

GUIDED PRACTICE

Vocabulary Check ✓

1. State the name of the property illustrated.

a. $a^m \cdot a^n = a^{m+n}$

b. $(a^m)^n = a^{mn}$

c. $(ab)^m = a^m b^m$

Concept Check ✓

2. **ERROR ANALYSIS** Describe the mistake made in simplifying the expression.

a. ~~$(-2)^2(-2)^3 = 4^5$~~

b. ~~$\frac{x^8}{x^2} = x^4$~~

c. ~~$x^4 \cdot x^3 = x^{12}$~~

Skill Check ✓

Evaluate the expression. Tell which properties of exponents you used.

3. $6 \cdot 6^2$

4. $(9^6)(9^2)^{-3}$

5. $(2^3)^2$

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

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

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

Simplify the expression. Tell which properties of exponents you used.

9. $z^{-2} \cdot z^{-4} \cdot z^6$

10. $yz^{-2}(x^2y)^3z$

11. $(4x^3)^{-2}$

12. $\left(\frac{2}{x^{-3}}\right)^6$

13. $\frac{3y^6}{y^3}$

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

15. **ASTRONOMY** Earth has a radius of about 6.38×10^3 kilometers. The sun has a radius of about 6.96×10^5 kilometers. Use the formula for the volume of a sphere given on page 325 to calculate the volume of the sun and the volume of Earth. Divide the volumes. Do you get the same result as in Example 3?

PRACTICE AND APPLICATIONS

STUDENT HELP

▶ **Extra Practice**
to help you master
skills is on p. 947.

EVALUATING NUMERICAL EXPRESSIONS Evaluate the expression. Tell which properties of exponents you used.

16. $4^2 \cdot 4^4$

17. $(5^{-2})^3$

18. $(-9)(-9)^3$

19. $(8^2)^3$

20. $\frac{5^2}{5^5}$

21. $\left(\frac{3}{7}\right)^3$

22. $\left(\frac{5}{9}\right)^{-3}$

23. $11^{-2} \cdot 11^0$

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

25. $\left(\frac{1}{8}\right)^{-4}$

26. $(2^{-4})^{-2}$

27. $\frac{2^2}{2^{-9}}$

28. $\frac{6^2}{(6^{-2} \cdot 5^1)^{-2}}$

29. $6^0 \cdot 6^3 \cdot 6^{-4}$

30. $\left(\frac{1}{10}\right)^3 \left(\frac{1}{10}\right)^{-3}$

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

SIMPLIFYING ALGEBRAIC EXPRESSIONS Simplify the expression. Tell which properties of exponents you used.

32. $x^8 \cdot \frac{1}{x^3}$

33. $(2^3x^2)^5$

34. $(x^2y^2)^{-1}$

35. $\frac{x^5}{x^{-2}}$

36. $\frac{x^5y^2}{x^4y^0}$

37. $(x^4y^7)^{-3}$

38. $\frac{x^{11}y^{10}}{x^{-3}y^{-1}}$

39. $-3x^{-4}y^0$

40. $(10x^3y^5)^{-3}$

41. $\frac{x^{-1}y}{xy^{-2}}$

42. $(4x^2y^5)^{-2}$

43. $\frac{2x^2y}{6xy^{-1}}$

44. $\frac{5x^3y^9}{20x^2y^{-2}}$

45. $\frac{xy^9}{3y^{-2}} \cdot \frac{-7y}{21x^5}$

46. $\frac{y^{10}}{2x^3} \cdot \frac{20x^{14}}{xy^6}$

47. $\frac{12xy}{7x^4} \cdot \frac{7x^5y^2}{4y}$

STUDENT HELP

▶ HOMEWORK HELP

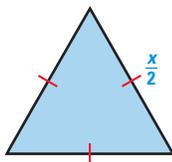
Example 1: Exs. 16–31

Example 2: Exs. 32–51

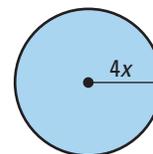
Examples 3, 4: Exs. 52–56

GEOMETRY CONNECTION Write an expression for the area or volume of the figure in terms of x .

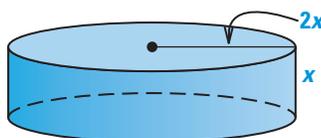
48. $A = \frac{\sqrt{3}}{4} s^2$



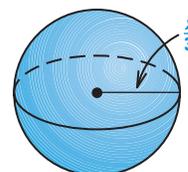
49. $A = \pi r^2$



50. $V = \pi r^2 h$



51. $V = \frac{4}{3} \pi r^3$



SCIENTIFIC NOTATION In Exercises 52–56, use scientific notation.

52. **NATIONAL DEBT** On June 8, 1999, the national debt of the United States was about \$5,608,000,000,000. The population of the United States at that time was about 273,000,000. Suppose the national debt was divided evenly among everyone in the United States. How much would each person owe?



DATA UPDATE of Bureau of the Public Debt and U.S. Census Bureau data at www.mcdougallittell.com

53. **SOCIAL STUDIES CONNECTION** The table shows the population and gross domestic product (GDP) in 1997 for each of six different countries. Calculate the per capita GDP for each country.



DATA UPDATE of UN/ECE Statistical Division data at www.mcdougallittell.com

Country	Population	GDP (U.S. dollars)
France	58,607,000	1,249,600,000,000
Germany	82,061,000	1,839,300,000,000
Ireland	3,661,000	71,300,000,000
Luxembourg	420,000	13,600,000,000
The Netherlands	15,600,000	333,400,000,000
Sweden	8,849,000	177,300,000,000

FOCUS ON CAREERS



ORNITHOLOGIST

An ornithologist is a scientist who studies the history, classification, biology, and behavior of birds.



CAREER LINK

www.mcdougallittell.com

54. **BIOLOGY CONNECTION** A red blood cell has a diameter of approximately 0.00075 centimeter. Suppose one of the arteries in your body has a diameter of 0.0456 centimeter. How many red blood cells could fit across the artery?

55. **SPACE EXPLORATION** On February 17, 1998, *Voyager 1* became the most distant manmade object in space, at a distance of 10,400,000,000 kilometers from Earth. How long did it take *Voyager 1* to travel this distance given that it traveled an average of 1,390,000 kilometers per day? ▶ Source: NASA

56. **ORNITHOLOGY** Some scientists estimate that there are about 8600 species of birds in the world. The mean number of birds per species is approximately 12,000,000. About how many birds are there in the world?