



COLLEGE ALGEBRA



SETS OF NUMBERS

The illustration shows the relationships between the various sets of numbers.



- **Natural numbers (N):** Counting numbers, beginning at 1.
EX: $\{1, 2, 3, \dots\}$
- **Whole numbers (W):** Natural numbers and 0.
EX: $\{0, 1, 2, 3, \dots\}$
- **Integers (Z):** Positive and negative whole numbers.
EX: $\{\dots, -3, -2, -1, 0, 1, 2, 3, \dots\}$
- **Rational numbers (Q):** Numbers that can be written as the ratio of two integers (but not dividing by 0).
EX: $\{\frac{1}{2}, \frac{7}{5}, \frac{13}{1}, -\frac{35}{100}\}$
- **Irrational numbers (I):** Any number that can be written as a non-repeating, non-terminating decimal.
EX: $\{\pi, e\}$
- **Real numbers (R):** All the rational and irrational numbers.
EX: $\{1, \frac{7}{5}, 2.753\}$
- **Imaginary numbers (I):** Numbers that when squared result in a negative number.
EX: $\{\sqrt{-1}, i, -4.7i\}$

- **Complex numbers (C):** Real and imaginary numbers in the form $a + bi$, where a and b are real and i is imaginary.
EX: $\{1 + i, 2 - 5.2i\}$

Exponent Rules

Rule Name	Rule	Example
Product rules	$a^m \cdot a^n = a^{m+n}$	$3^2 \cdot 3^3 = 3^{2+3} = 3^5 = 2,437$
	$a^m \cdot b^m = (a \cdot b)^m$	$2^2 \cdot 3^2 = (2 \cdot 3)^2 = 10^2 = 100$
Quotient rules	$\frac{a^m}{a^n} = a^{m-n}$	$\frac{2^5}{2^2} = 2^{5-2} = 2^3 = 8$
	$\frac{a^m}{b^m} = (\frac{a}{b})^m$	$\frac{6^2}{2^2} = (\frac{6}{2})^2 = 3^2 = 9$
	$(\frac{a}{b})^m = \frac{a^m}{b^m}$	$(\frac{6}{2})^2 = \frac{6^2}{2^2} = \frac{36}{4} = 9$
Power rules	$(a^m)^n = a^{m \cdot n}$	$(2^3)^2 = 2^{3 \cdot 2} = 2^6 = 64$
	$\sqrt[n]{a^m} = a^{\frac{m}{n}}$	$\sqrt[3]{2^9} = 2^{\frac{9}{3}} = 2^3 = 8$
	$a^{\frac{m}{n}} = \sqrt[n]{a^m}$	$2^{\frac{9}{3}} = \sqrt[3]{2^9} = \sqrt[3]{512} = 8$
Negative exponents	$a^{-n} = \frac{1}{a^n}$	$4^{-2} = \frac{1}{4^2} = \frac{1}{16} = 0.0625$
	$a^0 = 1$	$9^0 = 1$

Base of 0	$0^a = 0$, for $a > 0$	$0^0 = 1$
Exponent of 1	$a^1 = a$	$1^a = 1$
Base of 1	$1^a = 1$	$1^a = 1$
Base of -1	$(-1)^a = 1$, a even -1 , a odd	$(-1)^a = 1$ if a is even $(-1)^a = -1$ if a is odd

Properties & Formulas

- **Slope:** The slope or rate of change of a line is the ratio of the change in y -values over the change in x -values.
 $m = \frac{y_2 - y_1}{x_2 - x_1}$
- **Pythagorean Theorem:** $a^2 + b^2 = c^2$, where a and b are the legs of a right triangle and c is the hypotenuse.
- **Distance Formula:** $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$
- **Midpoint Formula:** $M(x, y) = (\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2})$
- **Quadratic Formula:** Given an equation $ax^2 + bx + c = 0$, where $a \neq 0$.
 $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

EQUATIONS & INEQUALITIES

Forms of Linear Equations

- **Linear function:** A function whose graph is a non-vertical line or part of a non-vertical line. There are three forms of linear equations: slope-intercept, point-slope, and standard form.
- **Slope-intercept form:** $y = mx + b$, where m is the slope and b is the y -intercept of the line.
- **Point-slope form:** $y - y_1 = m(x - x_1)$, where m is the slope and (x_1, y_1) is a point on the line.
- **Standard form:** $Ax + By = C$, where A , B , and C are integers and A is positive. The slope is $-\frac{A}{B}$ and the y -intercept is $-\frac{C}{B}$. This form of a line is most often used to find intercepts by plugging 0 in for x and y separately and solving.

EX: Given the line $2x + 5y = 3$, the slope is $-\frac{2}{5}$ and the y -intercept is $\frac{3}{5}$. The intercepts could also be found by substitution as follows:
 x -intercept (plug in 0 for y):
 $2x + 5(0) = 3$
 $2x = 3$
 $x = \frac{3}{2}$
 y -intercept (plug in 0 for x):
 $2x + 5y = 3$
 $2(0) + 5y = 3$
 $5y = 3$
 $y = \frac{3}{5}$

Solving Linear Equations: Equivalent equations: An equation that has the same solution as the original equation before a property of equality was performed.

- Solving an equation means isolating the variable on one side of the equation and then simplifying the other side as much as possible.
- The table shows properties that can be used and examples of solving linear equations.
- Multi-step equations are solved by using combinations of the properties as needed.

Addition Property of Equality: Adding the same number or term to each side of an equation produces an equivalent equation.

For any real numbers a , b , and c , if $a = b$, then $a + c = b + c$.
EX:
 $x - 4 = 2$
 $x - 4 + 4 = 2 + 4$
 $x = 6$

Subtraction Property of Equality: Subtracting the same number from each side of an equation produces an equivalent equation.

For any real numbers a , b , and c , if $a = b$, then $a - c = b - c$.
EX:
 $x + 4 = 2$
 $x + 4 - 4 = 2 - 4$
 $x = -2$

Multiplication Property of Equality: Multiplying each side of an equation by the same number produces an equivalent equation.

For any real numbers a , b , and c , if $a = b$, then $ac = bc$.
EX:
 $\frac{x}{5} = 3$
 $5 \cdot \frac{x}{5} = 5 \cdot 3$
 $x = 15$

Division Property of Equality: Dividing each side of an equation by the same nonzero number produces an equivalent equation.

For any real numbers a , b , and c , $c \neq 0$, if $a = b$, then $\frac{a}{c} = \frac{b}{c}$.
EX: $4x = 20$
 $\frac{4x}{4} = \frac{20}{4}$
 $x = 5$

Absolute Value Equations

- The absolute value of a number is its distance from 0 on the number line. So, an equation such as $|x| = 2$ has 2 solutions because both 2 and -2 are a distance of 2 from 0.
- To solve: Isolate the absolute value expression on one side of the equation and then solve the disjunction.

EX:
 $|x - 3| + 5 = 7$
 $|x - 3| = 2$
 $x - 3 = 2$ or $x - 3 = -2$
 $x - 3 + 3 = 2 + 3$ or
 $x - 3 + 3 = -2 + 3$
 $x = 5$ or $x = 1$

Quadratic Equations

- Quadratic equations are written in the form $ax^2 + bx + c = 0$ and can have none, one, or two real-number solutions.
- To solve: Graph, factor, use square roots, complete the square, and use the quadratic formula.

Choosing a Solution Method	Solution
Equation: $2x^2 - 8 = 0$ Method: Square Roots Justification: There is no x -term.	$2x^2 - 8 = 0$ $2x^2 = 8$ $x^2 = 4$ $x = 2$ or -2
Equation: $x^2 + x - 6 = 0$ Method: Factoring Justification: 6 has only a few factors to check.	$x^2 + x - 6 = 0$ $(x + 3)(x - 2) = 0$ $x = -3$ or 2
Equation: $2x^2 + 5x - 9 = 0$ Method: Quadratic Formula	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ $x = \frac{-5 \pm \sqrt{5^2 - 4(2)(-9)}}{2(2)}$ $x = \frac{-5 \pm \sqrt{25 + 72}}{4}$ $x = \frac{-5 \pm \sqrt{97}}{4}$
Equation: $x^2 - 4x + 3 = 0$ Method: Completing the Square or Quadratic Formula Justification: The coefficient of the x^2 term is 1, but the equation cannot be factored.	$x^2 - 4x + 3 = 0$ $x^2 - 4x + 4 = -3 + 4$ $(\frac{b}{2})^2 = (\frac{-4}{2})^2 = 4$ $x^2 - 4x + 4 = -3 + 4$ $(x - 2)^2 = 1$ $x - 2 = \pm \sqrt{1}$ $x - 2 = 1$ or $x - 2 = -1$ $x = 3$ or $x = 1$

You can determine how many solutions the quadratic equation will have by using the discriminant. The discriminant is the expression under the radical in the quadratic formula.

Study Guide For College Algebra 3rd Ed

VM Jensen



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