

# Reteach

## Chapter 8

Name \_\_\_\_\_

*What you should learn:*

**8.1** How to multiply with exponents and use exponential equations to model real-life situations.

**Correlation to Pupil's Textbook:**

**Mid-Chapter Test (p. 425)**    **Chapter Test (p. 449)**  
Exercises 1–5, 17, 18, 25, 26    Exercises 1, 5, 9, 13, 24

### Examples

#### *Multiplying Powers and Using Powers and Models In Real-Life*

Simplify using multiplication properties of exponents.

a.  $2^2 \cdot 2^5 = 2^{2+5}$   
 $= 2^7$

b.  $(5^3)^2 = 5^3 \cdot 2$   
 $= 5^6$

c.  $(-2x)^4 = (-2 \cdot x)^4$   
 $= (-2)^4 \cdot x^4$   
 $= 16x^4$

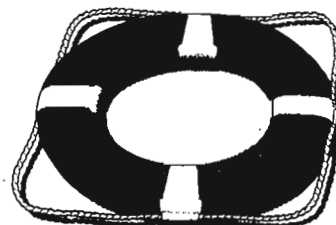
d.  $-(2x)^4 = -(2 \cdot x)^4$   
 $= -(2^4) \cdot x^4$   
 $= -16x^4$

e.  $(3a^4)^3 (\frac{1}{3}a^3)^2 = (3 \cdot a^4)^3 (\frac{1}{3} \cdot a^3)^2$   
 $= (3)^3 \cdot (a^4)^3 \cdot (\frac{1}{3})^2 \cdot (a^3)^2$   
 $= 27a^{12} \cdot \frac{1}{9}a^6$   
 $= 3a^{18}$

- f. Your three-year-old brother has a new plastic swimming pool. The pool has a circular base with a radius of 60 centimeters. The height of the pool is 15 centimeters. How many cubic centimeters of water are needed to completely fill the swimming pool?

The volume of a circular cylinder is the height times the area of the circular base. The area of a circle is  $\pi$  times the square of the radius of the circle. Thus, the volume of the pool is:

$$\pi r^2 h = \pi (60)^2 (15) = 54,000\pi \approx 169,646 \text{ cubic centimeters.}$$



### Guidelines:

- To multiply powers that have the same base, add the exponents.
- To find a power of a power, multiply the exponents.
- To find a power of a product, find the power of each factor and multiply.
- The general form of an exponential equation is  $y = c(a)^x$  where  $c$  is an initial amount,  $a$  is a "change" factor, and  $x$  is the number of times change occurs.

### EXERCISES

In Exercises 1–9, simplify (if possible).

1.  $7^4 \cdot 7^6$

2.  $(-3y^5)^4$

3.  $(5x)^3 \cdot (-4x)$

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

5.  $(-2a^3b)^3 (\frac{1}{2}a)^2$

6.  $[(3x + 1)^3]^4$

7.  $[(-2cd)^3]^2$

8.  $(-t)^6 (-t)^5 (-t)$

9.  $x^6 y^3$

# Extra Practice

# 8.1

Name \_\_\_\_\_

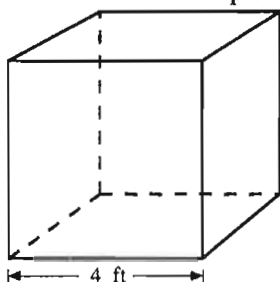
In 1–12, simplify, if possible.

1.  $3^2 \cdot 3^4$
2.  $(2^3)^5$
3.  $x^5 \cdot x^3$
4.  $(y^2)^8$
5.  $(2x)^3$
6.  $(-3x^4)^2$
7.  $(x^2)^7$
8.  $(-2x)^3(-x^2)$
9.  $(xy)^3(z^6)^2$
10.  $(a^2bc^3)^4 \cdot (b^2c)^3$
11.  $(-x)^3(-y^2)^4(xyz^5)^2$
12.  $(2x)^3(2y^2)^4\left(\frac{1}{2}xy\right)^5$

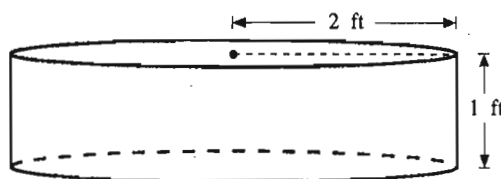
In 13–24, simplify. Then evaluate the expression when  $x = 2$  and  $y = 1$ .

13.  $(x^3)^2$
14.  $(xy^2)^3$
15.  $(x^2y)(3x)$
16.  $(x^4y^2)(y^5)$
17.  $(-2xy)^3$
18.  $(-3x)^2(2y)^3$
19.  $(xy^2)^2(5y^3)$
20.  $(2y)^4(3y^2)^2$
21.  $(-3x)^3(4y^3)^2$
22.  $(-xy)^4(xy^8)^2$
23.  $(x^2y)(xy^2)^2$
24.  $-2x^2y(x^3y^2)^3$

25. **Volume** Find the total volume of four cubic crates identical to the one pictured below.



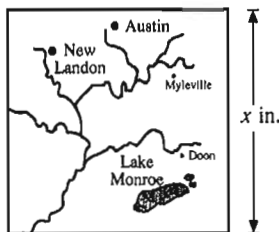
26. **Volume** Find the total volume of two cylindrical tanks identical to the one pictured below.



27. **Savings Account** You put \$100 in an account that pays an annual rate of 4%. The balance in the account,  $A$ , after  $t$  years, is given by  $A = 100(1.04)^t$ . What is the balance after 2 years?

28. **Collecting Pennies** You collect pennies. You start with one penny and double the number of pennies you have each day for 20 days. How many pennies will you have at the end of 20 days? Is it likely that you will be able to collect this many pennies?

29. **Maps** The scale of a square map indicates that each inch on the map corresponds to 5 miles. Write an expression that describes the area of land shown on the map. If the map is 8 inches on one side, what is the area of land shown on the map?



## EXERCISES

### Guided Practice

THINKING ABOUT THE LESSON

- Can  $x^8y^4$  be simplified? Explain.
- Simplify  $(a^{10})^3$ . What property did you use?
- Is  $a^5 \cdot a^3 = a^{15}$ ? Why or why not?
- Is  $(-3b)^4 = -12b^4$ ? Why or why not?
- Simplify  $a^3 \cdot a^4$ . Confirm your result by letting  $a = 2$  and evaluating the expression in both its original form and its simplified form.
- Use a calculator to evaluate  $(1.06)^{11}$ . Round your result to two decimal places.
- In the general exponential equation  $y = C(a)^x$ , suppose that  $a = 2$ , and  $x = 3$ . Describe how  $y$  changes when  $x$  is increased by 1.
- Identify each of these equations as a model of exponential growth or of exponential decay.
  - $y = 3^x$
  - $y = 0.5(3)^x$
  - $y = (0.5)^x$
  - $y = 2(0.5)^x$

### Independent Practice

In Exercises 9–41, simplify, if possible.

- |                                  |                                  |                             |
|----------------------------------|----------------------------------|-----------------------------|
| 9. $4^2 \cdot 4^3$               | 10. $6^5 \cdot 6^4$              | 11. $[(-9)^2]^4$            |
| 12. $10^2 \cdot 10^9$            | 13. $x \cdot x^5$                | 14. $(5^5)^4$               |
| 15. $[(2x + 3)^3]^2$             | 16. $(2x)^3$                     | 17. $(3 \cdot 7)^4$         |
| 18. $[(5 + x)^3]^6$              | 19. $(-5a)^2$                    | 20. $(16 \cdot 2)^2$        |
| 21. $(4a)^2 \cdot a$             | 22. $6^2 \cdot (6x^3)^2$         | 23. $[(-3xy)^2]^3$          |
| 24. $(x \cdot x^2)^3 \cdot 3x$   | 25. $(3a)^2 \cdot (-4a)^4$       | 26. $(9a^3)^2 \cdot (2a)^3$ |
| 27. $2x^3 \cdot (3x)^2$          | 28. $3y^2 \cdot (2y)^3$          | 29. $(-ab)(a^2b)^2$         |
| 30. $(-rs)(rs^3)^2$              | 31. $(-2xy)^3(-x^2)$             | 32. $(-3cd)^3(-d^2)$        |
| 33. $(4a^2)^3(\frac{1}{2}a^3)^2$ | 34. $(8b^3)^2(\frac{1}{4}b^2)^2$ | 35. $(-x)^5(-x)^2(-x)^3$    |
| 36. $(-y)^4(-y)^3(-y)^2$         | 37. $(2t)^3(-t^2)$               | 38. $(-w^3)(3w^2)^2$        |
| 39. $(abc^2)^3(a^2b)^2$          | 40. $(r^2st^3)^2(s^4t)^3$        | 41. $(-3xy^2)^3(-2x^2y)^2$  |

In Exercises 42–47, evaluate the expression when  $a = 1$  and  $b = 2$ .

- |                |                                     |                                   |
|----------------|-------------------------------------|-----------------------------------|
| 42. $(a^4)^3$  | 43. $b^3 \cdot b^4$                 | 44. $(a^2 \cdot b)^3$             |
| 45. $(a^2b)^5$ | 46. $(b^2 \cdot b^3) \cdot (b^2)^4$ | 47. $[(a + 4)^2]^3 \cdot (a + 4)$ |

In Exercises 48–50, say which number is larger.

- |                                      |  |                                      |
|--------------------------------------|--|--------------------------------------|
| 48. $(5 \cdot 7)^3$ or $5 \cdot 7^3$ | 49. $5^4 \cdot 2^5$ or $(5 \cdot 2)^5$ | 50. $(4^5 \cdot 4^{10})$ or $4^{50}$ |
|--------------------------------------|--|--------------------------------------|

# Reteach

## Chapter 8

Name \_\_\_\_\_

*What you should learn:*

**8.2** How to use negative and zero exponents and use powers as models in real-life situations.

**Correlation to Pupil's Textbook:**

**Mid-Chapter Test (p. 425)** **Chapter Test (p. 449)**

Exercises 6–8, 13, 14, 27      Exercises 2–4, 6, 8, 10,  
14, 15, 18

### Examples

#### Evaluating Negative and Zero Exponents and Modelling with Powers

a.  $3x^{-2} = 3 \cdot \frac{1}{x^2}$   
 $= \frac{3}{x^2}$

b.  $(3x)^{-2} = \frac{1}{(3x)^2}$   $(3x)^{-2}$  is the reciprocal of  $(3x)^2$ .  
 $= \frac{1}{9x^2}$

c.  $\frac{5y^{-3}}{x^{-4}} = \frac{5x^4}{y^3}$  Factors move from denominator to numerator  
(or vice versa) to have positive exponents.

d.  $(-14x)^0 = 1$  A nonzero number to the zero power is 1.

e.  $7^{-3} \cdot 7^3 = 7^{-3+3} = 7^0 = 1$  Use multiplication properties of exponents  
and the definition of a zero exponent.

f. An investor deposits \$100,000 in a trust fund with an annual percentage rate of 6%. The balance in the account after  $t$  years is given by  $A = 100,000(1.06)^t$ . Use a calculator to find the balance after 4 years.

$$A = 100,000(1.06)^4 = 100,000(1.26247696) \approx 126,247.70$$

The balance in the account after 4 years is \$126,247.70.

**Guidelines:**

- $a^{-n}$  is the reciprocal of  $a^n$  if  $a$  is a nonzero number and  $n$  is a positive integer.
- $a$  raised to the zero power is 1 for  $a \neq 0$ .

### EXERCISES

In Exercises 1–9, rewrite the expression using positive exponents.

1.  $(14a)^{-1}$

2.  $8y^{-3}$

3.  $(-5)^0 x^{-1}$

4.  $\frac{7}{b^{-4}}$

5.  $\frac{a^{-7}}{3}$

6.  $\frac{c^{-2}}{d^{-6}}$

7.  $x^{-5} \cdot y^5$

8.  $x^{-5} \cdot x^5$

9.  $(5x^{-2})^0$

# Extra Practice

# 8.2

Name \_\_\_\_\_

In 1–12, evaluate the expression.

1.  $3^{-3}$
2.  $2^{-5}$
3.  $\frac{1}{4^{-2}}$
4.  $8^0 \cdot 2^{-3}$
5.  $3^5 \cdot 3^{-4}$
6.  $5^{-7} \cdot 5^9$
7.  $9^{-5} \cdot 9^5$
8.  $-4 \cdot (-4)^{-3}$
9.  $\frac{3^0}{2^{-3}}$
10.  $(2^3)^{-2}$
11.  $(6^{-1})^2$
12.  $(-2^3)^{-1}$

In 13–24, rewrite the expression using positive exponents.

13.  $x^{-8}$
14.  $3x^{-5}$
15.  $\frac{1}{7x^{-2}}$
16.  $\frac{9}{x^{-4}}$
17.  $8x^{-7}y^{-8}$
18.  $\frac{1}{6x^{-4}y^{-3}z^5}$
19.  $\frac{3x^0}{y^{-3}}$
20.  $(4x)^{-2}$
21.  $(-2x)^{-4}$
22.  $\frac{1}{(3x)^{-3}}$
23.  $(5x)^0y^{-2}$
24.  $(2x)^{-2} \cdot 3y^5$

25. Sketch the graph of  $y = 3^x$ .

26. Sketch the graph of  $y = \left(\frac{1}{2}\right)^x$ .

27. **Radium Isotope** The half-life of the radium isotope  $Ra^{226}$  is about 1620 years. If there were initially 100 grams of  $Ra^{226}$ , then the number of grams remaining after  $h$  half-life periods is  $W = 100\left(\frac{1}{2}\right)^h$ . Complete the table.

| Half-life period, $h$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------------------|---|---|---|---|---|---|---|
| Grams, $W$            | ? | ? | ? | ? | ? | ? | ? |

28. **Endangered Species** Between 1980 and 1990 the population of an endangered species decreased at a rate of 0.1% per year. The population,  $P$ , in year  $t$  is given by  $P = 1200(0.999)^t$  where  $t = 0$  corresponds to 1985. Find the population of the species in 1980, 1985, 1990, and the projected population in the year 2000.

29. **Nobelium Isotope** The half-life of the Nobelium isotope  $No^{257}$  is about 23 seconds. 230 seconds (or 10 half-life periods) after the isotope was released there were 10 grams remaining. The number of grams of  $No^{257}$  after  $h$  half-life periods is  $W = 10\left(\frac{1}{2}\right)^h$  where  $h = 0$  corresponds to 230 seconds after the isotope was released. How much  $No^{257}$  was initially released?

30. **Town Population** Between 1960 and 1990, the population of a town increased at a rate of 0.34% per year. The population,  $P$ , in year  $t$  is given by  $P = 2000(1.0034)^t$  where  $t = 0$  corresponds to 1980. Find the population of the town in 1960, 1970, 1980, and 1990.

## EXERCISES

### Guided Practice

#### CRITICAL THINKING about the Lesson

1. **True or False?** If  $a$  is positive,  $a^{-n}$  is positive. Explain your reasoning.
2. Simplify  $a^5 \cdot a^{-5}$ . The result implies that  $a^5$  and  $a^{-5}$  are ? of each other.
3. Rewrite  $5a^{-3}b^{-2}$  with positive exponents. Why does the 5 stay in the numerator?
4. Simplify  $3c^{-5} \cdot 4c^4$ . Can a simplified form have a negative exponent?
5. If  $a^0 = 1$  ( $a \neq 0$ ), what point do all graphs of the form  $y = (a)^x$  have in common? Is this true for  $y = 2(a)^x$ ?

### Independent Practice

In Exercises 6–17, rewrite the expression using positive exponents.

- |                         |                         |                               |                                |
|-------------------------|-------------------------|-------------------------------|--------------------------------|
| 6. $x^{-7}$             | 7. $x^{-9}$             | 8. $5x^{-4}$                  | 9. $3x^{-2}$                   |
| 10. $\frac{1}{2x^{-3}}$ | 11. $\frac{1}{4x^{-5}}$ | 12. $x^{-2}y^3$               | 13. $x^6y^{-7}$                |
| 14. $3x^{-3}y^{-8}$     | 15. $6x^{-2}y^{-4}$     | 16. $\frac{1}{7x^{-4}y^{-1}}$ | 17. $\frac{1}{2x^{-10}y^{12}}$ |

In Exercises 18–29, evaluate the expression.

- |                        |                          |                                   |                        |
|------------------------|--------------------------|-----------------------------------|------------------------|
| 18. $3^{-2}$           | 19. $2^{-4}$             | 20. $-4^0 \cdot \frac{1}{2^{-2}}$ | 21. $4^{-3} \cdot 4^2$ |
| 22. $6^3 \cdot 6^{-1}$ | 23. $8^4 \cdot 8^{-4}$   | 24. $7^{-9} \cdot 7^9$            | 25. $(5^{-3})^2$       |
| 26. $(-4^{-2})^{-1}$   | 27. $-6 \cdot (-6)^{-1}$ | 28. $5 \cdot 5^{-1}$              | 29. $2^0 \cdot 3^{-3}$ |

In Exercises 30–41, rewrite the expression using positive exponents.

- |                           |                        |                           |                           |
|---------------------------|------------------------|---------------------------|---------------------------|
| 30. $(-3)^0x$             | 31. $(5y)^{-2}$        | 32. $(-2x)^{-3}$          | 33. $(-4a)^0$             |
| 34. $(-3x)^{-1} \cdot 2y$ | 35. $(4xy)^{-2}$       | 36. $(3x)^{-1}$           | 37. $(2a^{-3})^3$         |
| 38. $\frac{4}{b^{-2}}$    | 39. $\frac{5}{a^{-3}}$ | 40. $\frac{1}{(4x)^{-3}}$ | 41. $\frac{1}{(2y)^{-5}}$ |

In Exercises 42–45, say if the graph of the function contains the point  $(0, 1)$ .

- |                |               |                       |                |
|----------------|---------------|-----------------------|----------------|
| 42. $y = -3^x$ | 43. $y = 4^x$ | 44. $y = 3 \cdot 1^x$ | 45. $y = 50^x$ |
|----------------|---------------|-----------------------|----------------|

46. Between 1970 and 1990, Missouri's population increased at the rate of 0.47% per year. The population,  $P$ , in year  $t$  is given by

$$P = 4,903,000 \cdot 1.0047^t$$

where  $t = 0$  corresponds to 1980. Find the population in 1970, 1980, and 1990.

47. Between 1970 and 1990, the population of Buffalo, New York, decreased at the rate of 0.82% per year. The population,  $P$ , in year  $t$  is given by

$$P = 1,025,000 \cdot 0.9918^t$$

where  $t = 0$  corresponds to 1980. Find the population in 1970, 1980, and 1990.

# Reteach

## Chapter 8

Name \_\_\_\_\_

**What you should learn:**

**8.3** How to divide expressions with exponents and use powers as models in real-life situations.

**Correlation to Pupil's Textbook:**

**Mid-Chapter Test (p. 425) Chapter Test (p. 449)**

Exercises 9–12, 15, 16

Exercises 7, 11, 12, 16, 17

### Examples

*Dividing with Exponents and Using Powers as Models in Real-Life*

$$\begin{aligned} \text{a. } \frac{(-5)^7}{(-5)^5} &= (-5)^{7-5} \\ &= (-5)^2 \\ &= 25 \end{aligned}$$

$$\begin{aligned} \text{b. } \left(\frac{3}{4}\right)^{-2} &= \frac{3^{-2}}{4^{-2}} \\ &= \frac{4^2}{3^2} \\ &= \frac{16}{9} \end{aligned}$$

$$\begin{aligned} \text{c. } \frac{5ab^3}{3a^2b} \cdot \frac{12a^4b}{b^5} &= \frac{(5ab^3)(12a^4b)}{(3a^2b)b^5} \\ &= \frac{60a^5b^4}{3a^2b^6} \\ &= 20a^3b^{-2} \\ &= \frac{20a^3}{b^2} \end{aligned}$$

*Multiply fractions.*

*Product of powers property*

*Quotient of powers property*

*Write with positive exponents.*

- d. If a millimeter is  $10^{-3}$  meters and a kilometer is  $10^3$  meters, find the ratio of one millimeter to one kilometer.

$$\text{The ratio is } \frac{10^{-3} \text{ meters}}{10^3 \text{ meters}} = \frac{1}{10^6} \text{ or } \frac{1}{1,000,000}.$$

**Guidelines:**

- Divide powers having the same base by subtracting exponents.
- Find a power of a quotient by finding the power of the numerator and the power of the denominator and dividing.

### EXERCISES

In Exercises 1–6, simplify.

$$1. c^8 \cdot \frac{1}{c^2}$$

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

$$3. \left(\frac{a}{b}\right)^{-2}$$

$$4. \frac{-10x^2y}{3x^4y^3} \cdot \frac{9x^2y}{2x}$$

$$5. \frac{8a^{-3}b^{-2}}{a^2} \cdot \frac{ab^{-1}}{a^{-1}b}$$

$$6. \left(\frac{xy^{-1}}{x^{-3}y^2}\right)^2 \cdot \left(\frac{x^3y^2}{2yx^{-1}}\right)^{-2}$$

# Extra Practice

# 8.3

Name \_\_\_\_\_

In 1–12, evaluate the expression.

1.  $\frac{7^5}{7^3}$

2.  $\frac{6^5}{6^7}$

3.  $\frac{18^6}{18^6}$

4.  $\frac{(-5)^9}{5^9}$

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

6.  $\frac{4^5 \cdot 4^3}{4^6}$

7.  $\frac{3^2 \cdot 3^4}{3^9}$

8.  $(\frac{2}{3})^3$

9.  $(\frac{4}{5})^2$

10.  $(-\frac{1}{2})^5$

11.  $(\frac{11}{3})^{-1}$

12.  $(\frac{3}{2})^{-2}$

In 13–24, simplify the expression.

13.  $(\frac{x}{3})^4$

14.  $\frac{x^7}{x^2}$

15.  $(\frac{2}{x})^6$

16.  $x^5 \cdot \frac{1}{x^8}$

17.  $x^{12} \cdot \frac{1}{x^3}$

18.  $\frac{2x^2y}{x^3y^2} \cdot \frac{4x^7y^2}{2x^3}$

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

20.  $\frac{-8x^6y^{-3}}{3x^{-2}y^{-5}} \cdot \frac{-6x^{-10}y}{-4x}$

21.  $\frac{4x^{-2}y^{-1}}{3x^{-3}} \cdot \frac{6x^{-3}y^{-2}}{8y^{-7}}$

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

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

24.  $\frac{5x^{-1}y^3}{xy^{-4}} \cdot \frac{(-2x^2)^{-3}}{y}$

25. **Personal Computers** From 1982 to 1992, the cost of manufacturing a PC has decreased by about the same percentage each year. The cost,  $C$  (in dollars), in year  $t$  can be modeled by  $C = 3000(\frac{5}{6})^t$  where  $t = 0$  corresponds to 1982. Find the ratio of the cost in 1990 to the cost in 1985.

26. **Assembly Speed** An assembly line worker increases the speed at which he can work by approximately the same percentage for the first 7 months of employment. The speed,  $s$  (in parts assembled per hour), in  $t$  months can be modeled by  $s = 10(1.01)^t$  where  $t = 0$  corresponds to the month a worker is hired. Find the ratio of the speed of a worker after 7 months of experience to the speed of a worker after 4 months of experience.

27. **Grade Point Average** From Carmen's freshman year to her senior year, her grade-point average (GPA) increased by approximately the same percentage each year. Carmen's GPA in year  $t$  can be modeled by  $\text{GPA} = 2(\frac{6}{5})^t$  where  $t = 0$  corresponds to her freshman year. Complete the table showing Carmen's GPA throughout her high school career.

| Year, $t$ | 0 | 1 | 2 | 3 |
|-----------|---|---|---|---|
| GPA       | ? | ? | ? | ? |

28. **Memory** Suppose that you memorized a list of 100 German vocabulary words. Each week you forget  $\frac{1}{8}$  of the words you knew the previous week. The number of vocabulary words,  $V$ , you remember after  $t$  weeks can be modeled by  $V = 100(\frac{7}{8})^t$ . Complete the table showing the number of words you remember each week.

| Week, $t$  | 0 | 5 | 10 | 15 | 20 | 25 | 30 |
|------------|---|---|----|----|----|----|----|
| Words, $V$ | ? | ? | ?  | ?  | ?  | ?  | ?  |



## EXERCISES

### Guided Practice

#### CRITICAL THINKING about the Lesson

1. Can  $\frac{x^{10}}{y^6}$  be simplified? Why or why not?
2. Does  $\frac{x^{-4}}{x^{-5}}$  simplify as  $x$  or  $\frac{1}{x}$ ?
3. When you divide powers with the same base, do you add or subtract exponents?
4. What is the relationship between  $\frac{x^4}{x^2}$  and  $\frac{x^{-4}}{x^{-2}}$ ? Are they equivalent or are they reciprocals of each other? Explain.

### Independent Practice

In Exercises 5–16, evaluate the expression.

- |                               |                         |                                 |
|-------------------------------|-------------------------|---------------------------------|
| 5. $\frac{6^6}{6^4}$          | 6. $\frac{8^3}{8^1}$    | 7. $\frac{(-4)^5}{(4)^5}$       |
| 8. $\frac{(-3)^9}{(-3)^9}$    | 9. $\frac{2^2}{2^{-3}}$ | 10. $\frac{8^3 \cdot 8^2}{8^5}$ |
| 11. $\frac{7^4 \cdot 7}{7^7}$ | 12. $(\frac{3}{4})^2$   | 13. $(\frac{5}{3})^3$           |
| 14. $(-\frac{2}{3})^3$        | 15. $(-\frac{4}{5})^2$  | 16. $(\frac{9}{6})^{-1}$        |

In Exercises 17–28, simplify the expression.

- |  |  |  |
|--|--|--|
| 17. $(\frac{2}{x})^4$  | 18. $\frac{x^4}{x^5}$  | 19. $(\frac{1}{x})^6$  |
| 20. $x^3 \cdot \frac{1}{x^2}$                                    | 21. $x^7 \cdot \frac{1}{x^9}$                                    | 22. $\frac{3x^2y^2}{3xy} \cdot \frac{6xy^3}{3y}$                           |
| 23. $\frac{4xy^3}{2y} \cdot \frac{5xy^{-3}}{x^2}$                | 24. $\frac{16x^3y}{-4xy^3} \cdot \frac{-2xy}{-x}$                | 25. $\frac{-9x^5y^7}{x^2y^3} \cdot \frac{(2xy)^2}{-6x^2y^2}$               |
| 26. $\frac{6x^{-2}y^2}{xy^{-3}} \cdot \frac{(4x^2y)^{-2}}{xy^2}$ | 27. $\frac{7x^{-1}y^3}{x^2y^{-2}} \cdot \frac{(3xy^2)^{-1}}{xy}$ | 28. $(\frac{2xy^{-2}y^4}{3yx^{-1}})^{-2} \cdot (\frac{4xy}{2x^{-1}y^3})^2$ |

**Mercury Levels** In Exercises 29 and 30, use the information from Example 4.

29. As the FDA inspector, you test a  $4\frac{1}{2}$ -kilogram fish and find that it has 4 milligrams of methylmercury. Does this fish meet FDA requirements?
30. A fish weighing 9 kilograms is found to contain 11 milligrams of methylmercury. As an FDA inspector, do you allow this fish to be sold? If not, how much would the fish have to weigh for 11 milligrams of methylmercury to be acceptable?



# Reteach

## Chapter 8

Name \_\_\_\_\_

*What you should learn :*

**8.4**

How to write numbers in scientific notation and perform operations using scientific notation.

**Correlation to Pupil's Textbook:**

**Mid-Chapter Test (p. 425) Chapter Test (p. 449)**

Exercises 19–24, 28

Exercises 19–22

### Examples

#### *Using Scientific Notation*

- a. Write  $6.7239 \times 10^{-4}$  in decimal form.

$$6.7239 \times 10^{-4} = 0.00067239 \quad \text{Move decimal point 4 places to the left.}$$

- b. Write  $1.884 \times 10^5$  in decimal form.

$$1.884 \times 10^5 = 188,400.0 \quad \text{Move decimal point 5 places to the right.}$$

- c. Write 26,645 in scientific notation.

$$26,645 = 2.6645 \times 10^4 \quad \text{Move decimal point 4 places to the left.}$$

- d. Write 0.00829 in scientific notation.

$$0.00829 = 8.29 \times 10^{-3} \quad \text{Move decimal point 3 places to the right.}$$

- e. Use properties of exponents to evaluate  $(2.6 \times 10^6)(4.7 \times 10^{-2})$ .

$$\begin{aligned}(2.6 \times 10^6)(4.7 \times 10^{-2}) &= (2.6 \times 4.7)(10^6 \cdot 10^{-2}) \\ &= 12.22 \times (10^4) \\ &= 1.222 \times 10^5\end{aligned}$$

#### *Guidelines:*

- Scientific notation uses powers of ten to express decimal numbers.
- Numbers in scientific notation are written  $c \times 10^n$  where  $c$  is a decimal number greater than or equal to 1 and less than 10.
- To multiply, divide or find powers of numbers in scientific notation, use the properties of exponents.

### EXERCISES

In Exercises 1–3, rewrite the scientific notation in decimal form.

1.  $9.33 \times 10^{-6}$

2.  $2.78 \times 10^0$

3.  $4.57 \times 10^7$

In Exercises 4–6, rewrite the decimal in scientific notation.

4. 13,400,000,000

5. 0.000035

6. 75.2

In Exercises 7–9, use a calculator to evaluate. Write the result in scientific notation.

7.  $0.000525 \cdot 134,000$

8.  $(3.88 \times 10^{-5})^4$

9.  $9,220,000 \times 0.0046$

# Extra Practice

# 8.4

Name \_\_\_\_\_

In 1–9, rewrite the scientific notation in decimal form.

- |                         |                           |                          |
|-------------------------|---------------------------|--------------------------|
| 1. $2.03 \times 10^3$   | 2. $3.4578 \times 10^4$   | 3. $6.43 \times 10^1$    |
| 4. $7.2 \times 10^5$    | 5. $5.2 \times 10^0$      | 6. $4.68 \times 10^{-2}$ |
| 7. $1.3 \times 10^{-6}$ | 8. $8.497 \times 10^{-3}$ | 9. $9.8 \times 10^{-4}$  |

In 10–18, rewrite the decimal in scientific notation.

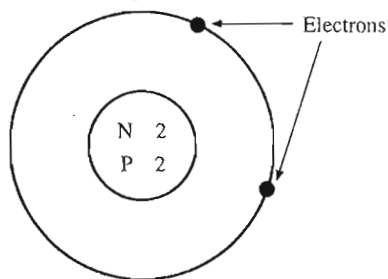
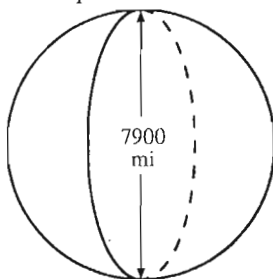
- |             |                 |               |
|-------------|-----------------|---------------|
| 10. 25,000  | 11. 36.41       | 12. 4,000,000 |
| 13. 564,200 | 14. 9.32        | 15. 0.15      |
| 16. 0.0083  | 17. 0.000000718 | 18. 0.0673    |

In 19–27, evaluate the expression without a calculator. Write the answer in scientific notation.

- |  |   |   |
|--|---|---|
| 19. $2 \times 10^3 \cdot 3 \times 10^8$    | 20. $3 \times 10^{-4} \cdot 3 \times 10^{-5}$ | 21. $2 \times 10^{-5} \cdot 3 \times 10^7$    |
| 22. $4 \times 10^{-6} \cdot 2 \times 10^5$ | 23. $3 \times 10^6 \cdot 4 \times 10^3$       | 24. $7 \times 10^{-3} \cdot 5 \times 10^{-1}$ |
| 25. $3 \times 10^5 \cdot 8 \times 10^{-2}$ | 26. $12 \times 10^3 \cdot 3 \times 10^{-6}$   | 27. $6 \times 10^{-8} \cdot 7 \times 10^6$    |

In 28–33, write the number in scientific notation.

- |  |   |
|--|---|
| 28. <b>Earth to Pluto</b> As the planets orbit the sun, the closest Pluto gets to Earth is approximately 2,700,000,000 miles.  | 29. <b>Red Blood Cells</b> The thickness of a red blood cell is approximately 0.0003125 inch.   |
| 30. <b>Human Cells</b> The body of a human has more than 1,000,000,000,000 cells.  | 31. <b>Speed of Light</b> The speed of light in a vacuum is approximately 186,000 miles per second.   |
| 32. <b>Earth's Diameter</b> The polar diameter of Earth is approximately 7,900 miles. There are approximately 161,000 cm in one mile. What is the polar diameter of Earth in cm? | 33. <b>Mass of Helium Atom</b> A proton (P) and a neutron (N) each weigh $1.67 \times 10^{-24}$ gram. An electron weighs $9.11 \times 10^{-28}$ gram. Find the mass of one helium atom. |



34. **Surface Area** The total surface area of Earth is about  $1.97 \times 10^8$  square miles. The surface area of land on Earth is about  $5.73 \times 10^7$  square miles. Find the ratio of surface area of land to that of the entire planet.

## EXERCISES

### Guided Practice

#### CRITICAL THINKING about the Lesson

- The following numbers are equal. Which one is in scientific notation?  
a. 912    b.  $9.12 \times 10^2$
- To write 0.000032 in scientific notation, how many places must you move the decimal point?
- Which is equal to 62,000,  $6.2 \times 10^4$  or  $6.2 \times 10^{-4}$ ?
- What is one thousand times one millionth? Write your answer in scientific notation.

### Independent Practice

In Exercises 5–12, rewrite the scientific notation in decimal form.

- |                          |                            |                           |                         |
|--------------------------|----------------------------|---------------------------|-------------------------|
| 5. $1.09 \times 10^6$    | 6. $2.345 \times 10^8$     | 7. $6.21 \times 10^0$     | 8. $9.4675 \times 10^4$ |
| 9. $8.52 \times 10^{-3}$ | 10. $7.021 \times 10^{-5}$ | 11. $8.67 \times 10^{-2}$ | 12. $4.73 \times 10^0$  |

In Exercises 13–20, rewrite the decimal in scientific notation.

- |                |                 |                   |            |
|----------------|-----------------|-------------------|------------|
| 13. 93,000,000 | 14. 900,000,000 | 15. 1,637,000,000 | 16. 67.8   |
| 17. 0.000435   | 18. 0.008367    | 19. 0.004392      | 20. 0.0875 |

In Exercises 21–26, evaluate the expression without a calculator. Write the result in decimal form.

- |   |  |   |
|---|--|---|
| 21. $6 \times 10^{-2} \cdot 3 \times 10^4$    | 22. $5 \times 10^5 \cdot 5 \times 10^{-5}$ | 23. $4 \times 10^4 \cdot 2 \times 10^{-1}$  |
| 24. $6 \times 10^{-3} \cdot 7 \times 10^{-4}$ | 25. $9 \times 10^{-3} \cdot 4 \times 10^8$ | 26. $8 \times 10^4 \cdot 10 \times 10^{-1}$ |

In Exercises 27–32, use a calculator to evaluate the expression. Write the result in both decimal form and in scientific notation.

- |                               |                               |                                    |
|-------------------------------|-------------------------------|------------------------------------|
| 27. $8,000,000 \cdot 623,000$ | 28. $3,000,000 \cdot 43,000$  | 29. $0.000345 \cdot 8,980,000,000$ |
| 30. $345,000 \cdot 0.000086$  | 31. $(3.28 \times 10^{-6})^4$ | 32. $0.000045^3$                   |

In Exercises 33–36, write the number in scientific notation.

- |   |   |
|---|---|
| 33. An atom of carbon has a mass of 0.000000000000000000000004 gram.                              | 34. <i>Population of the United States</i> In 1990, the United States population was about 250,000,000. |
| 35. Jim Kelly, the quarterback for the Buffalo Bills football team, was paid \$4,800,000 in 1990. | 36. <i>Metric Conversion</i> One meter is equal to one thousandth of a kilometer.                       |

# Reteach

## Chapter 8

Name \_\_\_\_\_

*What you should learn:*

**8.5** How to use scientific notation to solve real-life problems.

Correlation to Pupil's Textbook:

Chapter Test (p. 449)

Exercise 23

### Examples

#### Using Scientific Notation In Real Life

- a. The planet Earth is 93 million miles from the sun. The planet Pluto is 3.7 billion miles from the sun. Find the ratio of Earth's distance from the sun to Pluto's distance from the sun.

Express the distances in scientific notation and find the ratio.

$$\begin{aligned}\frac{9.3 \times 10^7}{3.7 \times 10^9} &\approx 2.5 \times 10^{-2} \\ &= 0.025 \\ &= \frac{25}{1000} \\ &= \frac{1}{40}\end{aligned}$$



- b. The mass of the sun is approximately  $1.99 \times 10^{30}$  kilograms. The mass of the moon is approximately  $7.36 \times 10^{22}$  kilograms. The mass of the sun is approximately how many times that of the moon?

$$\begin{aligned}\frac{1.99 \times 10^{30}}{7.36 \times 10^{22}} &\approx 0.27 \times 10^8 \\ &= 2.7 \times 10^7\end{aligned}$$

The mass of the sun is about 27,000,000 times the mass of the moon.

#### Guidelines:

- Use scientific notation when solving problems with very large or very small numbers.

### EXERCISES

1. A nanosecond is one billionth of a second and a megasecond is one million seconds. Find the ratio of a nanosecond to a megasecond.
2. The world's worst inflation occurred in Hungary in 1946. One gold pengö was worth 130 million million million paper pengös. Express the 1946 value of one paper pengö in scientific notation.
3. The Pacific Ocean covers 166,241,000 square kilometers. The Baltic Sea covers 414,400 square kilometers. The Pacific Ocean is approximately how many times as large as the Baltic Sea?

# Extra Practice

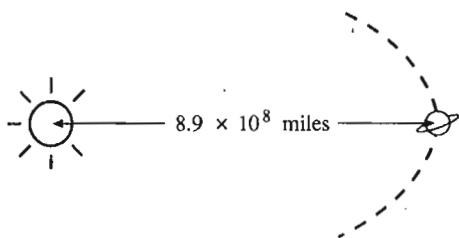
# 8.5

Name \_\_\_\_\_

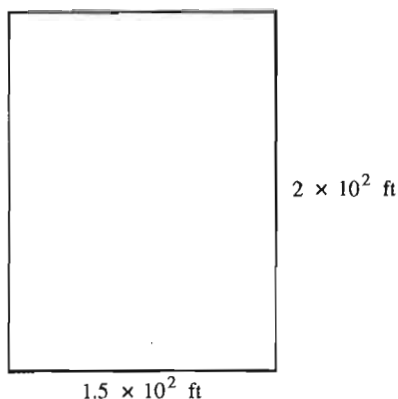
1. **Population Density** In 1990 there were approximately  $7 \times 10^6$  people living in New York City. New York City has an area of approximately  $8.31 \times 10^2$  square kilometers. What was the population density (people per square kilometers) of New York City in 1990?

3. **Typing a Novel** A typist can type 80 words per minute. How long will it take to type an 830-page novel that has an average of 100 words per page?

5. **Speed of Light** The distance between Saturn and the sun is approximately  $8.9 \times 10^8$  miles. The speed of light is approximately  $1.9 \times 10^5$  miles per second. How long does it take light to travel from the sun to Saturn?



7. **Cost of Land** In 1992, the lot of land shown below cost  $\$1.1 \times 10^4$ . Find the area (in square feet) of the lot. What was the price of the land per square foot?



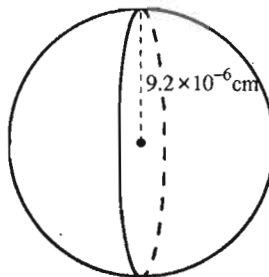
2. **National Debt** The population of the United States is approximately  $2.5 \times 10^8$ . The national debt is approximately  $\$1 \times 10^{12}$ . How much money would each person have to pay to eliminate the debt?

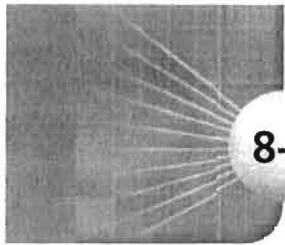
4. **Ballpark Hotdogs** There are  $3 \times 10^4$  fans in a stadium watching a game. A hotdog vendor sells  $\$3000$  worth of hotdogs at  $\$1.50$  each. What was the ratio of hotdogs sold to the number of fans?

6. **Computer Backup** A computer has a hard drive that stores approximately  $8.4 \times 10^7$  bytes. A high density  $5\frac{1}{4}$ -inch floppy disk holds approximately  $1.3 \times 10^6$  bytes. How many floppies are needed to back up the hard drive?



8. **Volume of a Virus** A certain virus is shaped like a sphere. The radius of the virus is  $9.2 \times 10^{-6}$  cm. Find the volume of the virus. (Hint: The volume of a sphere is  $V = \frac{4}{3} \pi r^3$ )





## 8-1 Skills Practice

### *Multiplying Monomials*

Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

1. 11

2.  $a - b$

3.  $\frac{p^2}{q^2}$

4.  $y$

5.  $j^3k$

6.  $2a + 3b$

**Simplify.**

7.  $a^2(a^3)(a^6)$

8.  $x(x^2)(x^7)$

9.  $(y^2z)(yz^2)$

10.  $(\ell^2k^2)(\ell^3k)$

11.  $(e^2f^4)(e^2f^2)$

12.  $(cd^2)(c^3d^2)$

13.  $(2x^2)(3x^5)$

14.  $(5a^7)(4a^2)$

15.  $(4xy^3)(3x^3y^5)$

16.  $(7a^5b^2)(a^2b^3)$

17.  $(-5m^3)(3m^8)$

18.  $(-2c^4d)(-4cd)$

19.  $(10^2)^3$

20.  $(p^3)^{12}$

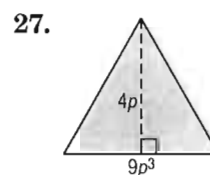
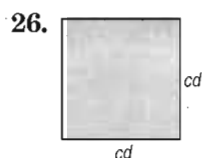
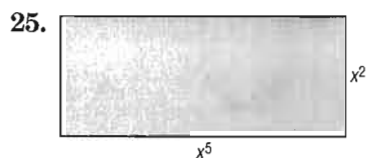
21.  $(-6p)^2$

22.  $(-3y)^3$

23.  $(3pq^2)^2$

24.  $(2b^3c^4)^2$

**GEOMETRY** Express the area of each figure as a monomial.



## 8-2 Skills Practice

### Dividing Monomials

Simplify. Assume that no denominator is equal to zero.

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

2.  $\frac{9^{12}}{9^8}$

3.  $\frac{x^4}{x^2}$

4.  $\frac{r^3s^2}{r^3s^4}$

5.  $\frac{m}{m^3}$

6.  $\frac{9d^7}{3d^6}$

7.  $\frac{12n^5}{36n}$

8.  $\frac{w^4u^3}{w^4u}$

9.  $\frac{a^3b^5}{ab^2}$

10.  $\frac{m^7n^2}{m^3n^2}$

11.  $\frac{-21w^5u^2}{7w^4u^5}$

12.  $\frac{32x^3y^2z^5}{-8xyz^2}$

13.  $\left(\frac{4p^7}{7s^2}\right)^2$

14.  $4^{-4}$

15.  $8^{-2}$

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

17.  $\left(\frac{9}{11}\right)^{-1}$

18.  $\frac{h^3}{h^{-6}}$

19.  $k^0(k^4)(k^{-6})$

20.  $k^{-1}(\ell^{-6})(m^3)$

21.  $\frac{f^{-7}}{f^4}$

22.  $\left(\frac{16p^5q^2}{2p^3q^3}\right)^0$

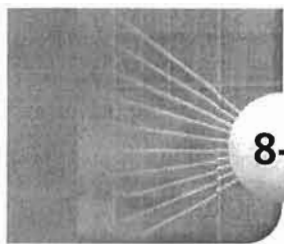
23.  $\frac{f^{-5}g^4}{h^{-2}}$

24.  $\frac{15x^6y^{-9}}{5xy^{-11}}$

25.  $\frac{-15w^0u^{-1}}{5u^3}$

26.  $\frac{48x^6y^7z^5}{-6xy^5z^6}$





## 8-3 Skills Practice

### Scientific Notation

Express each number in standard notation.

1.  $4 \times 10^3$

2.  $2 \times 10^8$

3.  $3.2 \times 10^5$

4.  $3 \times 10^{-6}$

5.  $9 \times 10^{-2}$

6.  $4.7 \times 10^{-7}$

**ASTRONOMY** Express the number in each statement in standard notation.

7. The diameter of Jupiter is  $1.42984 \times 10^5$  kilometers.

8. The surface density of the main ring around Jupiter is  $5 \times 10^{-6}$  grams per centimeter squared.

9. The minimum distance from Mars to Earth is  $5.45 \times 10^7$  kilometers.

Express each number in scientific notation.

10. 41,000,000

11. 65,100

12. 283,000,000

13. 264,701

14. 0.019

15. 0.000007

16. 0.000010035

17. 264.9

18.  $150 \times 10^2$

Evaluate. Express each result in scientific and standard notation.

19.  $(3.1 \times 10^7)(2 \times 10^{-5})$

20.  $(5 \times 10^{-2})(1.4 \times 10^{-4})$

21.  $(3 \times 10^3)(4.2 \times 10^{-1})$

22.  $(3 \times 10^{-2})(5.2 \times 10^9)$

23.  $(2.4 \times 10^2)(4 \times 10^{-10})$

24.  $(1.5 \times 10^{-4})(7 \times 10^{-5})$

25.  $\frac{5.1 \times 10^6}{1.5 \times 10^2}$

26.  $\frac{7.2 \times 10^{-5}}{4 \times 10^{-3}}$

## Dividing Monomials

$$\frac{18x^6y}{3x^3y^5} = \frac{18}{3} \cdot \frac{x^{6-3}}{1} \cdot \frac{1}{y^{5-1}} = \frac{6x^3}{y^4}$$

1.  $\frac{m^{10}}{m^5} =$

9.  $\frac{5x^4}{5} =$

2.  $\frac{x^3y^2}{2x^2y^2} =$

10.  $\frac{18x^2y}{24xy} =$

3.  $\frac{4ab^3}{2a^2b^2} =$

11.  $\frac{56s^2t^3}{4s^2t} =$

4.  $\frac{27u^2v^3}{18u^4v^5} =$

12.  $\frac{48a^3bc^5}{12a^5b^3c^2} =$

5.  $\frac{13c^9d^{10}}{26c^9d} =$

13.  $\frac{25x^2y}{15xy^2} =$

6.  $\frac{3s^5t}{3s^5t} =$

14.  $\frac{8m^2n^2}{12m^2n^3} =$

7.  $\frac{52x^3y^2z}{13xy^2} =$

15.  $\frac{17c^5d^4}{51cd^3} =$

8.  $\frac{8xy^2}{16x^3y^5} =$

16.  $\frac{24x^2y^3z^4}{44x^4y^3z^2} =$

## More Properties of Exponents

Date\_\_\_\_\_ Period\_\_\_\_

**Simplify. Your answer should contain only positive exponents.**

1)  $(x^{-2}x^{-3})^4$

2)  $(x^4)^{-3} \cdot 2x^4$

3)  $(n^3)^3 \cdot 2n^{-1}$

4)  $(2v)^2 \cdot 2v^2$

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

6)  $\frac{2y^3 \cdot 3xy^3}{3x^2y^4}$

7)  $\frac{x^3y^3 \cdot x^3}{4x^2}$

8)  $\frac{3x^2y^2}{2x^{-1} \cdot 4yx^2}$

9)  $\frac{x}{(2x^0)^2}$

10)  $\frac{2m^{-4}}{(2m^{-4})^3}$

$$11) \frac{(2m^2)^{-1}}{m^2}$$

$$12) \frac{2x^3}{(x^{-1})^3}$$

$$13) (a^{-3}b^{-3})^0$$

$$14) x^4y^3 \cdot (2y^2)^0$$

$$15) ba^4 \cdot (2ba^4)^{-3}$$

$$16) (2x^0y^2)^{-3} \cdot 2yx^3$$

$$17) \frac{2k^3 \cdot k^2}{k^{-3}}$$

$$18) \frac{(x^{-3})^4 x^4}{2x^{-3}}$$

$$19) \frac{(2x)^{-4}}{x^{-1} \cdot x}$$

$$20) \frac{(2x^3z^2)^3}{x^3y^4z^2 \cdot x^{-4}z^3}$$

$$21) \frac{(2pm^{-1}q^0)^{-4} \cdot 2m^{-1}p^3}{2pq^2}$$

$$22) \frac{(2hj^2k^{-2} \cdot h^4j^{-1}k^4)^0}{2h^{-3}j^{-4}k^{-2}}$$

## More Properties of Exponents

Date \_\_\_\_\_ Period \_\_\_\_\_

**Simplify. Your answer should contain only positive exponents.**

1)  $(x^{-2}x^{-3})^4$

$$\frac{1}{x^{20}}$$

2)  $(x^4)^{-3} \cdot 2x^4$

$$\frac{2}{x^8}$$

3)  $(n^3)^3 \cdot 2n^{-1}$

$$2n^8$$

4)  $(2v)^2 \cdot 2v^2$

$$8v^4$$

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

$$8x^8y^6$$

6)  $\frac{2y^3 \cdot 3xy^3}{3x^2y^4}$

$$\frac{2y^2}{x}$$

7)  $\frac{x^3y^3 \cdot x^3}{4x^2}$

$$\frac{x^4y^3}{4}$$

8)  $\frac{3x^2y^2}{2x^{-1} \cdot 4yx^2}$

$$\frac{3xy}{8}$$

9)  $\frac{x}{(2x^0)^2}$

$$\frac{x}{4}$$

10)  $\frac{2m^{-4}}{(2m^{-4})^3}$

$$\frac{m^8}{4}$$

$$11) \frac{(2m^2)^{-1}}{m^2}$$

$$\frac{1}{2m^4}$$

$$12) \frac{2x^3}{(x^{-1})^3}$$

$$2x^6$$

$$13) (a^{-3}b^{-3})^0$$

$$1$$

$$14) x^4y^3 \cdot (2y^2)^0$$

$$x^4y^3$$

$$15) ba^4 \cdot (2ba^4)^{-3}$$

$$\frac{1}{8b^2a^8}$$

$$16) (2x^0y^2)^{-3} \cdot 2yx^3$$

$$\frac{x^3}{4y^5}$$

$$17) \frac{2k^3 \cdot k^2}{k^{-3}}$$

$$2k^8$$

$$18) \frac{(x^{-3})^4 x^4}{2x^{-3}}$$

$$\frac{1}{2x^5}$$

$$19) \frac{(2x)^{-4}}{x^{-1} \cdot x}$$

$$\frac{1}{16x^4}$$

$$20) \frac{(2x^3z^2)^3}{x^3y^4z^2 \cdot x^{-4}z^3}$$

$$\frac{8x^{10}z}{y^4}$$

$$21) \frac{(2pm^{-1}q^0)^{-4} \cdot 2m^{-1}p^3}{2pq^2}$$

$$\frac{m^3}{16p^2q^2}$$

$$22) \frac{(2hj^2k^{-2} \cdot h^4j^{-1}k^4)^0}{2h^{-3}j^{-4}k^{-2}}$$

$$\frac{h^3j^4k^2}{2}$$

## Properties of Exponents

Date \_\_\_\_\_ Period \_\_\_\_\_

**Simplify. Your answer should contain only positive exponents.**

1)  $2m^2 \cdot 2m^3$

2)  $m^4 \cdot 2m^{-3}$

3)  $4r^{-3} \cdot 2r^2$

4)  $4n^4 \cdot 2n^{-3}$

5)  $2k^4 \cdot 4k$

6)  $2x^3y^{-3} \cdot 2x^{-1}y^3$

7)  $2y^2 \cdot 3x$

8)  $4v^3 \cdot vu^2$

9)  $4a^3b^2 \cdot 3a^{-4}b^{-3}$

10)  $x^2y^{-4} \cdot x^3y^2$

11)  $(x^2)^0$

12)  $(2x^2)^{-4}$

13)  $(4r^0)^4$

14)  $(4a^3)^2$

15)  $(3k^4)^4$

16)  $(4xy)^{-1}$

$$17) (2b^4)^{-1}$$

$$18) (x^2y^{-1})^2$$

$$19) (2x^4y^{-3})^{-1}$$

$$20) (3m)^{-2}$$

$$21) \frac{r^2}{2r^3}$$

$$22) \frac{x^{-1}}{4x^4}$$

$$23) \frac{3n^4}{3n^3}$$

$$24) \frac{m^4}{2m^4}$$

$$25) \frac{3m^{-4}}{m^3}$$

$$26) \frac{2x^4y^{-4}z^{-3}}{3x^2y^{-3}z^4}$$

$$27) \frac{4x^0y^{-2}z^3}{4x}$$

$$28) \frac{2h^3j^{-3}k^4}{3jk}$$

$$29) \frac{4m^4n^3p^3}{3m^2n^2p^4}$$

$$30) \frac{3x^3y^{-1}z^{-1}}{x^{-4}y^0z^0}$$



## Properties of Exponents

Date \_\_\_\_\_ Period \_\_\_\_\_

**Simplify. Your answer should contain only positive exponents.**

$$1) \frac{2m^2 \cdot 2m^3}{4m^5}$$

$$2) \frac{m^4 \cdot 2m^{-3}}{2m}$$

$$3) \frac{4r^{-3} \cdot 2r^2}{r}$$

$$4) \frac{4n^4 \cdot 2n^{-3}}{8n}$$

$$5) \frac{2k^4 \cdot 4k}{8k^5}$$

$$6) \frac{2x^3y^{-3} \cdot 2x^{-1}y^3}{4x^2}$$

$$7) \frac{2y^2 \cdot 3x}{6y^2x}$$

$$8) \frac{4v^3 \cdot vu^2}{4v^4u^2}$$

$$9) \frac{4a^3b^2 \cdot 3a^{-4}b^{-3}}{ab}$$

$$10) \frac{x^2y^{-4} \cdot x^3y^2}{y^2}$$

$$11) \frac{(x^2)^0}{1}$$

$$12) \frac{(2x^2)^{-4}}{16x^8}$$

$$13) \frac{(4r^0)^4}{256}$$

$$14) \frac{(4a^3)^2}{16a^6}$$

$$15) \frac{(3k^4)^4}{81k^{16}}$$

$$16) \frac{(4xy)^{-1}}{4xy}$$

$$17) \left(2b^4\right)^{-1}$$

$$\frac{1}{2b^4}$$

$$18) \left(x^2y^{-1}\right)^2$$

$$\frac{x^4}{y^2}$$

$$19) \left(2x^4y^{-3}\right)^{-1}$$

$$\frac{y^3}{2x^4}$$

$$20) (3m)^{-2}$$

$$\frac{1}{9m^2}$$

$$21) \frac{r^2}{2r^3}$$

$$\frac{1}{2r}$$

$$22) \frac{x^{-1}}{4x^4}$$

$$\frac{1}{4x^5}$$

$$23) \frac{3n^4}{3n^3}$$

$$n$$

$$24) \frac{m^4}{2m^4}$$

$$\frac{1}{2}$$

$$25) \frac{3m^{-4}}{m^3}$$

$$\frac{3}{m^7}$$

$$26) \frac{2x^4y^{-4}z^{-3}}{3x^2y^{-3}z^4}$$

$$\frac{2x^2}{3yz^7}$$

$$27) \frac{4x^0y^{-2}z^3}{4x}$$

$$\frac{z^3}{y^2x}$$

$$28) \frac{2h^3j^{-3}k^4}{3jk}$$

$$\frac{2h^3k^3}{3j^4}$$

$$29) \frac{4m^4n^3p^3}{3m^2n^2p^4}$$

$$\frac{4m^2n}{3p}$$

$$30) \frac{3x^3y^{-1}z^{-1}}{x^{-4}y^0z^0}$$

$$\frac{3x^7}{yz}$$