Guided Practice

Write each expression using exponents. (Example 1)

1. $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$ **2^6**

2. $d \cdot d \cdot d \cdot d \cdot d \cdot d$ **d^6**

3. $\left(-\frac{1}{4}\right)\left(-\frac{1}{4}\right)\left(-\frac{1}{4}\right)$ **$\left(-\frac{1}{4}\right)^3$**

4. $4 \cdot m \cdot m \cdot m \cdot q \cdot q \cdot q$ **$4m^3q^3$**

5. $(y-3)(y-3)(y-3)$ **$(y-3)^3$**

6. $(a+1)(a+1)$ **$(a+1)^2$**

7. The longhorn beetle can have a body length of more than 2^4 centimeters. How many centimeters long is this? (Example 2) **16 cm**

8. **STEM** Theo sends an E-mail to three friends. Each friend forwards the E-mail to three friends. Each of those friends forwards it to three friends, and so on. Write the number of E-mails sent during the fifth stage as a power. Then find the value of the power. (Example 2) **3^5; 243**

Evaluate each expression if $a = 3$, $b = -4$, and $c = 3.5$. (Example 3)

9. $a^3 + 2$ **29**

10. $3(b-1)^2$ **75**

11. $c^2 + b^2$ **28.25**

12. $4c - 7 + b^3$ **−57**

Independent Practice

Write each expression using exponents. (Example 1)

13. $11 \cdot 11 \cdot 11 \cdot 11$ **11^4**

14. $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$ **3^5**

15. $(-8)(-8)(-8)(-8)(-8)(-8)$ **$(-8)^6$**

16. $(-14) \cdot (-14) \cdot (-14)$ **$(-14)^3$**

17. $\left(-\frac{1}{5}\right)\left(-\frac{1}{5}\right)\left(-\frac{1}{5}\right)\left(-\frac{1}{5}\right)$ **$\left(-\frac{1}{5}\right)^4$**

18. $(-1.5)(-1.5)(-1.5)$ **$(-1.5)^3$**

19. $ab \cdot ab \cdot ab \cdot ab$ **$(ab)^4$ or a^4b^4**

20. $5 \cdot p \cdot p \cdot p \cdot q \cdot q \cdot q$ **$5p^3q^3$**

21. $3 \cdot 7 \cdot m \cdot m \cdot n \cdot n \cdot n \cdot n$ **$21m^2n^4$**

22. $8(c+4)(c+4)$ **$8(c+4)^2$**

23. $(n-5)(n-5)(n-5)$ **$(n-5)^3$**

24. $(2x+3y)(2x+3y)$ **$(2x+3y)^2$**

25. **STEM** The longest chain of active volcanoes is in the South Pacific. This chain is more than $3 \cdot 10^4$ miles long and has approximately $3^5 \cdot 5$ volcanoes. (Example 2)

    a. How long is the chain of volcanoes? **30,000 mi**

    b. How many volcanoes are there? **1215 volcanoes**

26. A water park has a wave pool that contains about $2^6 \cdot 4^3 \cdot 10^2$ gallons of water. How many gallons of water is this? (Example 2) **409,600 gal**

Evaluate each expression if $x = -2$, $y = 3$, and $z = 2.5$. (Example 3)

27. y^4 **81**

28. z^3 **15.625**

29. $7x^2$ **28**

30. xy^3 **−54**

31. $z^2 + x$ **4.25**

32. $y^4 + 9$ **90**

33. $2y + z^3$ **21.625**

34. $x^2 + 2y - 3$ **7**

35. $y^2 - 3x + 8$ **23**

36. $4(y+1)^4$ **1024**

37. $3(2z+4)^2$ **243**

38. $5(x^3+6)$ **−10**

Guided Practice

Find each product. Express using positive exponents. (Examples 1–3)

1. $2^4 \cdot 2^6$ **2^{10}**
2. $8^5 \cdot 8$ **8^6**
3. $5^{-6} \cdot 5^9$ **5^3**
4. $3^2 \cdot 3^{-5}$ **$\dfrac{1}{3^3}$**

5. $x^{10} \cdot x^6$ **x^{16}**
6. $-w^2(5w^7)$ **$-5w^9$**
7. $m^8 \cdot m^{-10}$ **$\dfrac{1}{m^2}$**
8. $y^{-4} \cdot y^{12}$ **y^8**

Find each quotient. Express using positive exponents. (Example 4)

9. $\dfrac{4^5}{4^3}$ **4^2**
10. $7^9 \div 7$ **7^8**
11. $\dfrac{6^7}{6^{-5}}$ **6^{12}**
12. $9^{-2} \div 9^6$ **$\dfrac{1}{9^8}$**

13. $\dfrac{r^8}{r^4}$ **r^4**
14. $b^{11} \div b^2$ **b^9**
15. $\dfrac{c^{-7}}{c^2}$ **$\dfrac{1}{c^9}$**
16. $n^5 \div n^{-4}$ **n^9**

17. The Grand Canyon is approximately 2^9 kilometers long. Mariner Valley is a canyon on Mars that is approximately 2^{12} kilometers long. About how many times as long is the length of Mariner Valley than that of the Grand Canyon? (Example 5) **2^3 or 8 times**

18. A snake is 2^5 inches long. An earthworm is 2^{-1} inch long. About how many times as long is the length of the snake than the length of the earthworm? (Example 5) **2^6 or 64 times**

Independent Practice

Find each product. Express using positive exponents. (Examples 1–3)

19. $5^6 \cdot 5^2$ **5^8**
20. $(-2)^3 \cdot (-2)^2$ **-2^5**
21. $a^7 \cdot a^2$ **a^9**

22. $(t^3)(t^3)$ **t^6**
23. $4^{-5} \cdot 4^6$ **4^1 or 4**
24. $6^5 \cdot 6^{-5}$ **6^0 or 1**

25. $c^2 \cdot c^{-3}$ **$\dfrac{1}{c}$**
26. $(w^{-4})(w^6)$ **w^2**
27. $(10x)(4x^{-7})$ **$\dfrac{40}{x^6}$**

28. $6p^7 \cdot 9p^7$ **$54p^{14}$**
29. $m^{-5} \cdot (-4m^6)$ **$-4m$**
30. $(-8s^3)(-3s^4)$ **$24s^7$**

Find each quotient. Express using positive exponents. (Example 4)

31. $\dfrac{5^{10}}{5^2}$ **5^8**
32. $\dfrac{7^6}{7}$ **7^5**
33. $\dfrac{a^8}{a^7}$ **a**
34. $\dfrac{k^{12}}{k^9}$ **k^3**

35. $\dfrac{8^{-7}}{8^4}$ **$\dfrac{1}{8^{11}}$**
36. $\dfrac{3^3}{3^{-1}}$ **3^4**
37. $\dfrac{b^4}{b^5}$ **$\dfrac{1}{b}$**
38. $\dfrac{y^{15}}{y^{-2}}$ **y^{17}**

39. $(-1.5)^8 \div (-1.5)^3$ **$(-1.5)^5$**
40. $8^{15} \div 8^{-9}$ **8^{24}**
41. $r^{20} \div r^6$ **r^{14}**
42. $(-n)^{-6} \div (-n)^4$ **$\dfrac{1}{n^{10}}$ or $\dfrac{1}{(-n)^{10}}$**

43. Sound intensity is measured in decibels. The decibel scale is based on powers of ten, as shown. (Example 5)

  a. How many times as intense is a rock concert as a normal conversation? **10^5 or 100,000 times**

  b. How many times as intense is a vacuum cleaner as a person whispering? **10^6 or 1,000,000 times**

Sound	Decibels	Intensity
rock concert	110	10^{11}
vacuum cleaner	80	10^8
normal conversation	60	10^6
whispering	20	10^2

44. A large beetle can be 2^7 millimeters long. One of the smallest beetles can be 2^{-2} millimeter long. How many times as great is the length of the large beetle than the length of the small beetle? (Example 5) **2^9 or 512 times**

Independent Practice

Express each number in standard form. (Example 1)

12. 6.89×10^4 **68,900**

13. 1.5×10^{-4} **0.00015**

14. 2.3×10^{-5} **0.000023**

15. 9.51×10^{-3} **0.00951**

16. 3.062×10^6 **3,062,000**

17. 7.924×10^2 **792.4**

18. A dollar bill is approximately 1.09×10^{-2} centimeter thick. Write 1.09×10^{-2} in standard form. **0.0109**

19. It is estimated that more than 1.71×10^{11} E-mails are sent each day around the world. Write 1.71×10^{11} in standard form. **171,000,000,000**

Express each number in scientific notation. (Example 2)

20. 700,000 7×10^5

21 32,000,000 3.2×10^7

22. 0.045 4.5×10^{-2}

23. 0.000918 9.18×10^{-4}

24. 1,000,000 1×10^6

25. 0.006752 6.752×10^{-3}

Estimate each value using scientific notation. (Example 3) **26–28. Sample answers are given.**

26. 0.00000095 centimeter
1×10^{-6} **cm**

27. 8.375×10^{-23} pound
8×10^{-23} **lb**

28. 56,300,001 miles
6×10^7 **mi**

29. The distance between Earth and the Moon is about 3.84×10^5 kilometers. Estimate this distance using scientific notation. (Example 3) **Sample answer: 4×10^5 km**

30. The usual growth rate of human hair is 3.3×10^{-4} meter per day. Is it more appropriate to report the rate as 3.3×10^{-4} meter per day or 0.33 millimeter per day? Explain your reasoning. (Example 4)

30. 0.33 millimeter per day; The length is very small, so choosing a smaller unit of measure is more meaningful.

31. One ounce of a certain cheese has 219 milligrams of calcium. Is it more appropriate to include on the nutrition label that the cheese has 2.19×10^{-4} kilogram of calcium or 219 milligrams of calcium? (Example 4) **219 mg**

Order each set of numbers from least to greatest. (Example 5)

32. 2.4×10^2, 2.45×10^{-2}, 2.45×10^2, 2.4×10^{-2} **2.4×10^{-2}, 2.45×10^{-2}, 2.4×10^2, 2.45×10^2**

33. 2.81×10^4, 2805, 2.08×10^5, 3.2×10^4, 3.024×10^2 **3.024×10^2, 2805, 2.81×10^4, 3.2×10^4, 2.08×10^5**

34. 5.9×10^6, 5.9×10^4, 5.01×10^5, 5.1×10^{-3} **5.1×10^{-3}, 5.9×10^4, 5.01×10^5, 5.9×10^6**

35. 9,562,301, 9.05×10^{-6}, 9.5×10^6, 905,000 **9.05×10^{-6}, 905,000, 9.5×10^6, 9,562,301**

36. List the states in the table at the right from least to greatest production of maple syrup. (Example 5) **New Hampshire, Wisconsin, New York, Maine, Vermont**

B ▶ 37. **STEM** A sheet of gold leaf is approximately 1.25×10^{-5} centimeter thick.

a. Write the value of the thickness as a decimal. **0.0000125 cm**

b. Use the formula $V = \ell wh$ to find the volume in cubic meters of a sheet of gold that is 2 meters wide and 5 meters long. **1.25×10^{-6} m^3**

State	Amount of Syrup Produced (L)
Maine	1.10×10^6
New Hampshire	3.14×10^5
New York	9.65×10^5
Vermont	1.89×10^6
Wisconsin	3.79×10^5