Name _____ Class _____ Date _____

Reteaching 8-2

Scientific Notation

OBJECTIVE: Writing numbers in scientific notation

MATERIALS: None

To write a number in **scientific notation**, follow these steps:

- Move the decimal to the right of the first integer.
- If the original number is greater than 1, multiply by 10^n, where n represents the number of places the decimal was moved to the left.
- If the original number is less than 1, multiply by 10^{-n}, where n represents the number of places the decimal was moved to the right.

Examples

Write each number in scientific notation.

a. 9,040,000,000 ← **standard form**

9.040 000 000. ← **Move the decimal to the left nine places.**

9.04×10^9 ← **Drop all insignificant 0's. Multiply by the appropriate power of 10.**

b. 0.000 000 8 ← **standard form**

0.000 000 8. ← **Move the decimal to the right seven places.**

8.0×10^{-7} ← **Multiply by the appropriate power of 10.**

Exercises

Write each number in scientific notation.

1. 420,000 **2.** 5,100,000,000 **3.** 260 billion

4. 830 million **5.** 0.00075 **6.** 0.004005

Write each number in standard notation.

7. 6.345×10^8 **8.** 3.2×10^{-5} **9.** 4.081×10^6

10. 2.581×10^{-3} **11.** 3.07×10^{-2} **12.** 1.526×10^6

13. 8.04×10^{-4} **14.** 7.625×10^5 **15.** 6.825×10^4

16. 3.081×10^{-5} **17.** 8.3847×10^2 **18.** 3.6245×10^{-2}

Name _____ Class _____ Date _____

Practice 8-2

Scientific Notation

Write each number in standard notation.

1. 7×10^4
2. 3×10^{-2}
3. 2.6×10^5
4. 7.1×10^{-4}
5. 5.71×10^{-5}
6. 4.155×10^7
7. 3.0107×10^2
8. 9.407×10^{-5}
9. 31.3×10^6
10. 83.7×10^{-4}
11. 0.018×10^{-1}
12. 0.016×10^5
13. 8.0023×10^{-3}
14. 6.902×10^8
15. 1005×10^2
16. 0.095×10^{-1}

Write each number in scientific notation.

17. 51,000,000
18. 975,000,000,000
19. 0.00000012
20. 0.000005008
21. 1560 billion
22. 0.5 million
23. 2 thousandths
24. 1095 millionths
25. 194×10^3
26. 154×10^{-3}
27. 0.05×10^6
28. 0.031×10^{-4}
29. 790 thousand
30. 25 hundredths
31. 0.000000000159
32. 5,000,900,000,000

Order the numbers in each list from least to greatest.

33. $7 \times 10^{-7}, 6 \times 10^{-8}, 5 \times 10^{-6}, 4 \times 10^{-10}$
34. $5.01 \times 10^{-4}, 4.8 \times 10^{-3}, 5.2 \times 10^{-2}, 5.6 \times 10^{-2}$
35. $62{,}040, 6.2 \times 10^2, 6.207 \times 10^3, 6.34 \times 10^{-1}$
36. $10^{-3}, 5 \times 10^{-3}, 8 \times 10^{-2}, 4 \times 10^{-1}$

Simplify. Write each answer using scientific notation.

37. $4(3 \times 10^5)$
38. $5(7 \times 10^{-2})$
39. $8(9 \times 10^9)$
40. $7(9 \times 10^6)$
41. $3(1.2 \times 10^{-4})$
42. $2(6.1 \times 10^{-8})$
43. $3(1.2 \times 10^{-4})$
44. $3(4.3 \times 10^{-4})$
45. $3(3.2 \times 10^{-2})$

Complete the table.

	Units of Area in Square Feet		
	Unit	Standard Form	Scientific Notation
46.	1 $in.^2$		6.9444×10^{-3}
47.	1 $link^2$	0.4356	
48.	1 rod^2	272.25	
49.	1 mi^2		2.78×10^7
50.	1 cm^2	0.001076	
51.	1 hectare		1.08×10^7

LESSON 4-7

Name _____ Date _____

Practice

For use with pages 204-209

Write the number in scientific notation.

1. 1250

2. 205,000

3. 0.0035

4. 0.00058

5. 5,220,000

6. 0.000064

Write the number in standard form.

7. 5.3×10^2

8. 7.2×10^{-2}

9. 4.3×10^{-3}

10. 1.2×10^5

11. 9.45×10^{-5}

12. 6.32×10^6

Complete the statement using <, >, or =.

13. 1.8×10^2 ____ 1800

14. 43,000 ____ 4.3×10^3

15. 6.9×10^{-3} ____ 0.0068

16. 1.8×10^{-4} ____ 0.0018

Order the numbers from least to greatest.

17. 1.2×10^2, 1.19×10^3, 1.12×10^3

18. 4.8×10^{-2}, 4.8×10^{-3}, 4.8×10^{-4}

Name _____ Date _____

Practice

For use with pages 204–209

21. The sun has a diameter of 1.39×10^6 kilometers. The diameter of Earth is 1.28×10^4 kilometers. How many times larger is the sun's diameter than the Earth's diameter? Give your answer in scientific notation.

Order the numbers from least to greatest.

22. 2400; 2.5×10^2; 2.3×10^3

23. 4.8×10^5; 481,000; 4.7×10^5

24. 0.036; 3.5×10^{-2}; 3.7×10^{-2}

25. 8.3×10^{-4}; 0.0084; 8.2×10^{-4}

Write the number in scientific notation.

26. Volume (in cubic kilometers) of water in Lake Michigan: 4920

27. Approximate density (in grams per milliliter) of one helium atom: 0.0001787

Write the number in standard form.

28. Floor area (in square meters) of the Sears Tower in Chicago: 4.16×10^5

29. Approximate width (in meters) of a United States dollar bill: 6.6294×10^{-2}

30. Volume (in cubic meters) of a mole of helium atoms: 2.1×10^{-5}

10.6 Exercises

Check It Out
Help with Homework
BigIdeasMath.com

Vocabulary and Concept Check

1. **REASONING** How do you know whether a number written in standard form will have a positive or a negative exponent when written in scientific notation?
2. **WRITING** When is it appropriate to use scientific notation instead of standard form?

Practice and Problem Solving

Write the number in scientific notation.

(1) (2) 3. 0.0021
4. 5,430,000
5. 321,000,000
6. 0.00000625
7. 0.00004
8. 10,700,000
9. 45,600,000,000
10. 0.000000000009256
11. 840,000

ERROR ANALYSIS **Describe and correct the error in writing the number in scientific notation.**

12. ✗ 0.000036 (5)
3.6×10^5

13. ✗ $72{,}500{,}000$ (6)
72.5×10^6

Order the numbers from least to greatest.

(4) 14. 1.2×10^8, 1.19×10^8, 1.12×10^8
15. 6.8×10^{-5}, 6.09×10^{-5}, 6.78×10^{-5}
16. 5.76×10^{12}, 9.66×10^{11}, 5.7×10^{10}
17. 4.8×10^{-6}, 4.8×10^{-5}, 4.8×10^{-8}
18. 9.9×10^{-15}, 1.01×10^{-14}, 7.6×10^{-15}
19. 5.78×10^{23}, 6.88×10^{-23}, 5.82×10^{23}

20. **HAIR** What is the diameter of a human hair written in scientific notation?

Diameter: 0.000099 meter

21. **EARTH** What is the circumference of Earth written in scientific notation?

Circumference at the equator: about 40,100,000 meters

22. **CHOOSING UNITS** In Exercise 21, name a unit of measurement that would be more appropriate for the circumference. Explain.

Name _____ Date _____

10.6 Practice

For use after Lesson 10.6

Write the number in scientific notation.

1. 4,200,000

2. 0.038

3. 600,000

4. 0.0000808

5. 0.0007

6. 29,010,000,000

Order the numbers from least to greatest.

7. $6.4 \times 10^8, 5.3 \times 10^9, 2.3 \times 10^8$

8. $9.1 \times 10^{-3}, 9.6 \times 10^{-3}, 9.02 \times 10^{-3}$

9. $7.3 \times 10^7, 5.6 \times 10^{10}, 3.7 \times 10^9$

10. $1.4 \times 10^{-5}, 2.01 \times 10^{-15}, 6.3 \times 10^{-2}$

11. A patient has 0.0000075 gram of iron in 1 liter of blood. The normal level is between 6×10^{-7} gram and 1.6×10^{-5} gram. Is the patient's iron level normal? Write the patient's amount of iron in scientific notation.

Name _____ Class _____ Date _____

Reteaching 8-3

Multiplication Properties of Exponents

OBJECTIVE: Multiplying powers with the same base

MATERIALS: None

- A power is an expression in the form a^n.
- To multiply powers with the same base, add the exponents $a^m \cdot a^n = a^{m+n}$

Example

Simplify $4^6 \cdot 4^3$.

$4^6 \cdot 4^3$

$= 4^{6+3}$ ← **Rewrite as one base with the exponents added.**

$= 4^9$ ← **Add the exponents.**

So $4^6 \cdot 4^3 = 4^9$.

Exercises

Complete each equation.

1. $8^2 \cdot 8^3 = 8^{\square}$
2. $2^{\square} \cdot 2^6 = 2^9$
3. $a^{12} \cdot a^{\square} = a^{15}$
4. $x^{\square} \cdot x^5 = x^6$
5. $b^{-4} \cdot b^3 = b^{\square}$
6. $6^4 \cdot 6^{\square} = 6^2$
7. $3^4 \cdot 3^8 = 3^{\square}$
8. $c^{\square} \cdot c^{-7} = c^{11}$
9. $10^{-6} \cdot 10^{-3} = 10^{\square}$

Simplify each expression.

10. $3x^2 \cdot 4x \cdot 2x^3$
11. $m^2 \cdot 3m^4 \cdot 6a \cdot a^{-3}$
12. $p^3q^{-1} \cdot p^2q^{-8}$
13. $5x^2 \cdot 3x \cdot 8x^4$
14. $x^2 \cdot y^5 \cdot 8x^5 \cdot y^{-2}$
15. $7y^2 \cdot 3x^2 \cdot 9$
16. $2y^2 \cdot 3y^2 \cdot 4y^5$
17. $x^4 \cdot x^{-5} \cdot x^4$
18. $x^{12} \cdot x^{-8} \cdot y^{-2} \cdot y^3$
19. $6a^2 \cdot b \cdot 2a^{-1}$
20. $r^6 \cdot s^{-3} \cdot r^{-2} \cdot s$
21. $3p^{-2} \cdot q^3 \cdot p^3 \cdot q^{-2}$

Name _____ Class _____ Date _____

Practice 8-3

Multiplication Properties of Exponents

Simplify each expression.

1. $(3d^{-4})(5d^{8})$
2. $(-8m^{4})(4m^{8})$
3. $n^{-6} \cdot n^{-9}$
4. $a^{3} \cdot a$
5. $3^{8} \cdot 3^{5}$
6. $(3p^{-15})(6p^{11})$
7. $p^{7} \cdot q^{5} \cdot p^{6}$
8. $(-1.5a^{5}b^{2})(6a)$
9. $(-2d^{3}e^{3})(6d^{4}e^{6})$
10. $\frac{1}{b^{-7} \cdot b^{5}}$
11. $p^{5} \cdot q^{2} \cdot p^{4}$
12. $\frac{1}{n^{7} \cdot n^{-5}}$
13. $(8d^{4})(4d^{7})$
14. $x^{-9} \cdot x^{3} \cdot x^{2}$
15. $2^{3} \cdot 2^{2}$
16. $r^{7} \cdot s^{4} \cdot s \cdot r^{3}$
17. $b^{7} \cdot b^{13}$
18. $(7p^{4})(5p^{9})$
19. $2^{8} \cdot 2^{-9} \cdot 2^{3}$
20. $(6r^{4}s^{3})(9rs^{2})$
21. $4^{3} \cdot 4^{2}$
22. $m^{12} \cdot m^{-14}$
23. $s^{7} \cdot t^{4} \cdot t^{8}$
24. $(-3xy^{6})(3.2x^{5}y)$
25. $5^{-7} \cdot 5^{9}$
26. $\frac{1}{h^{7} \cdot h^{3}}$
27. $\frac{1}{t^{-5} \cdot t^{-3}}$
28. $f^{5} \cdot f^{2} \cdot f^{0}$
29. $r^{6} \cdot r^{-13}$
30. $5^{-6} \cdot 5^{4}$

Simplify each expression. Write each answer in scientific notation.

31. $(7 \times 10^{7})(5 \times 10^{-5})$
32. $(3 \times 10^{8})(3 \times 10^{4})$
33. $(9.5 \times 10^{-4})(2 \times 10^{-5})$
34. $(4 \times 10^{9})(4.1 \times 10^{8})$
35. $(7.2 \times 10^{-7})(2 \times 10^{-5})$
36. $(5 \times 10^{7})(4 \times 10^{3})$
37. $(6 \times 10^{-6})(5.2 \times 10^{4})$
38. $(4 \times 10^{6})(9 \times 10^{8})$
39. $(6.1 \times 10^{9})(8 \times 10^{14})$
40. $(2.1 \times 10^{-4})(4 \times 10^{-7})$
41. $(1.6 \times 10^{5})(3 \times 10^{11})$
42. $(9 \times 10^{12})(0.3 \times 10^{-18})$
43. $(4 \times 10^{9})(11 \times 10^{3})$
44. $(5 \times 10^{13})(9 \times 10^{-9})$
45. $(7 \times 10^{6})(4 \times 10^{9})$
46. $(6 \times 10^{-8})(12 \times 10^{-7})$
47. $(6 \times 10^{15})(3.2 \times 10^{2})$
48. $(5 \times 10^{8})(2.6 \times 10^{-16})$

49. In 1990, the St. Louis metropolitan area had an average of 82×10^{-6} g/m^3 of pollutants in the air. How many grams of pollutants were there in 2×10^{3} m^3 of air?

50. Light travels approximately 5.87×10^{12} mi in one year. This distance is called a light-year. Suppose a star is 2×10^{4} light-years away. How many miles away is that star?

51. The weight of 1 m^3 of air is approximately 1.3×10^{3} g. Suppose that the volume of air inside of a building is 3×10^{6} m^3. How much does the air inside the building weigh?

52. Light travels 1.18×10^{10} in. in 1 second. How far will light travel in 1 nanosecond or 1×10^{-9} s?

Multiplying Monomials with the Same Base

To multiply monomials that have the same base, add their exponents. For example, $(2^3)(2^2) = 2^{3+2} = 2^5$, because $(2^3)(2^2) = (2 \cdot 2 \cdot 2)(2 \cdot 2) = 2^5$. Therefore, $(a^5)(a^3) = a^{6+3} = a^9$.

When the monomials have coefficients other than 1, multiply the coefficients first.

EXAMPLE 1

Simplify: $s \cdot s$

$s^1 \cdot s^1 = s^{1+1}$

$= s^2$

EXAMPLE 2

Simplify: $(3m^4)(3m^3)$

$(3m^4)(3m^3) = (3 \cdot 3)m^{4+3}$

$= 9m^7$

EXAMPLE 3

Simplify: $(d^3ef)(de^4)$

$(d^3ef)(de^4) = (d^{3+1})(e^{1+4})(f^1)$

$= d^4e^5f$

PRACTICE

Simplify.

	a	b	c	d
1.	$(a^3)(a^5) =$	$(b^3)(b^4) =$	$(c^6)(c^6) =$	$(d^3)(d^7) =$
2.	$5^2 \cdot (5^3 \cdot 5^1) =$	$(a^3b)(ab^2) =$	$(m^5n)(m^2n) =$	$(x^6y)(xy^3) =$
3.	$(abc)(a) =$	$(xyz)(x^2) =$	$(rst)(s^2) =$	$(def)(e^5) =$
4.	$(a^3xy)(ay^2) =$	$(a^4bc)(ab^2) =$	$2(4^3 \cdot 4^2) =$	$(b^3df^3)(b^5d) =$
5.	$(7m^2n^2)(m^6n^2) =$	$(6a^5b^6)(3ab) =$	$(8b^3cd)(2b) =$	$(5x^2y^3)(5x^2y^3) =$
6.	$(9ay)(^-8y) =$	$(^-6ab^2)(^-9bc) =$	$(2xy^3)(6x^4) =$	$2mr(^-6mr^6) =$
7.	$(4z^5)(12yz) =$	$3^2\,(4^1 \cdot 4^2) =$	$(^-16z^3)(9yz) =$	$(^-15r^6)(^-5r^3s) =$
8.	$(15x^3y^2)(2axy) =$	$(^-10bc^3d)(^-5bcd) =$	$(6x^3y)(^-6axy) =$	$(8c^2d)(6abd^2) =$

Powers of Powers

When a base with an exponent is raised to another exponent, such as $(2^2)^3$, simplify by multiplying the two exponents. You can check the multiplication by showing the factors and adding the exponents.

Remember to multiply the exponents of *all* the factors in each expression, including coefficients. If no exponent is used, the exponent 1 is understood.

EXAMPLE 1

Simplify: $(2^2)^3$

$(2^2)^3 = 2^{2 \cdot 3} = 2^6 = 64$

Check:

$(2^2)^3 = (2^2 \cdot 2^2 \cdot 2^2)$

$= 2^{2+2+2} = 2^6 = 64$

EXAMPLE 2

Simplify: $(3x^3)^3$

$(3x^3)^3 = (3^{1 \cdot 3})(x^{3 \cdot 3})$

$= 3^3x^9 = 27x^9$

Check:

$(3x^3)^3 = (3 \cdot 3 \cdot 3)(x^3 \cdot x^3 \cdot x^3)$

$= 27x^{3+3+3} = 27x^9$

EXAMPLE 3

Simplify: $(2ab^2)^2(a^2)^3$

$(2ab^2)^2(a^2)^3 = (2^2a^2b^4)(a^6)$

$= 2^2a^{2+6}b^4$

$= 4a^8b^4$

PRACTICE

Simplify.

	a	b	c	d
1.	$(3^2)^3 =$	$(4^2)^2 =$	$(5^2)^3 =$	$(6^3)^2 =$
2.	$(2a^4)^2 =$	$(3h^3)^4 =$	$(2n^5)^4 =$	$(5k^7)^3 =$
3.	$(a^4b)^4 =$	$(st)^6 =$	$(xy^3z)^5 =$	$(m^2np)^8 =$
4.	$(a^4b)^2 =$	$(y^2z)^2 =$	$(mn^4)^3 =$	$(p^6q)^3 =$
5.	$(m^2n^4)^2 =$	$(p^5q^2)^2 =$	$(r^2s^4)^3 =$	$(x^4y^2)^4 =$
6.	$(2c^2de^3)^2 =$	$(4x^3y^2z)^2 =$	$(2mn^5p^3)^4 =$	$(5r^4s^2t^3)^3 =$

Simplify.

	a	b	c
7.	$(ab^4)(a^2b)^2 =$	$(m^2n)(m^6n)^2 =$	$(j^2k^3)(j^2k^2)^3 =$
8.	$(xy)^2(x^3y^2)^3 =$	$(mn^2)^3(m^2n^3)^4 =$	$(g^4h)^3(g^4h^2)^3 =$
9.	$(^-3y^2)^2(x^2y^2)^3 =$	$(7pq^3)^2(p^4q^6)^3 =$	$(3x)^3(xy^4)^2 =$

Name _____ Class _____ Date _____

Practice 8-4

More Multiplication Properties of Exponents

Simplify each expression.

1. $(4a^5)^3$
2. $(2^{-3})^4$
3. $(m^{-3}n^4)^{-4}$
4. $(x^5)^2$
5. $2^5 \cdot (2^4)^2$
6. $(4x^4)^3(2xy^3)^2$
7. $x^4 \cdot (x^4)^3$
8. $(x^5y^3)^3(xy^5)^2$
9. $(5^2)^2$
10. $(a^4)^{-5} \cdot a^{13}$
11. $(3f^4g^{-3})^3(f^2g^{-2})^{-1}$
12. $x^3 \cdot (x^3)^5$
13. $(d^2)^{-4}$
14. $(a^3b^4)^{-2}(a^{-3}b^{-5})^{-4}$
15. $(x^2y)^4$
16. $(12b^{-2})^2$
17. $(m^{-5})^{-3}$
18. $(x^{-4})^5(x^3y^2)^5$
19. $(y^6)^{-3} \cdot y^{21}$
20. $n^6 \cdot (n^{-2})^5$
21. $(m^5)^{-3}(m^4n^5)^4$
22. $(a^3)^6$
23. $b^{-9} \cdot (b^2)^4$
24. $(4^{-1}s^3)^{-2}$
25. $(5a^3b^5)^4$
26. $(b^{-3})^6$
27. $(y^6)^3$
28. $a^{-4} \cdot (a^4b^3)^2$
29. $(x^4y)^3$
30. $d^3 \cdot (d^2)^5$

Simplify. Write each answer in scientific notation.

31. $10^{-9} \cdot (2 \times 10^2)^2$
32. $(3 \times 10^{-6})^3$
33. $10^4 \cdot (4 \times 10^6)^3$
34. $(9 \times 10^7)^2$
35. $10^{-3} \cdot (2 \times 10^3)^5$
36. $(7 \times 10^5)^3$
37. $(5 \times 10^5)^4$
38. $(2 \times 10^{-3})^3$
39. $(5 \times 10^2)^{-3}$
40. $(3 \times 10^5)^4$
41. $(4 \times 10^8)^{-3}$
42. $(1 \times 10^{-5})^{-5}$
43. $10^5 \cdot (8 \times 10^7)^3$
44. $(10^2)^3(6 \times 10^{-3})^3$
45. $10^7 \cdot (2 \times 10^2)^4$

46. The kinetic energy, in joules, of a moving object is found by using the formula $E = \frac{1}{2}mv^2$, where m is the mass and v is the speed of the object. The mass of a car is 1.59×10^3 kg. The car is traveling at 2.7×10^1 m/s. What is the kinetic energy of the car?

47. The moon is shaped somewhat like a sphere. The surface area of the moon is found by using the formula $S = 12.56r^2$. What is the surface area of the moon if the radius is 1.08×10^3 mi?

48. Because of a record corn harvest, excess corn is stored on the ground in a pile. The pile is shaped like a cone. The height of the pile is 25 ft, and the radius of the pile is 1.2×10^2 ft. Use the formula $V = \frac{1}{3}\pi r^2 h$ to find the volume.

49. Suppose the distance in feet that an object travels in t seconds is given by the formula $d = 64t^2$. How far would the object travel after 1.5×10^3 seconds?