



GUIDED PRACTICE

1. **Vocabulary** In the expression $\sqrt[5]{3x}$, what is the *index*?

SEE EXAMPLE 1

p. 422

Simplify each expression.

2. $8^{\frac{1}{3}}$

3. $16^{\frac{1}{2}}$

4. $0^{\frac{1}{6}}$

5. $27^{\frac{1}{3}}$

6. $81^{\frac{1}{2}}$

7. $216^{\frac{1}{3}}$

8. $1^{\frac{1}{9}}$

9. $625^{\frac{1}{4}}$

10. $36^{\frac{1}{2}} + 1^{\frac{1}{3}}$

11. $8^{\frac{1}{3}} + 64^{\frac{1}{2}}$

12. $81^{\frac{1}{4}} + 8^{\frac{1}{3}}$

13. $25^{\frac{1}{2}} - 1^{\frac{1}{4}}$

SEE EXAMPLE 2

p. 423

14. $81^{\frac{3}{4}}$

15. $8^{\frac{5}{3}}$

16. $125^{\frac{2}{3}}$

17. $25^{\frac{3}{2}}$

18. $36^{\frac{3}{2}}$

19. $64^{\frac{4}{3}}$

20. $1^{\frac{3}{4}}$

21. $0^{\frac{3}{2}}$

SEE EXAMPLE 3

p. 423

22. **Geometry** Given a square with area a , you can use the formula $P = 4a^{\frac{1}{2}}$ to find the perimeter P of the square. Find the perimeter of a square that has an area of 64 m^2 .

SEE EXAMPLE 4

p. 424

Simplify. All variables represent nonnegative numbers.

23. $\sqrt{x^4y^2}$

24. $\sqrt[4]{z^4}$

25. $\sqrt{x^6y^6}$

26. $\sqrt[3]{a^{12}b^6}$

27. $\left(a^{\frac{1}{2}}\right)^2 \sqrt{a^2}$

28. $\left(x^{\frac{1}{3}}\right)^6 \sqrt[4]{y^4}$

29. $\frac{\left(\frac{1}{3}\right)^3}{\sqrt{z^2}}$

30. $\frac{\sqrt[3]{x^6y^9}}{x^2}$

PRACTICE AND PROBLEM SOLVING

Independent Practice

For Exercises	See Example
31–42	1
43–50	2
51	3
52–59	4

Simplify each expression.

31. $100^{\frac{1}{2}}$

32. $1^{\frac{1}{5}}$

33. $512^{\frac{1}{3}}$

34. $729^{\frac{1}{2}}$

35. $32^{\frac{1}{5}}$

36. $196^{\frac{1}{2}}$

37. $256^{\frac{1}{8}}$

38. $400^{\frac{1}{2}}$

39. $125^{\frac{1}{3}} + 81^{\frac{1}{2}}$

40. $25^{\frac{1}{2}} - 81^{\frac{1}{4}}$

41. $121^{\frac{1}{2}} - 243^{\frac{1}{5}}$

42. $256^{\frac{1}{4}} + 0^{\frac{1}{3}}$

43. $4^{\frac{3}{2}}$

44. $27^{\frac{2}{3}}$

45. $256^{\frac{3}{4}}$

46. $64^{\frac{5}{6}}$

47. $100^{\frac{3}{2}}$

48. $1^{\frac{5}{3}}$

49. $9^{\frac{5}{2}}$

50. $243^{\frac{2}{5}}$

Extra Practice

Skills Practice p. EP15

Application Practice p. EP30

51. **Biology** Biologists use a formula to estimate the mass of a mammal's brain. For a mammal with a mass of m grams, the approximate mass B of the brain, also in grams, is given by $B = \frac{1}{8}m^{\frac{2}{3}}$. Find the approximate mass of the brain of a mouse that has a mass of 64 grams.

Simplify. All variables represent nonnegative numbers.

52. $\sqrt[3]{a^6c^9}$

53. $\sqrt[3]{8m^3}$

54. $\sqrt[4]{x^{16}y^4}$

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

56. $\left(x^{\frac{1}{2}}y^{\frac{1}{3}}\right)^2 \sqrt{x^2}$

57. $(a^2b^4)^{\frac{1}{2}} \sqrt[3]{b^6}$

58. $\frac{\sqrt[3]{x^6y^6}}{yx^2}$

59. $\frac{\left(a^2b^2\right)^4}{\sqrt{b^2}}$

Fill in the boxes to make each statement true.

60. $256^{\square} = 4$

61. $\square^{\frac{1}{5}} = 1$

62. $225^{\frac{1}{\square}} = 15$

63. $\square^{\frac{1}{6}} = 0$

64. $64^{\frac{\square}{3}} = 16$

65. $\square^{\frac{3}{4}} = 125$

66. $27^{\frac{4}{\square}} = 81$

67. $36^{\frac{\square}{2}} = 216$

Simplify each expression.

68. $\left(\frac{81}{169}\right)^{\frac{1}{2}}$

69. $\left(\frac{8}{27}\right)^{\frac{1}{3}}$

70. $\left(\frac{256}{81}\right)^{\frac{1}{4}}$

71. $\left(\frac{1}{16}\right)^{\frac{1}{2}}$

72. $\left(\frac{9}{16}\right)^{\frac{3}{2}}$

73. $\left(\frac{8}{27}\right)^{\frac{2}{3}}$

74. $\left(\frac{16}{81}\right)^{\frac{3}{4}}$

75. $\left(\frac{4}{49}\right)^{\frac{3}{2}}$

76. $\left(\frac{4}{25}\right)^{\frac{3}{2}}$

77. $\left(\frac{1}{81}\right)^{\frac{3}{4}}$

78. $\left(\frac{27}{64}\right)^{\frac{2}{3}}$

79. $\left(\frac{8}{125}\right)^{\frac{4}{3}}$

80. **Multi-Step** Scientists have found that the life span of a mammal living in captivity is related to the mammal's mass. The life span in years L can be approximated by the formula $L = 12m^{\frac{1}{5}}$, where m is the mammal's mass in kilograms. How much longer is the life span of a lion compared with that of a wolf?

Typical Mass of Mammals	
Mammal	Mass (kg)
Koala	8
Wolf	32
Lion	243
Giraffe	1024

81. **Geometry** Given a sphere with volume V , the formula $r = 0.62V^{\frac{1}{3}}$ may be used to approximate the sphere's radius r . Find the approximate radius of a sphere that has a volume of 27 in^3 .
82. **Reasoning** Show that a number raised to the power $\frac{1}{3}$ is the same as the cube root of that number. (*Hint:* Use properties of exponents to find the cube of $b^{\frac{1}{3}}$. Then compare this with the cube of $\sqrt[3]{b}$. Use the fact that if two numbers have the same cube, then they are equal.)
83. **Critical Thinking** Compare $n^{\frac{2}{3}}$ and $n^{\frac{3}{2}}$ for values of n greater than 1. When simplifying each of these expressions, will the result be greater than n or less than n ? Explain.
84. **ERROR ANALYSIS** Two students simplified $64^{\frac{3}{2}}$. Which solution is incorrect? Explain the error.

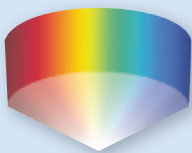
A

$$\begin{aligned} 64^{\frac{3}{2}} &= (\sqrt[3]{64})^2 \\ &= (4)^2 \\ &= 16 \end{aligned}$$


B

$$\begin{aligned} 64^{\frac{3}{2}} &= (\sqrt{64})^3 \\ &= (8)^3 \\ &= 512 \end{aligned}$$

CONCEPT CONNECTION



85. This problem will prepare you for the Concept Connection on page 428. You can estimate an object's distance in inches from a light source by using the formula $d = \left(0.8\frac{L}{B}\right)^{\frac{1}{2}}$, where L is the light's luminosity in lumens and B is the light's brightness in lumens per square inch.
- Find an object's distance to a light source with a luminosity of 4000 lumens and a brightness of 32 lumens per square inch.
 - Suppose the brightness of this light source decreases to 8 lumens per square inch. How does the object's distance from the source change?

-  **86. Write About It** You can write $4^{\frac{3}{2}}$ as $4^{3 \cdot \frac{1}{2}}$ or as $4^{\frac{1}{2} \cdot 3}$. Use the Power of a Power Property to show that both expressions are equal. Is one method easier than the other? Explain.

Multiple Choice For Exercises 87–90, choose the best answer.

- 87.** What is $9^{\frac{1}{2}} + 8^{\frac{1}{3}}$?
 (A) 4 (B) 5 (C) 6 (D) 10
- 88.** Which expression is equal to 8?
 (A) $4^{\frac{3}{2}}$ (B) $16^{\frac{1}{2}}$ (C) $32^{\frac{4}{5}}$ (D) $64^{\frac{3}{2}}$
- 89.** Which expression is equivalent to $\sqrt[3]{a^9b^3}$?
 (A) a^2b (B) a^3 (C) a^3b (D) a^3b^3
- 90.** Which of the following is NOT equal to $16^{\frac{3}{2}}$?
 (A) $(\sqrt{16})^3$ (B) 4^3 (C) $(\sqrt[3]{16})^2$ (D) $\sqrt{16^3}$


CHALLENGE AND EXTEND

Use properties of exponents to simplify each expression.

- 91.** $(a^{\frac{1}{3}})(a^{\frac{1}{3}})(a^{\frac{1}{3}})$ **92.** $(x^{\frac{1}{2}})^5(x^{\frac{3}{2}})$ **93.** $(x^{\frac{1}{3}})^4(x^5)^{\frac{1}{3}}$

You can use properties of exponents to help you solve equations. For example, to solve $x^3 = 64$, raise both sides to the $\frac{1}{3}$ power to get $(x^3)^{\frac{1}{3}} = 64^{\frac{1}{3}}$. Simplifying both sides gives $x = 4$. Use this method to solve each equation. Check your answer.

- 94.** $y^5 = 32$ **95.** $27x^3 = 729$ **96.** $1 = \frac{1}{8}x^3$

-  **97. Geometry** The formula for the surface area of a sphere S in terms of its volume V is $S = (4\pi)^{\frac{1}{3}}(3V)^{\frac{2}{3}}$. What is the surface area of a sphere that has a volume of $36\pi \text{ cm}^3$? Leave the symbol π in your answer. What do you notice?



SPIRAL STANDARDS REVIEW

3.0, 6.0, 17.0

Solve each equation. (Lesson 2-7)

- 98.** $|x + 6| = 2$ **99.** $|5x + 5| = 0$ **100.** $|2x - 1| = 3$

Solve each inequality and graph the solutions. (Lesson 3-4)

- 101.** $3n + 5 < 14$ **102.** $4 \leq \frac{1}{2}x + 3$ **103.** $7 \geq 2y + 11$

Give the domain and range of each relation. Tell whether the relation is a function. Explain. (Lesson 4-2)

- 104.** $\{(2, 3), (2, 4), (2, 5), (2, 6)\}$ **105.** $\{(-2, 0), (-1, 1), (0, 2), (1, 3)\}$

106.

x	y
5	2
7	2
9	2
11	2

