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Scientific Notation

A number is written in **scientific notation** when it is represented as the product of a factor and a power of 10. The factor must be greater than or equal to 1 and less than 10.

$c \times 10^n$ $\quad 1 \le c < 10$ and n is an integer

When a number is written in scientific notation, you can write the number in standard form using the absolute value of the exponent n. When n is negative, move the decimal point $|n|$ places to the left. When n is positive, move the decimal point $|n|$ places to the right.

Example 1 **Write (a) 7.4×10^5 and (b) 3.96×10^{-4} in standard form.**

a. $7.4 \times 10^5 = 740{,}000$ $\quad$ Move decimal point $|5| = 5$ places to the right.

b. $3.96 \times 10^{-4} = 0.000396$ $\quad$ Move decimal point $|-4| = 4$ places to the left.

When a number is written in standard form, you can write the number in scientific notation using the following steps.

Step 1 Move the decimal point so it is located to the right of the leading nonzero digit.

Step 2 Count the number n of places you moved the decimal point. The exponent of the power of 10 is n when you move the decimal point to the left and $-n$ when you move the decimal point to the right.

Example 2 **Write each number in scientific notation.**

a. 4,025,000,000

$4{,}025{,}000{,}000 = 4.025 \times 10^9$ $\quad$ Move decimal point 9 places to the left. The exponent is 9.

b. 0.00000591

$0.00000591 = 5.91 \times 10^{-6}$ $\quad$ Move decimal point 6 places to the right. The exponent is -6.

Practice

Check your answers at BigIdeasMath.com.

Write the number in standard form.

1. 2×10^4 **2.** 8.4×10^1 **3.** 7×10^{-3} **4.** 5.05×10^{-1}

5. 1.8×10^{-7} **6.** 6.29×10^{-5} **7.** 5.591×10^0 **8.** 3.0504×10^9

Write the number in scientific notation.

9. 400 **10.** 72,000 **11.** 0.8 **12.** 0.00019

13. 100,500,000 **14.** 324,900 **15.** 0.000002621 **16.** 0.05008

17. **NEURONS** A study found that the average human brain has 8.6×10^{10} neurons. Write this number in standard form. The cell bodies of neurons have widths between 0.000004 meter and 0.0001 meter. Write this range in scientific notation.

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Solving Linear Equations

To determine whether a value is a solution of an equation, substitute the value into the equation and simplify.

Example 1 **Determine whether (a) $x = 1$ or (b) $x = -2$ is a solution of $5x - 1 = 4$.**

a. $5x - 1 = -2x + 6$

$5(1) - 1 \stackrel{?}{=} -2(1) + 6$ Substitute.

$4 = 4$ ✓ Simplify.

▶ So, $x = 1$ is a solution.

b. $5x - 1 = -2x + 6$

$5(-2) - 1 \stackrel{?}{=} -2(-2) + 6$ Substitute.

$-11 \neq 10$ ✗ Simplify.

▶ So, $x = -2$ is *not* a solution.

To solve a linear equation, isolate the variable.

Example 2 **Solve each equation. Check your solution.**

a. $4x - 3 = 13$

$4x - 3 + 3 = 13 + 3$ Add 3.

$4x = 16$ Simplify.

$\frac{4x}{4} = \frac{16}{4}$ Divide by 4.

$x = 4$ Simplify.

Check

$4x - 3 = 13$

$4(4) - 3 \stackrel{?}{=} 13$

$13 = 13$ ✓

b. $2(y - 8) = y + 6$

$2y - 16 = y + 6$ Distributive Property

$2y - y - 16 = y - y + 6$ Subtract y.

$y - 16 = 6$ Simplify.

$y - 16 + 16 = 6 + 16$ Add 16.

$y = 22$ Simplify.

Check

$2(y - 8) = y + 6$

$2(22 - 8) \stackrel{?}{=} 22 + 6$

$28 = 28$ ✓

Practice

Check your answers at BigIdeasMath.com.

Determine whether (a) $x = -1$ or (b) $x = 3$ is a solution of the equation.

1. $5x + 7 = 2$
2. $-4x + 8 = -4$
3. $2x - 1 = 3x - 4$

Solve the equation. Check your solution.

4. $x - 9 = 24$
5. $n + 14 = 0$
6. $-16 = 4y$
7. $-\frac{5}{6}t = -15$
8. $81 = 46 - x$
9. $4x + 5 = 1$
10. $x + 5 = 11x$
11. $9(y - 3) = 45$
12. $6 = 7k + 8 - k$
13. $6n + 3 = -4n + 7$
14. $2c + 5 = 3(c - 8)$
15. $18m + 3(2m + 8) = 0$
16. $\frac{w - 6}{5} = 8$
17. $\frac{15 + h}{3} = 10$
18. $\frac{8 - 3x}{5} = x$
19. $(8r + 6) + (4r - 1) = 14$
20. $\frac{2}{3}y - 3 = 9$
21. $\frac{1}{2}x - \frac{3}{10} = \frac{5}{2}x + \frac{7}{10}$

22. **MONEY** You have a total of \$3.25 in change made up of 25 pennies, 6 nickels, 2 dimes, and x quarters. How many quarters do you have?

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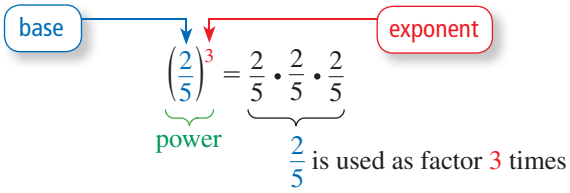
Powers and Exponents

A **power** is a product of repeated factors. The **base** of a power is the common factor. The **exponent** of a power indicates the number of times the base is used as a factor.



Example 1 **Write each product using exponents.**

a. $(-9) \cdot (-9) \cdot (-9) \cdot (-9) \cdot (-9)$

Because -9 is used as a factor 5 times, its exponent is 5.

▶ So, $(-9) \cdot (-9) \cdot (-9) \cdot (-9) \cdot (-9) = (-9)^5$.

b. $\pi \cdot \pi \cdot h \cdot h \cdot h$

Because π is used as a factor 2 times, its exponent is 2. Because h is used as a factor 3 times, its exponent is 3.

▶ So, $\pi \cdot \pi \cdot h \cdot h \cdot h = \pi^2 h^3$.

Example 2 **Evaluate each expression.**

a. $(-5)^4$

$(-5)^4 = (-5) \cdot (-5) \cdot (-5) \cdot (-5)$ Write as repeated multiplication.

$= 625$ Simplify.

b. -5^4

$-5^4 = -(5 \cdot 5 \cdot 5 \cdot 5)$ Write as repeated multiplication.

$= -625$ Simplify.

Practice

Check your answers at BigIdeasMath.com.

Write the product using exponents.

1. $7 \cdot 7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$

2. $\left(-\frac{1}{3}\right) \cdot \left(-\frac{1}{3}\right) \cdot \left(-\frac{1}{3}\right)$

3. $x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y$

4. $2.5 \cdot 2.5 \cdot b \cdot b \cdot b \cdot b$

5. $(-n) \cdot (-n) \cdot (-n) \cdot (-n)$

6. $(-12) \cdot (-12) \cdot v \cdot v \cdot v$

Evaluate the expression.

7. 10^4

8. -15^2

9. $\left(\frac{3}{4}\right)^3$

10. $\left(-\frac{1}{2}\right)^5$

11. **VOLUME** Write an expression involving a power that represents the volume (in cubic centimeters) of the die shown. Then find the volume.

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Simplifying Algebraic Expressions

Parts of an algebraic expression are called *terms*. **Like terms** are terms that have the same variables raised to the same exponents. Constant terms are also like terms.

An algebraic expression is in **simplest form** when it has no like terms and no parentheses. To *combine* like terms that have variables, use the Distributive Property to add or subtract the coefficients.

Example 1 **Simplify $8y + 7y$.**

$8y + 7y = (8 + 7)y$ Distributive Property

$= 15y$ Add coefficients.

Example 2 **Simplify $2(x + 5) - 3(x - 2)$.**

$2(x + 5) - 3(x - 2) = 2(x) + 2(5) - 3(x) - 3(-2)$ Distributive Property

$= 2x + 10 - 3x + 6$ Multiply.

$= 2x - 3x + 10 + 6$ Group like terms.

$= -x + 16$ Combine like terms.

Example 3 **Simplify $xy + 3y - 2x + 5y - 3xy$.**

$xy + 3y - 2x + 5y - 3xy = xy - 3xy + 3y + 5y - 2x$ Group like terms.

$= -2xy + 8y - 2x$ Combine like terms.

Practice

Check your answers at BigIdeasMath.com.

Simplify the expression.

1. $7x + 15x$
2. $8y - 14y$
3. $7d + 9 - 5d$
4. $3w + 2(2 - 3w) + 2$
5. $(x + 3) + (3x - 7)$
6. $(5k + 6) + (4k - 8)$
7. $(-7n + 6) + (5n + 15)$
8. $(9z + 12) - (6z + 8)$
9. $(8b + 1) - (-10b - 5)$
10. $s(8 - 2t) + 3t(4 - 2s) + 5t$
11. $qr + 2q^2 - 3qr - r^2 - 6q^2$
12. $g^3(h - 4g) - h(3 - 2g^3)$

13. **EARNINGS** The original price of a model car is d dollars. You use a coupon and buy the kit for $(d - 10)$ dollars. You assemble the model car and sell it for $(2d - 20)$ dollars. Write an expression that represents your earnings. Interpret the expression.

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Solving Systems of Equations

A **system of linear equations** is a set of two or more linear equations in the same variables. An example is shown at the right. A **solution of a system of linear equations** in two variables is an ordered pair that is a solution of each equation in the system.

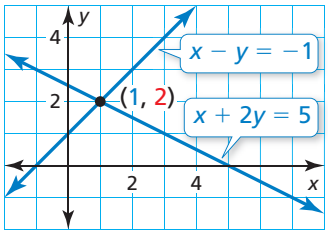
$x + 2y = 5$ Equation 1
$x - y = -1$ Equation 2

Example 1 **Solve the system of linear equations above by (a) graphing, (b) substitution, and (c) elimination.**

a. Graph each equation. The graphs appear to intersect at (1, 2). Check this point.

Equation 1 $x + 2y = 5$
$1 + 2(2) \stackrel{?}{=} 5$
$5 = 5$ ✓

Equation 2 $x - y = -1$
$1 - 2 \stackrel{?}{=} -1$
$-1 = -1$ ✓



▶ The solution is (1, 2).

b. Solve for x in Equation 2. $x - y = -1$
$x = y - 1$

Substitute $y - 1$ for x in Equation 1 and solve for y. $x + 2y = 5$
$(y - 1) + 2y = 5$
$y = 2$

Substitute 2 for y in Equation 2 and solve for x. $x - y = -1$
$x - 2 = -1$
$x = 1$

▶ The solution is (1, 2).

c. Multiply Equation 2 by 2. Then add the equations and solve the resulting equation.

$x + 2y = 5 \Rightarrow x + 2y = 5$
$x - y = -1 \Rightarrow 2x - 2y = -2$
$3x = 3$
$x = 1$

Substitute 1 for x in Equation 2 and solve for y. $x - y = -1$
$1 - y = -1$
$2 = y$

▶ The solution is (1, 2).

Practice

Check your answers at BigIdeasMath.com.

Solve the system of linear equations by graphing.

1. $y = x - 3$
$y = -x + 1$

2. $-x + 2y = -1$
$x + y = 4$

3. $2x + y = 5$
$4x - 2y = 6$

4. $9x - 3y = 3$
$3x + y = 1$

Solve the system of linear equations by substitution.

5. $y = 1 - x$
$-2x + y = 4$

6. $x = y + 3$
$5x - y = 7$

7. $3x - y = 5$
$2x - y = -3$

8. $x - 2y = -3$
$7x - 2y = 15$

Solve the system of linear equations by elimination.

9. $-2x + 2y = -2$
$2x + y = 5$

10. $x - 4y = -3$
$4x + y = 5$

11. $x + 5y = -2$
$5x + y = 14$

12. $2x + 3y = 5$
$4x + 6y = -10$