

9-1 Practice**Powers and Exponents**

Write each expression using exponents.

- | | |
|---|---|
| 1. $11 \cdot 11 \cdot 11$ | 2. $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$ |
| 3. 5 | 4. $(-4)(-4)$ |
| 5. $a \cdot a \cdot a \cdot a$ | 6. $n \cdot n \cdot n \cdot n \cdot n$ |
| 7. $4 \cdot 4 \cdot 4$ | 8. $(b \cdot b)(b \cdot b)(b \cdot b)$ |
| 9. $(-v)(-v)(-v)(-v)$ | 10. $x \cdot x \cdot z \cdot z \cdot z$ |
| 11. $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot t \cdot t$ | 12. $m \cdot m \cdot m \cdot n \cdot p \cdot p$ |
| 13. $(-6)(-6)(-6)(-d)(-d)(-d)(-d)$ | 14. $3 \cdot 3 \cdot 3 \cdot 3 \cdot p \cdot q \cdot q \cdot q$ |

Evaluate each expression if $x = 3$, $y = -2$, and $z = 4$.

- | | |
|-----------------------|---------------------|
| 15. y^z | 16. x^z |
| 17. y^x | 18. 51^0 |
| 19. z^2 | 20. x^2 |
| 21. 9^x | 22. $z^2 \cdot 2^2$ |
| 23. y^5 | 24. $z^2 - y^4$ |
| 25. $x^2 + y^2 + z^2$ | 26. $z^2 - x^2$ |

FAMILY TREE For Exercises 27 and 28, refer to the following information.

When examining a family tree, the branches are many. You are generation "now." One generation ago, your 2 parents were born. Two generations ago, your 4 grandparents were born.

27. How many great-grandparents were born three generations ago?
28. How many "great" grandparents were born ten generations ago?

9-1 Word Problem Practice

Powers and Exponents

1. GEOMETRY Mr. Daniels is building a clubhouse for his children. He has decided that the floor will be a square with an area of 64 square feet. Write this number using a power greater than 1 and a lesser base.

2. STOCK MARKET The Nikkei 225 is a stock market index that records the progress of 225 Japanese companies. Write this number using a power greater than 1 and a lesser base.

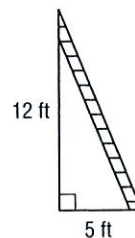
3. NUMBER SENSE A *googol* is a very large number expressed as 10^{100} . Ms. Rogers asked her students to determine which number is larger, a googol or 100^{10} . Explain how her students might use the idea of repeated factors in order to find the solution.

4. LIFE SCIENCE A scientist is studying bacterial growth in the laboratory. She starts her experiment with 1 bacterium and then counts the bacteria at regular intervals and records them in the table below. If the pattern continues, how long will it take to have over 1000 bacteria?

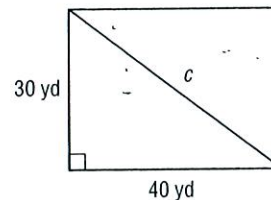
Time (hours)	0	3	6	9
Number of cells	1	2	4	8

5. GEOMETRY The sides of right triangles have a special relationship. The longest side of a right triangle, always located opposite the right angle, is related to the shorter side lengths by the formula $c = \sqrt{a^2 + b^2}$, where c is the length of the longest side and a and b are the lengths of the sides that intersect to form the right angle.

a. The following diagram shows a ladder leaning against a wall. The bottom of the ladder is 5 feet from the base of the wall, and the ladder reaches 12 feet up the wall. Find the length of the ladder.



b. Paula exercises regularly by power walking around a rectangular field. She usually begins at one corner of the field and walks the full perimeter. One day, she takes a shortcut home by walking across the diagonal of the field. How far does she walk across the field?



9-2**Practice****Prime Factorization**

Determine whether each number is *prime* or *composite*.

- | | |
|-------|-------|
| 1. 11 | 2. 63 |
| 3. 73 | 4. 75 |
| 5. 49 | 6. 69 |
| 7. 53 | 8. 83 |

Write the prime factorization of each number. Use exponents for repeated factors.

- | | |
|---------|----------|
| 9. 33 | 10. 24 |
| 11. 72 | 12. 276 |
| 13. 85 | 14. 1024 |
| 15. 95 | 16. 200 |
| 17. 243 | 18. 735 |

Factor each monomial.

- | | |
|--------------|--------------|
| 19. $35v$ | 20. $49c^2$ |
| 21. $-14b^3$ | 22. $-81h^2$ |
| 23. $33wz$ | 24. $-56ghj$ |

- 25. NUMBER THEORY** *Twin primes* are a pair of consecutive odd primes, which differ by 2. For example, 3 and 5 are twin primes. Find the twin primes less than 100. (*Hint*: There are 8 pairs of twins less than 100.)

9.3 Practice**Multiplying and Dividing Monomials**

Find each product or quotient. Express using exponents.

1. $4^2 \cdot 4^3$

2. $9^8 \cdot 9^6$

3. $7^4 \cdot 7^2$

4. $13^2 \cdot 13^4$

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

6. $(-21)^9(-21)^5$

7. $t^9 \cdot t^3$

8. $h^4 \cdot h^{13}$

9. $(m^6)(m^6)$

10. $(u^{11})(u^{10})$

11. $(-r)^7(-r)^{20}$

12. $(-w)(-w)^9$

13. $4d^5 \cdot 8d^6$

14. $7j^{50} \cdot 6j^{50}$

15. $-5b^9 \cdot 6b^2$

16. $12^1 \cdot 12^2$

17. $\frac{6^{11}}{6^3}$

18. $\frac{15^3}{15^2}$

19. $\frac{9^9}{9^7}$

20. $\frac{18^4}{18^4}$

21. $\frac{(-7)^6}{(-7)^5}$

22. $\frac{95^{21}}{95^{18}}$

23. $\frac{v^{30}}{v^{20}}$

24. $\frac{n^{19}}{n^{11}}$

25. the product of five cubed and five to the fourth power

26. the quotient of eighteen to the ninth power and eighteen squared

27. the product of z cubed and z cubed28. the quotient of x to the fifth power and x cubed

29. **SOUND** Decibels are units used to measure sound. The softest sound that can be heard is rated as 0 decibels (or a relative loudness of 1). Ordinary conversation is rated at about 60 decibels (or a relative loudness of 10^6). A rock concert is rated at about 120 decibels (or a relative loudness of 10^{12}). How many times greater is the relative loudness of a rock concert than the relative loudness of ordinary conversation?

9-4 Practice**Negative Exponents**

Write each expression using a positive exponent.

1. 7^{-8}

2. 10^{-6}

3. 23^{-1}

4. $(-5)^{-2}$

5. $(-18)^{-10}$

6. m^{-99}

7. $(-1)^{-12}$

8. c^{-6}

9. p^{-5}

10. g^{-17}

11. $5z^{-4}$

12. $3t^{-1}$

Write each fraction as an expression using a negative exponent.

13. $\frac{1}{2^{10}}$

14. $\frac{1}{29^3}$

15. $\frac{1}{4^4}$

16. $\frac{1}{39}$

17. $\frac{1}{81^7}$

18. $\frac{1}{m^4}$

19. $\frac{1}{x^3}$

20. $\frac{1}{a^2}$

21. $\frac{1}{49}$

22. $\frac{1}{8}$

23. $\frac{1}{144}$

24. $\frac{1}{169}$

Evaluate each expression if $x = 3$, $y = -2$, and $z = 4$.

25. x^{-4}

26. y^{-2}

27. y^{-5}

28. z^{-4}

29. 5^y

30. 10^y

31. $3z^{-1}$

32. z^y

33. $(xz)^{-2}$

34. **HAIR** Hair grows at a rate of $\frac{1}{64}$ inch per day. Write this number using negative exponents.

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WS "Stilwell Practice 9-3 & 9-4"

Find each product or quotient. N☺ negative exponents.

1) 2^{-3} _____ 2) 4^{-2} _____

3) 10^3 _____ 4) 10^{-3} _____

5) $(-2)^{-3}$ _____ 6) $(-6)^{-2}$ _____

7) y^{-3} _____ 8) x^{-2} _____

9) $4n^{-4}$ _____ 10) $5x^{-2}$ _____

11) $\left(\frac{2}{3}\right)^{-3}$ _____ 12) x^2y^{-2} _____

13) $\left(\frac{-3}{4}\right)^{-2}$ _____ 14) $\left(\frac{1}{5}\right)^{-2}$ _____

15) $r^{-2}t^3$ _____ 16) $(4y)^{-2}$ _____

17) $4c^{-2}d^{-2}$ _____ 18) $(-1)^{-1}$ _____

19) $\left(\frac{1}{2}\right)^{-4}$ _____ 20) $(3ab)^{-5}$ _____

21) m^0 _____ 22) $x^{-4}y^{-4}$ _____

23) $(2kp)^{-3}$ _____ 24) $c^{-4}p^{-4}$ _____

25) $x^{-3}x^{-2}$ _____ 26) $y^{-4}y^3$ _____

27) $\frac{m^4}{m^8}$ _____ 28) $\frac{c^5}{c^9}$ _____

29) $\frac{a^{-2}a^{-3}}{a^{-4}}$ _____ 30) $\frac{m^{-5}m^2}{m^6}$ _____

9-5**Skills Practice****Scientific Notation**

Express each number in standard form.

- | | |
|---------------------------|----------------------------|
| 1. 1.5×10^3 | 2. 4.01×10^4 |
| 3. 6.78×10^2 | 4. 5.925×10^6 |
| 5. 7.0×10^8 | 6. 9.99×10^7 |
| 7. 3.0005×10^5 | 8. 2.54×10^5 |
| 9. 1.75×10^4 | 10. 1.2×10^{-6} |
| 11. 7.0×10^{-1} | 12. 6.3×10^{-3} |
| 13. 5.83×10^{-2} | 14. 8.075×10^{-4} |
| 15. 1.1×10^{-5} | 16. 7.3458×10^7 |

Express each number in scientific notation.

- | | |
|--------------------|---------------|
| 17. 1,000,000 | 18. 17,400 |
| 19. 500 | 20. 803,000 |
| 21. 0.00027 | 22. 5300 |
| 23. 18 | 24. 0.125 |
| 25. 17,000,000,000 | 26. 0.01 |
| 27. 21,800 | 28. 2,450,000 |
| 29. 0.0054 | 30. 0.000099 |
| 31. 8,888,800 | 32. 0.00912 |

Choose the greater number in each pair.

- | | |
|--|--|
| 33. 8.8×10^3 , 9.1×10^{-4} | 34. 5.01×10^2 , 5.02×10^{-1} |
| 35. 6.4×10^3 , 900 | 36. 1.9×10^{-2} , 0.02 |
| 37. 2.2×10^{-3} , 2.1×10^2 | 38. 8.4×10^2 , 839 |

Order each set of numbers from least to greatest.

39. 3.6×10^4 ; 5.8×10^{-3} ; 2.1×10^6 ; 3.5×10^5
40. 64,000,000; 6.2×10^8 ; 6,400,000; 6.4×10^5

9.5 Practice**Scientific Notation**

Express each number in standard form.

- | | |
|---------------------------|---------------------------|
| 1. 2.4×10^4 | 2. 9.0×10^3 |
| 3. 4.385×10^7 | 4. 1.03×10^8 |
| 5. 3.05×10^2 | 6. 5.11×10^{10} |
| 7. 6.000032×10^6 | 8. 1.0×10^1 |
| 9. 8.75×10^5 | 10. 8.49×10^{-2} |
| 11. 7.1×10^{-6} | 12. 1.0×10^{-3} |
| 13. 4.39×10^{-7} | 14. 1.25×10^{-4} |

Express each number in scientific notation.

- | | |
|-----------------------|-------------|
| 15. 40,000 | 16. 16 |
| 17. 876,000,000 | 18. 4500 |
| 19. 151 | 20. 0.00037 |
| 21. 83,000,000 | 22. 919,100 |
| 23. 5,000,000,000,000 | 24. 0.13 |
| 25. 0.0000007 | 26. 0.0067 |

Order each set of numbers from least to greatest.

27. 7.35×10^4 , 1.7×10^{-6} , 8.26×10^3 , 9.3×10^{-2}
28. 0.00048, 4.37×10^{-4} , 4.02×10^{-3} , 0.04

NIAGARA FALLS For Exercises 29 and 30, use the following information.

Every minute, 840,000,000,000 drops of water flow over Niagara Falls.

29. Write this number in scientific notation.
30. How many drops flow over the falls in a day?

9.5 Word Problem Practice

Scientific Notation

- 1. EARTH SCIENCE** Mr. Bell's class is studying the solar system. The circumference of Earth at the equator is about 24,900 miles. Express this number in scientific notation.
- 2. LIGHT SPEED** The speed of light is approximately 6.71×10^8 miles per hour. Express this number in standard form.
- 3. EARTH SCIENCE** If it takes light 8.3 minutes to reach the Sun from Earth, use the light speed from Exercise 2 to determine the distance from Earth to the Sun. Write your answer in scientific notation.
- 4. EARTH SCIENCE** The students in Mr. Bell's class have learned that the mass of Earth is approximately 5.97×10^{24} kilograms. They have also found that mass of an electron is approximately 9.11×10^{-31} kilograms. How many times greater than the mass of an electron is the mass of Earth?
- 5. AIRCRAFT** The SR-71 "Blackbird" is one of the world's fastest airplanes. It is capable of traveling at a cruising speed of Mach 3, or three times the speed of sound. The speed of sound is approximately 7.6×10^2 miles per hour. What is Mach 3 in miles per hour? Write your answer in scientific notation.

- 6. POPULATION** Geographers keep track of how many people live in different areas of the world. They are especially interested in how the populations of certain areas change. The table below shows the population of different regions in 1985 and in 2005.

Place	Population	
	1985	2005
Earth	4.9×10^9	6.4×10^9
China	1.1×10^9	1.3×10^9
India	7.6×10^8	1.1×10^9
United States	2.4×10^8	3.0×10^8

Source: U.S. Census Bureau

- In 2005, how many times greater than China's population is the population of the world?
- How many more people inhabited Earth in 2005 than in 1985?
- What was the percentage increase in population in India from 1985 to 2005? Round your answer to the nearest percent.
- Was India's percent increase in population greater than or less than the percent increase of the whole world for the same time period? Explain.

9-6**Practice****Powers of Monomials**

No negative exponents!

Simplify.

1. $(19^3)^6$

2. $(-8^4)^9$

3. $(28^2)^{-5}$

4. $(q^8)^{-2}$

5. $(w^3)^4$

6. $(-46^{10})^7$

7. $(b^9)^{-3}$

8. $(m^5)^{-2}$

9. $(-103^4)^{12}$

10. $(88^3)^7$

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

12. $(v^{-4})^4$

13. $(7l^8)^2$

14. $(-4x^3)^4$

15. $(-9f^7)^3$

16. $(12r^{-5})^2$

17. $(3s^8)^4$

18. $(-5y^7)^4$

19. $(10u^5v^{-3})^5$

20. $(-2h^5i^3)^7$

21. $(4c^{-8}d^6)^2$

22. $(9f^5g^{-5})^3$

23. $(11j^{-4}k^{-2})^2$

24. $(-3b^5c^{-7})^5$

25. $(-5x^{-3}y^{-5}z^2)^2$

26. $(-7a^5b^6c^7)^2$

27. $(4g^6h^{-2}i^{-8})^6$

28. $[(4^2)^3]^2$

29. $(0.6c^{-5})^2$

30. $(\frac{1}{4}r^4s^6)^3$

31. **GEOMETRY** Find the area of a square with sides of length $6x^2y^5$ units.32. **GEOMETRY** Find the volume of a cube with sides of length $4a^4b^6$ units.33. **ASTRONOMY** The diameter of the Sun is 8.65×10^5 miles. Use the formula $A = 3.14 \cdot r^2$ to find the area of the cross section of the Sun at the equator.

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Chapter 9 Bringing It All Together (Powers & Exponents)

Write each expression using exponents.

1) $17 \cdot r \cdot r \cdot r \cdot r \cdot w \cdot w$ _____ 2) $(4)(4)(4)(4)(4)$ _____

3) $(p - 9)(p - 9)(p - 9)(p - 9)(p - 9)(p - 9)(p - 9)$ _____

Evaluate each expression if $y = 4$ and $z = 3.6$

4) $(-y)^5 + 41^0$ _____ 5) $-7(3z + 9)^2$ _____

Evaluate each expression if $e = 6$ and $f = -8$

6) $f^3 + 5$ _____ 7) $e - 5f^2$ _____

Determine whether each number is *prime* or *composite*.

8) 87 _____ 9) 3,146 _____ 10) 51 _____

11) 195 _____ 12) 201 _____

Write the prime factorization of each number. Use exponents for repeated factors.

13) 225 _____ 14) 846 _____ 15) 96 _____

Factor each monomial.

16) $-32h^4i^5j$ _____

17) $25rs$ _____

18) $56t^6s^2$ _____

OVER →

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Find each product. Express using exponents.

19) $(-17)^9(-17)^5$ _____ 20) $g^0 \cdot g^{49}$ _____

21) the product of three squared and three to the fourth power _____

22) $(22w^8x)(-8x)$ _____ 23) $(-21b^3c^2)(3b^2c^6)$ _____

Find each quotient for #24-28. Express using exponents.

24) $\frac{82^{13}}{82^{10}}$ _____

25) $y^{15} \div y$ _____

26) the quotient of C cubed and C cubed _____

27) $\frac{q^3q^{-4}}{q^7}$ _____

28) $\frac{a^{-5}a^{-2}}{a^{-9}}$ _____

Write each expression using a positive exponent.

29) 5^{-11} _____

30) $(-4)^{-3}$ _____

31) d^{-24} _____

32) $6h^{-7}$ _____

Write each fraction as an expression using a negative exponent other than -1 .

33) $\frac{1}{5^3}$ _____

34) $\frac{1}{81}$ _____

35) $\frac{1}{b^{19}}$ _____

36) $\frac{4}{z^8}$ _____

Evaluate each expression if $s = 2$, $r = -4$ and $s = 5$.

37) $(qr)^{-4}$ _____

38) 4^r _____

39) $-s^{-1}$ _____

40) $3^r q^2$ _____

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Express each number in standard form.

41) 6.92×10^5 _____

42) 7.38×10^{-8} _____

43) 6.39452×10^3 _____

Express each number in scientific notation.

44) 478,100,000 _____

45) 0.0000003 _____

46) 0.0047 _____

Order from least to greatest.

44) 8,451,210 ; 8.04×10^{-5} ; 8.4×10^5 ; 804,000

Simplify.

45) $(4^5)^7$ _____

46) $(g^9)^{-4}$ _____

47) $(20u^4v)^2$ _____

48) $(-3a^3b^{-7})^6$ _____

FINALLY DONE

