .

$$11. x^a \cdot x^a \cdot x^a = x^2$$

$$(x^a)^3 = x^{3a} = x^2$$

$$3a = 2$$

$$a = \frac{2}{3}$$

$$12. x^a \cdot x^a \cdot x^a = x^4$$

$$13. 9 = 81^a$$

$$14. 5 = 625^a$$

$$15. 64^a = 2$$

$$16. 10,000^a = 10$$

## 6

Rewrite each expression in radical form.

$$17. 3^{\frac{1}{2}}$$

$$18. 7^{\frac{3}{2}}$$

$$\sqrt{3}$$

$$19. x^{\frac{5}{4}}$$

$$20. x^{\frac{3}{8}}$$

21.  $x^{\frac{1}{3}}y^{\frac{1}{2}}$

22.  $x^{\frac{1}{4}}y^{\frac{2}{3}}$

**Rewrite each expression in radical form. Then simplify completely.**

23.  $125^{\frac{2}{3}}$

24.  $16^{\frac{3}{4}}$

$$(\sqrt[3]{125})^2 = 5^2 = 25$$

25.  $81^{\frac{5}{4}}$

26.  $1000^{\frac{5}{3}}$

**Rewrite each expression in exponential form and simplify completely.**

27.  $\sqrt[3]{3^6}$

28.  $\sqrt[6]{5^2}$

$$3^{\frac{6}{3}} = 3^2 = 9$$

29.  $\sqrt[3]{9^2}$

30.  $\sqrt[5]{2^4}$

31.  $\sqrt[9]{x^3}$

32.  $\sqrt[6]{x^4}$

33.  $\sqrt[2]{x^3y^{10}}$

34.  $\sqrt[3]{x^{12}y^2}$

**Simplify each expression completely. Write the final answer in exponential form.**

35.  $(3^{\frac{2}{3}}y^{\frac{1}{6}})^3$

36.  $(5^{\frac{3}{4}}x^{\frac{5}{2}})^4$

$$(3^{\frac{2}{3}})^3(y^{\frac{1}{6}})^3 = 3^2y^{\frac{3}{6}} = 9y^{\frac{1}{2}}$$

37.  $(27x^2y^3)^{\frac{2}{3}} \cdot (x^{\frac{1}{2}}y^2)^4 \cdot (x^{-3}y^{\frac{1}{2}})^{-2}$

38.  $(2x^3y^{\frac{1}{3}})^6 \cdot (256x^8y^{\frac{4}{3}})^{\frac{1}{4}} \cdot (x^{\frac{1}{3}}y^3)^{-6}$



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## The Hockey Stick Graph Applications of Exponential Functions

### Vocabulary

Use the words below to fill in the blanks. Each word may be used more than once.

depreciate	exponential growth	exponential decay	half-life	decays
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1. Assets \_\_\_\_\_, or decrease in value over time.
2. A radioactive substance undergoes \_\_\_\_\_.
3. When a quantity \_\_\_\_\_, there is an amount of time after which the new sample size is half the original amount, known as its \_\_\_\_\_.
4. When a population grows by a certain percent each year, it undergoes \_\_\_\_\_.
5. Carbon-14 has a(n) \_\_\_\_\_ of 5730 years. After 5730 years, there will be half as much carbon-14 as in the initial amount.

### Problem Set

Calculate the value of each item.

1. A new car costs \$17,500 and depreciates at a rate of 7% annually. What will the value of the car be in 5 years?  
 $17,500(0.93)^5 = \$12,174.55$
2. A new computer costs \$850 and depreciates at a rate of 11% annually. What will the value of the computer be in 3 years?
3. A factory buys new equipment for \$125,000 and depreciates at a rate of 2.3%. What will the value of the equipment be in 12 years?

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4. A Cessna SkyCatcher costs \$111,500. If the SkyCatcher depreciates at a rate of 1.75% annually, what will the value of the airplane be in 6 years?

**Calculate the value of each item.**

5. A baseball card costs \$30. If the card appreciates at a rate of 5% annually, what will the value of the card be in 3 years?

$$30(1.05)^3 = \$34.73$$

6. Your mother buys an antique vase for \$120. If the vase appreciates at a rate of 4% annually, what will the value of the vase be in 16 years?

7. A vintage car costs \$26,700. If the car appreciates at a rate of 3.7% annually, what will the value of the car be in 22 years?

8. A gold watch costs \$1250. If the watch appreciates at a rate of 2.75% annually, what will the value of the watch be in 7 years?

**Calculate each population.**

9. Albany has a population of 15,000 people and grows at about 4% per year. What will the population be in 25 years?

$$15,000(1.04)^{25} = 39,987.54 \approx 39,988$$

10. Endwell has a population of 5650 people and grows at about 8% per year. What will the population be in 17 years?

**6**

11. A bird sanctuary contains 3250 birds. The bird population is decreasing by 3% per year. What will the population be in 23 years?

12. An aquarium contains 235 fish. The aquarium has a bacterium that kills 2% of the fish per year. How many fish will there be in 5 years?

13. A park contains 4652 trees and the number of trees increases by 7% per year. How many trees were in the park 8 years ago?
14. Tacoma had a population of 193,556 in the year 2000. If the population of Tacoma is decreasing by 5% per year, what was the population of Tacoma in 1994?

**Calculate the amount of each material remaining.**

15. Silicon-32 has a half-life of 150 years. If a computer has 3 kilograms of silicon-32 in it, how much silicon-32 will be left after 600 years?

$$3(0.5)^{\frac{600}{150}} = 0.1875 \text{ kilograms}$$

16. Chlorine-36 has a half-life of 301,000 years. If a bucket of pool chlorine has 300 grams of chlorine-36, how much chlorine-36 will the bucket have in 100,000 years?
17. Cesium-138 has a half-life of 33 minutes. If an atomic clock has 625 grams of cesium-138, how much cesium-138 will the clock have in 4 hours?
18. Zinc-61 has a half-life of 89 seconds. If an alloy has 2 kilograms of zinc-61, how much zinc will be left after 6 minutes?

**Complete each table of values.**

19. A bacteria is being eaten by a population of zooplankton. The bacteria's population starts at 450,000 and decreases by 2%. Complete the table below to show how many bacteria there will be after 0, 40, 80, and 120 days.

<b>Quantity Name</b>	<b>Time</b>	<b>Number of Bacteria</b>
<b>Unit</b>	days	thousands of bacteria
<b>Expression</b>	$t$	$450(0.98)^t$
	0	450
	40	200.5652
	80	89.392
	120	39.842

20. An antique typewriter is bought for \$250. It appreciates at a rate of 4% per year. Complete the table below to show how much the typewriter will be worth after 0, 10, 20, and 40 years.

<b>Quantity Name</b>		
<b>Unit</b>		
<b>Expression</b>		

21. A ring is bought for \$350. It appreciates at a rate of 5.4% per year. Complete the table below to show how much the ring will be worth after 0, 20, 40, and 60 years.

<b>Quantity Name</b>		
<b>Unit</b>		
<b>Expression</b>		



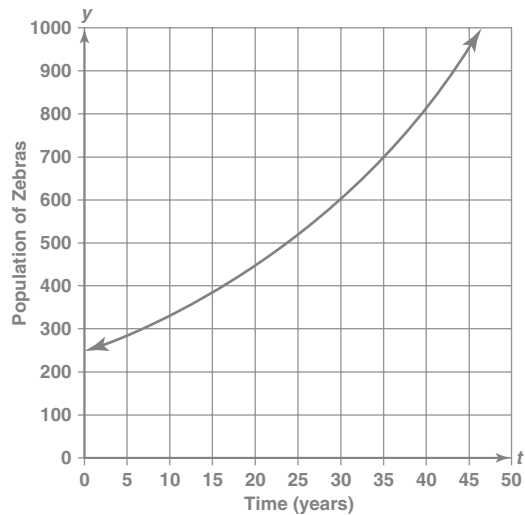
22. A road flare contains 50 grams of strontium-90, which has a half-life of about 29 years. Complete the table below to show how much strontium-90 will be in the road flare after 0, 20, 40, and 60 years.

<b>Quantity Name</b>	
<b>Unit</b>	
<b>Expression</b>	

Create a graph from each table.

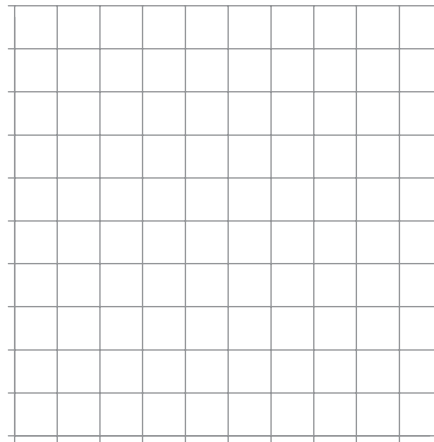
23. A population of zebras grows 3% per year. Their growth is given by the table below.

<b>Time</b>	<b>Population of Zebras</b>
<b>years</b>	<b>zebras</b>
0	250
20	451
40	816
60	1473



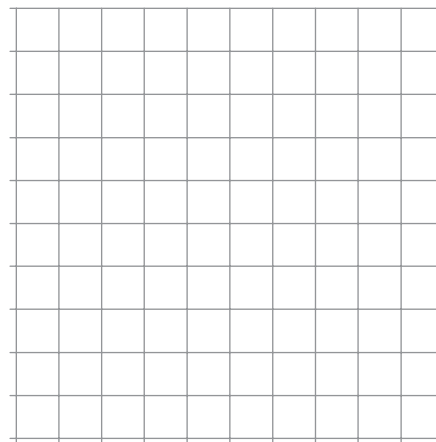
24. An airplane depreciates at a rate of 5% per year. Its value is given by the table below.

Time	Value of Airplane
years	thousands of dollars
0	750
10	449
20	269
30	161



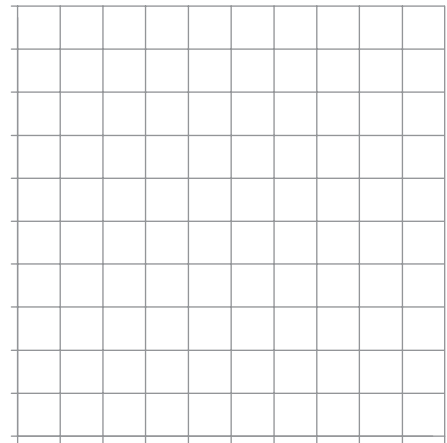
25. A bone loses half of its carbon-14 every 5730 years. The amount of carbon-14 in the bone is given below.

Time	Amount of Carbon-14
years	grams
0	140.0
1000	124.0
3000	97.4
6000	67.8



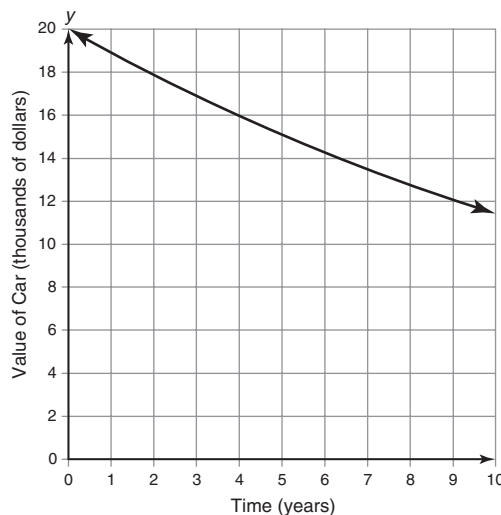
26. The population of falcons in a national park decreases by 2.5% per year. The number of falcons in the park is given in the table below.

Time	Population of Falcons
years	falcons
0	115
5	101
10	89
15	79



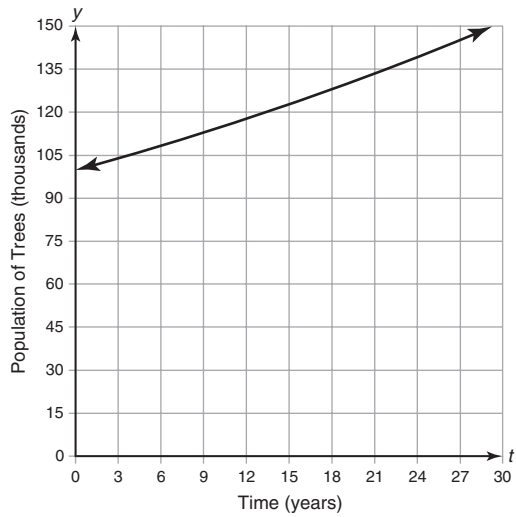
Use each graph to approximate a solution.

27. A car depreciates at 5.4% per year. The value of the car in thousands of dollars is given by the graph below. When will the car have a value of \$15,000?

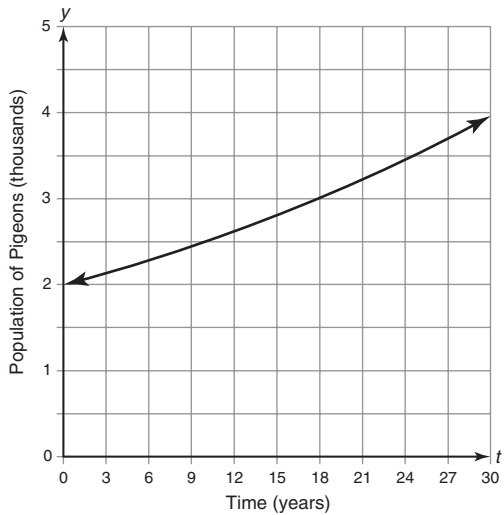


After about 5 years, the car will have a value of \$15,000.

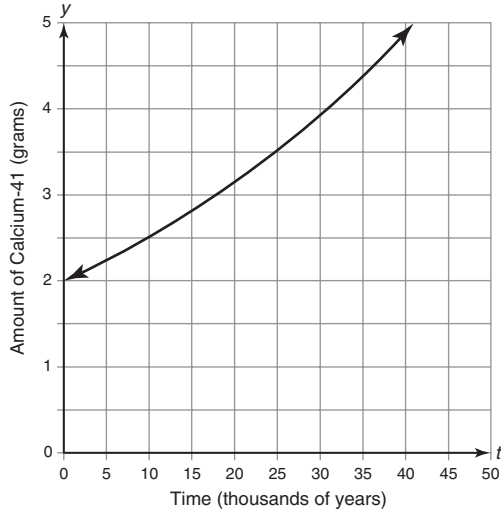
28. The population of trees in a forest grows by 1.4% per year. The tree population in the park, in thousands, is graphed below. When will the forest have 125,000 trees?



29. A population of pigeons grows by 2.3% per year. The pigeon population, in thousands, is graphed below. When will there be 3000 pigeons?



30. A prehistoric animal's bones contain an amount of calcium-41 that has a half-life of 100,000 years. The amount of calcium-41, in grams, in the animal's bones is graphed below, where the years are in thousands. When will the animal's bones contain 5 grams?





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## Log a What? Inverses of Exponential Functions: Logarithmic Functions

### Vocabulary

Define each term in your own words.

1. logarithm
2. base of a logarithm
3. common logarithm
4. natural logarithm

### Problem Set

Convert each exponential equation to logarithmic form. Write a sentence to demonstrate how the logarithm equation would be spoken.

1.  $7^x = 9$   
 $\log_7 9 = x$   
 $x$  is equal to the log base 7 of 9.
2.  $8^x = 12$

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3.  $3^{2x} = 4$

4.  $6^{3x} = 2$

5.  $e^x = 15$

6.  $e^x = \frac{1}{2}$

7.  $10^{2x-3} = 4$

8.  $10^{-6x+5} = 27$

9.  $7^{x-5} = 0.12$

**6**

10.  $8^{-3x+2} = 0.03$



**Evaluate each logarithm.**

11.  $\log_2 8$

3

12.  $\log_5 25$

13.  $\log 10,000$

14.  $\log 1,000,000$

15.  $\log_9 81$

16.  $\log_3 81$

17.  $\log_7 7^3$

18.  $\log_4 4^5$

**Write a sentence to demonstrate how each logarithmic equation would be spoken. Then convert each logarithmic equation to exponential form.**

19.  $x = \log_2 5$

The log base 2 of 5 is x.

$2^x = 5$

20.  $x = \log_4 6$

21.  $4x = \log_5 2.3$

22.  $0.2x = \log_8 4.2$

23.  $x + 5 = \log_2 5.1$

24.  $x - 11 = \log_3 0.02$

25.  $2x + 4 = \log_3 6$

26.  $3x - 6 = \log_7 15$

27.  $x = \log_4 7 + 3$

28.  $x = \log 8 - 4$

---

Solve each equation by writing each side of the equation as an exponential expression with the same base.

29.  $2^x = 32$

$$2^x = 2^5$$

$$x = 5$$

30.  $3^x = 81$

31.  $4^{x+2} = 64$

32.  $5^{-x-3} = 125$

Solve each equation by converting to logarithmic form.

33.  $10^{-x+3} = 1,000,000$

$$-x + 3 = \log 1,000,000$$

$$-x + 3 = 6$$

$$-x = 3$$

$$x = -3$$

34.  $10^{4x-3} = 100,000$

35.  $10^{2x+4} = 0.000001$

36.  $10^{-2x-5} = 0.001$

37.  $2^{5x} - 8 = 0$

38.  $9^{4x} - 3 = 0$

Write the inverse of each function.

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

$f^{-1}(x) = \log_5 x$

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

41.  $f(x) = \log x$

42.  $f(x) = \log_{1.3} x$

Complete each table of values for  $f(x)$  and  $f^{-1}(x)$ .

43.

$x$	$f^{-1}(x) = \log_5 x$
1	0
5	1
25	2
$\frac{1}{5}$	-1
$\frac{1}{25}$	-2

$x$	$f(x) = 5^x$
0	1
1	5
-1	$\frac{1}{5}$
2	25
-2	$\frac{1}{25}$

44.

$x$	$f(x) = 4^x$
0	
1	
-1	
2	
-2	

$x$	$f^{-1}(x) = \log_4 x$

45.

$x$	$f(x) = \log_{10} x$
1	
10	
100	
$\frac{1}{10}$	
$\frac{1}{100}$	

$x$	$f^{-1}(x) = 10^x$

46.

$x$	$f^{-1}(x) = 3^x$

$x$	$f(x) = \log_3 x$
1	
3	
$\frac{1}{3}$	
9	
$\frac{1}{9}$	

47.

$x$	$f(x) = 9^x$
0	
1	
-1	
2	
-2	

$x$	$f^{-1}(x) = \log_9 x$

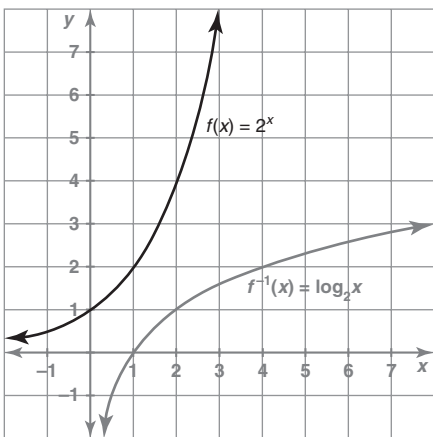
48.

$x$	$f^{-1}(x) = \log_{25} x$

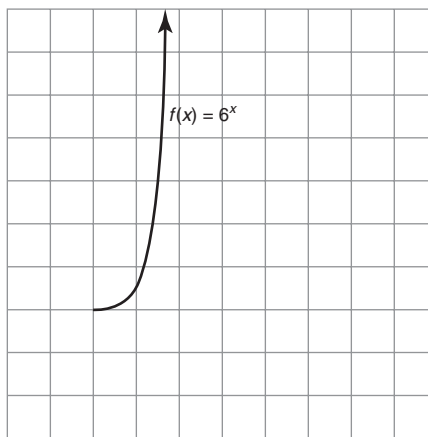
$x$	$f(x) = 25^x$
0	
1	
-1	
2	
-2	

Given each graph of  $f(x)$ , graph its inverse,  $f^{-1}(x)$ .

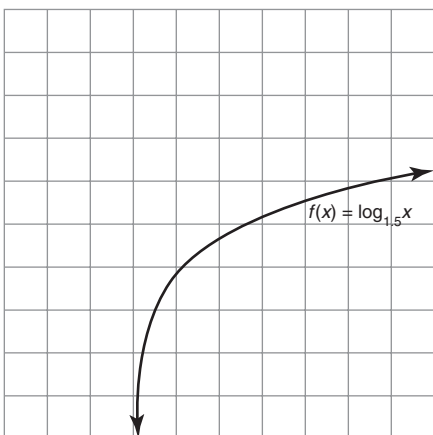
49.  $f(x) = 2^x$



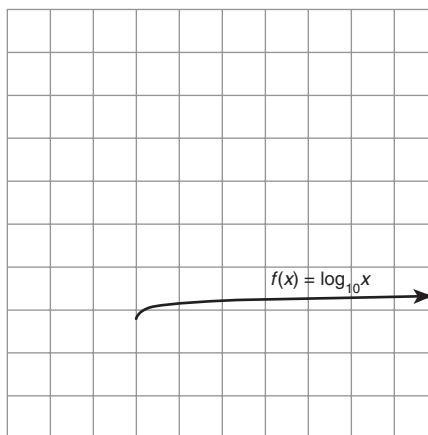
50.  $f(x) = 6^x$



51.  $f(x) = \log_{1.5} x$



52.  $f(x) = \log_{10} x$



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## Properties of Logarithms The Remainder and Factor Theorems

### Vocabulary

Match each expression below with the best word that describes it.

- |               |                                  |
|---------------|----------------------------------|
| 1. $x^{-3}$   | a. base with an exponent         |
| 2. $4^2$      | b. logarithm                     |
| 3. $\log_2 x$ | c. base with a negative exponent |

### Problem Set

For each property of exponents, write the corresponding property of logarithms.

- |                       |                          |
|-----------------------|--------------------------|
| 1. $a^m \cdot a^n$    | 2. $\frac{a^m}{a^n}$     |
| $\log_a m + \log_a n$ |                          |
| 3. $(a^m)^2$          | 4. $(a^n)^{\frac{1}{2}}$ |

Rewrite each expression using common logs. Then evaluate the expression.

- |   |                     |
|---|---------------------|
| 5. $\log_5 7$<br>$\frac{\log 7}{\log 5} \approx 1.2091$ | 6. $\log_9 11$      |
| 7. $\log_4 215$   | 8. $\log_{13} 144$  |
| 9. $\log_{23} 22$                                       | 10. $\log_{100} 25$ |

11.  $\ln 6$

12.  $\ln 12$

Write each logarithmic expression in expanded form.

13.  $\log_3 5x^2$

$\log_3 5 + 2 \log_3 x$

14.  $\log_2 3x^4$

15.  $\log_8 6x^3y^5$

16.  $\log_5 10x^9y^7$

17.  $\log_4 \frac{1}{x^2}$

18.  $\log_5 \frac{y}{x^4}$

19.  $\log_6 \frac{8x^4}{y^6}$

20.  $\log_3 \frac{2}{x^2y^{10}}$

21.  $\ln 4x^3y^6$

22.  $\ln \frac{x^3}{4y^2}$

Write each logarithmic expression using a single logarithm. Evaluate the logarithm if possible.

23.  $\log_{11} 5 + 2 \log_{11} y$

$\log_{11} 5y^2$

24.  $\log_3 6 + 5 \log_3 x$

25.  $\log_4 10 + 3 \log_4 x + 6 \log_4 y$

26.  $\log_7 122 + 5 \log_7 x + 8 \log_7 y$

27.  $3 \log 20 - 2 \log 4$

28.  $3 \log 5 + 8 \log 2$

29.  $2 \log 3 - 3 \log x + 6 \log y$

30.  $4 \log 5 + 5 \log x - 8 \log y$

31.  $4(\ln 2 - \ln y) + 2(\ln x - \ln 5)$

32.  $3(\ln 3 + \ln x - 2 \ln y) + 2(\ln 4 - 3 \ln y)$



Name \_\_\_\_\_ Date \_\_\_\_\_

## Continuous Growth, Decay, and Interest Solving Exponential and Logarithmic Equations

### Vocabulary

Write the term from the box that best completes each statement.

compound interest	natural number	simple interest
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1. The number  $e$  is called the \_\_\_\_\_.
2. \_\_\_\_\_ is when interest is paid only as a percent of the principal.
3. \_\_\_\_\_ is interest on both the principal and previously earned interest.

### Problem Set

Answer each question about population.

1. The town of Klamath has a population of 4000 and grows 3% annually. When will the population be 5000?

$$5000 = 4000(1.03)^t$$

$$1.25 = 1.03^t$$

$$\log 1.25 = t \log 1.03$$

$$\frac{\log 1.25}{\log 1.03} = t$$

$$t \approx 7.549$$

The population will be 5000 after approximately 7.5 years.

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2. The city of Brooklyn has a population of 135,000 and grows 4.2% annually. When will the population be 150,000?

3. The township of O'Hare has a population of 350 and grows 1.5% annually. When will the population double?

4. The municipality of Noren has a population of 12,000 and grows 2.9% annually. How long will it take the population to triple?



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**Calculate the time to double each investment.**

7. A bond of \$100 earns 1.3% compounded monthly.

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

$$2(100) = 100\left(1 + \frac{0.013}{12}\right)^{12(t)}$$

$$2 = \left(1 + \frac{0.013}{12}\right)^{12(t)}$$

$$\log 2 = 12t \log\left(1 + \frac{0.013}{12}\right)$$

$$t = \frac{\log 2}{12 \log\left(1 + \frac{0.013}{12}\right)}$$

$$t \approx 53.3478$$

The investment would double in about 53.35 years.

8. A money market account of \$1000 earns 3.5% compounded monthly.

Name \_\_\_\_\_ Date \_\_\_\_\_

9. A mutual fund of \$2000 earns 4.3% compounded annually.

10. A Roth IRA account of \$5000 earns 6% compounded annually.

11. A Swiss bank account of \$7000 earns 4.2% compounded continuously.

12. An ad in the paper is asking for an investment of \$10,000 and claims to offer you 7.8% compounded continuously.

**Answer each question about decay.**

13. Sodium-22 has a half-life of 2.6 years. Determine the age of a piece of salt, if 10% of the sodium-22 is left in the salt.

$$N = N_0(0.5)^{\frac{t}{\lambda}}$$

$$0.10N_0 = N_0(0.5)^{\frac{t}{2.6}}$$

$$0.10 = (0.5)^{\frac{t}{2.6}}$$

$$\ln 0.10 = \frac{t}{2.6} \ln 0.5$$

$$t = \frac{2.6 \ln 0.10}{\ln 0.5}$$

$$t \approx 8.6370$$

The piece of salt was made about 8.63 years ago.

14. Copper-60 has a half-life of 5.3 years. A museum has bought what it thinks to be a prehistoric tool. Determine the age of the tool if 0.002% of the copper-60 is left in the tool. Decide if the tool is from a prehistoric period at least 12,000 years ago.

15. Determine the decay constant for lead-210, if it has a half-life of 22.3 years.
16. Determine the decay constant for platinum-193, if it has a half-life of 50 years.

**Answer each question about the spread of disease.**

17. In a small town of 2000 people, 8 people have a cold. Each victim can infect 4 people a day. When will the entire town have the cold?

$$2000 = 8(4)^t$$

$$250 = 4^t$$

$$t = \log_4 250$$

$$t = \frac{\ln 250}{\ln 4}$$

$$t \approx 3.98$$

**The entire town could be infected in about 4 days.**

18. At a basketball conference of 64 athletes, 2 have a foot fungus. Each victim can infect 3 people a day. When will all the athletes have the fungus?

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19. A park of 240,000 trees experiences a blight that infects 12 trees, and each infected tree infects 6 more a day. When will all of the trees in the park be infected with the blight?

20. A puma population of 250 experiences a disease that infects 2, and each infected puma infects 2 more a day. When will all of the pumas be infected with the disease?