EXERCISES

For more practice, see *Extra Practice*.

Practice and Problem Solving

A Practice by Example

Example 1 (page 417)

Copy and complete each equation.

1. $\frac{5^9}{5^2} = 5^{\blacksquare}$
2. $\frac{2^4}{2^3} = 2^{\blacksquare}$
3. $\frac{3^2}{3^5} = 3^{\blacksquare}$
4. $\frac{5^2 5^3}{5^3 5^2} = 5^{\blacksquare}$

Simplify each expression.

5. $\frac{2^5}{2^7}$
6. $\frac{2^7}{2^5}$
7. $\frac{c^{12}}{c^{15}}$
8. $\frac{m^{-2}}{m^{-5}}$
9. $\frac{3s^{-9}}{6s^{-11}}$
10. $\frac{x^{13}y^2}{x^{13}y}$
11. $\frac{c^2d^{-3}}{c^3d^{-1}}$
12. $\frac{3^2m^3t^6}{3^5m^7t^{-5}}$

Example 2 (page 418)

Simplify each quotient. Write each answer in scientific notation.

13. $\frac{6.5 \times 10^{15}}{1.3 \times 10^8}$
14. $\frac{2.7 \times 10^{-8}}{9 \times 10^{-4}}$
15. $\frac{4.2 \times 10^8}{7 \times 10^5}$
16. $\frac{8.4 \times 10^{-5}}{2 \times 10^{-8}}$
17. $\frac{4.65 \times 10^{-4}}{3.1 \times 10^2}$
18. $\frac{3.5 \times 10^6}{5 \times 10^8}$

19. **Television** In 2000, people in the United States over age 2 watched television a total of 386 billion hours. The population of the United States over age 2 was about 265 million people.
   a. Write each number in scientific notation.
   b. Find the average number of hours of TV viewing per person older than age 2 for 2000.
   c. On average, how many hours per day did each person older than age 2 watch television in 2000?

20. **Computers** The speed of computers is measured in number of calculations per picosecond. There are 3.6×10^{15} picoseconds per hour. What fraction of a second is a picosecond?

Example 3 (page 419)

Simplify each expression.

21. $\left(\frac{3}{5}\right)^2$
22. $\left(\frac{1}{x}\right)^3$
23. $\left(\frac{2x}{y}\right)^5$
24. $\left(\frac{3a}{2b}\right)^4$
25. $\left(\frac{2^2}{5}\right)^3$
26. $\left(\frac{3^3}{3^4}\right)^2$
27. $\left(\frac{6}{n^6}\right)^2$
28. $\left(\frac{2p}{5}\right)^3$

Example 4 (page 419)

29. $\left(\frac{2}{3}\right)^{-1}$
30. $\left(\frac{2}{3}\right)^{-2}$
31. $\left(-\frac{2}{3}\right)^{-2}$
32. $\left(-\frac{2}{3}\right)^{-3}$
33. $\left(\frac{3x^4}{15}\right)^2$
34. $\left(\frac{4n}{2n^2}\right)^3$
35. $\left(\frac{c^5}{c^9}\right)^3$
36. $\left(\frac{3b^2}{5}\right)^0$

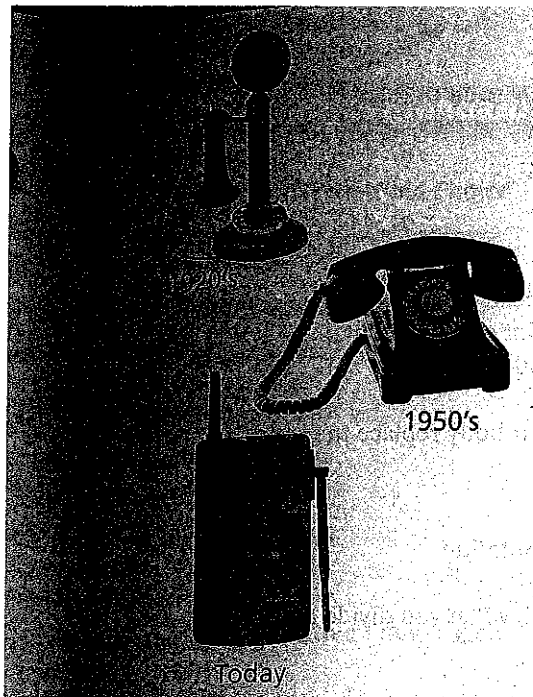
B Apply Your Skills

Explain why each expression is *not* in simplest form.

37. 5^3m^3
38. x^5y^{-2}
39. $(2c)^4$
40. x^0y
41. $\frac{d^7}{d}$

Simplify each expression.

42. $\frac{3^2 \cdot 5^0}{2^3}$
43. $\left(\frac{2m^5}{m^2}\right)^{-4}$
44. $\frac{5x^3}{(5x)^3}$
45. $\frac{(2a^7)(3a^2)}{6a^3}$
46. $\left(\frac{7t^3}{21t}\right)^3$
47. $\left(\frac{n^4n}{n^{-2}}\right)^{-4}$
48. $\left(\frac{2k^3}{3k^{-2}}\right)^{-2}$
49. $\frac{7^9 \cdot (1^9)^2}{7^7}$



50. Telecommunications In 2000, there were 97.4 million households with telephones. The people in these households made 544 billion local calls and 97 billion long distance calls.

a. Write each number in scientific notation.

b. What was the average number of local calls placed per household? Round to the nearest whole number.

c. What was the average number of long distance calls placed per household? Round to the nearest whole number.

51. a. Writing While simplifying the expression $\frac{c^4}{c^6}$, Kneale said, "I've found a property of exponents that's not in my algebra book!" Write an explanation of why Kneale's method works.

Kneale

$$\frac{c^4}{c^6} = \frac{1}{c^{6-4}} = \frac{1}{c^2}$$

b. Open-Ended Apply Kneale's method to an example you create.

Simplify each expression.

52. $\left(\frac{2ab^6}{a^3b}\right)^{-2}$ **53.** $\frac{a^3b^2c^{-4}}{a^{-2}b^5c^{-9}}$ **54.** $\frac{\left(\frac{1}{3}\right)^{-3}}{\left(\frac{1}{6}\right)^{-2}}$ **55.** $\frac{0.2^2 \cdot 0.2^3}{0.2^6}$

56. $\left(\frac{p^{-2}q^4r}{p^3q^5}\right)^5$ **57.** $\left(\frac{(-3)^2}{(-2)^{-4}}\right)^2$ **58.** $\left(\frac{(3x)^2y}{x^2y^4}\right)^{-2}$ **59.** $\frac{(5a^2)(6b^3)}{(2a^3)(25b^{-2})}$

60. a. Census The 2000 census counted approximately 281 million people in the United States. About 65,000 of those were centenarians, which means their ages are 100 or greater. Centenarians are about what percent of the population?

b. About what percent of the population does not include people who are centenarians?

61. Critical Thinking Lena and Jared used different methods to simplify $\left(\frac{b^7}{b^3}\right)^2$. Why are both methods correct?

Lena

$$\left(\frac{b^7}{b^3}\right)^2 = \frac{b^{14}}{b^6} = b^8$$

Jared

$$\left(\frac{b^7}{b^3}\right)^2 = (b^4)^2 = b^8$$

62. a. Finance In 1990, The United States government owed $3.23 trillion to its creditors. The population of the United States was 248.7 million people. How much did the government owe per person in 1990? Round to the nearest dollar.

b. In 1999 the debt had grown to $5.66 trillion, with a population of 273 million. How much did the government owe per person? Round to the nearest dollar.

c. What was the percent of increase in the average amount owed per person from 1990 to 1999?

63. a. Error Analysis What error did the student make in simplifying the expression at the right?

$$5^4 \div 5 = \frac{5^4}{5} = 1^4 = 1$$

b. What is the correct answer?