



# COLLEGE ALGEBRA

# EQUATIONS & ANSWERS

## 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, ...}
- **Whole numbers (W):** Natural numbers and 0.  
**EX:** {0, 1, 2, 3, ...}
- **Integers (Z):** Positive and negative whole numbers.  
**EX:** {..., -3, -2, -1, 0, 1, 2, 3, ...}
- **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:**  $\sqrt{2}, \pi$
- **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:**  $\{1 + 3i, 2 - 5.2i\}$

### Exponent Rules

Rule Name	Rule	Example
Product rules	$a^m \cdot a^n = a^{m+n}$	$3^2 \cdot 3^3 = 3^{2+3} = 3^5 = 2,487$
	$a^m \cdot b^n = (a \cdot b)^n$	$2^2 \cdot 3^2 = (2 \cdot 3)^2 = 10^2 = 100$
Quotient rules	$\frac{a^m}{a^n} = a^{m-n}$	$\frac{3^5}{3^2} = 3^{5-2} = 3^3 = 9$
	$\frac{a^m}{b^n} = \left(\frac{a}{b}\right)^n$	$\frac{6^2}{2^2} = \left(\frac{6}{2}\right)^2 = 2^2 = 4$
Power rules	$(a^m)^n = a^{m \cdot n}$	$(4^2)^3 = 4^{2 \cdot 3} = 4^6 = 4,096$
	$\sqrt[n]{a^m} = a^{\frac{m}{n}}$	$\sqrt[3]{2^6} = 2^{\frac{6}{3}} = 2^2 = 4$
Negative exponents	$a^{-n} = \frac{1}{a^n}$	$4^{-2} = \frac{1}{4^2} = 0.0625$
	$\frac{1}{a^{-n}} = a^n$	$27^{\frac{1}{3}} = \sqrt[3]{27} = 3$
Exponent of 0	$a^0 = 1$	$9^0 = 1$

Base of 0	$0^a = 0$ , for $a > 0$	$0^0 = 0$
Exponent of 1	$a^1 = a$	$7^1 = 7$
Base of 1	$1^n = 1$	$1^7 = 1$
Base of -1	$(-1)^n = 1$ , $n$ even $-1$ , $n$ odd	$(-1)^2 = 1$ $(-1)^7 = -1$

### 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:**  $M(x, y) = \left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$
- **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.
- EX:** If a line has a slope of 2 and  $y$ -intercept of 3, the equation of the line is  $y = 2x + 3$ .
- **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.
- EX:** If a line has a slope of -1 and contains the point  $(4, -3)$ , the equation of the line is  $y - (-3) = -1(x - 4)$  or  $y + 3 = -4x + 4$ .
- **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  $y$ ):  
 $2x + 5(0) = 3$   
 $2x = 3$   
 $x = \frac{3}{2}$   
 $x$ -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 equation.

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

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.

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# College Algebra Examination Guide Explained Answers

**TD Snyder**



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