# Glossary

## A

**absolute value of a complex number** (p. 275) If $z = a + bi$, then the absolute value of $z$, denoted $|z|$, is a nonnegative real number defined as $|z| = \sqrt{a^2 + b^2}$. Geometrically, the absolute value of a complex number is the number's distance from the origin in the complex plane.

**absolute value of a real number** (p. 50) The distance the number is from 0 on a number line. The absolute value of a number $x$ is written $|x|$.

**algebraic expression** (p. 12) An expression with variables.

**algebraic model** (p. 33) A mathematical statement that represents a real-life problem.

**amplitude** (p. 831) The amplitude of the graph of a sine or cosine function is $\frac{1}{2}(M - m)$ where $M$ is the maximum value of the function and $m$ is the minimum value of the function.

**angle of depression** (p. 771) The angle from a horizontal line through an object $A$ to a line connecting object $A$ and a lower object $B$.
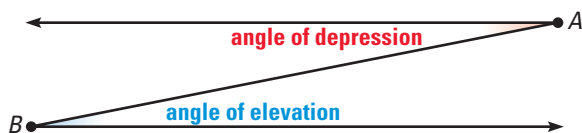


**angle of elevation** (p. 771) The angle from a horizontal line through an object $B$ to a line connecting $B$ and a higher object $A$.

**arithmetic sequence** (p. 659) A sequence in which the difference between consecutive terms is constant.

**arithmetic series** (p. 661) The expression formed by adding the terms of an arithmetic sequence.

**asymptote** (p. 465) A line that a graph approaches as you move away from the origin.

**augmented matrix** (p. 237) A matrix containing the coefficient matrix and the matrix of constants for a system of linear equations. The augmented matrix of the linear system $ax + by = e, cx + dy = f$ is $\begin{bmatrix} a & e \vdots d \\ b & c \vdots f \end{bmatrix}$.

**axis of symmetry of a parabola** (pp. 249, 595) The line perpendicular to the parabola's directrix and passing through its focus. In particular, the axis of symmetry is the vertical line through the vertex of the graph of a quadratic function.

## B

**base of an exponential function** (p. 465) *See* exponential function.

**base of a power** (p. 11) The number in a power that is used as a factor. The base of the expression $2^5$ is the number 2. *See also* exponent *and* power.

**best-fitting quadratic model** (p. 308) The model given by performing quadratic regression on a graphing calculator, which uses all the data points entered.

**binomial** (p. 256) An expression with two terms, such as $x + 3$.

**binomial distribution** (p. 739) The set of probabilities of all possible numbers of successes in a binomial experiment.

**binomial experiment** (p. 739) An experiment that satisfies the following three conditions. (1) There are $n$ independent trials. (2) Each trial has only two possible outcomes, success and failure. (3) The probability of success is the same for each trial. This probability is denoted by $p$. The probability of failure is given by $1 - p$.

**binomial theorem** (p. 710) The binomial expansion of $(a + b)^n$ for any positive integer $n$ is $(a + b)^n = {}_nC_0a^nb^0 + {}_nC_1a^{n-1}b^1 + {}_nC_2a^{n-2}b^2 + \cdots + {}_nC_na^0b^n = \sum_{r=0}^{n} {}_nC_ra^{n-r}b^r$.

**box-and-whisker plot** (p. 447) A type of statistical graph in which a "box" encloses the middle half of the data set and "whiskers" extend to the minimum and maximum data values. An example is shown.
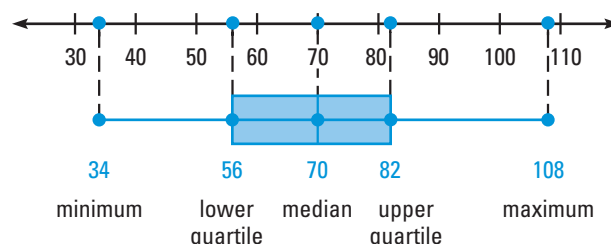


**branches of a hyperbola** (p. 540) Two symmetrical parts of a hyperbola. *See also* hyperbola.

## C

**center of a circle** (p. 601) *See* circle.

**center of a hyperbola** (p. 615) The midpoint of the transverse axis of a hyperbola. *See also* hyperbola.

**center of an ellipse** (p. 609) The midpoint of the major axis of an ellipse. *See also* ellipse.

**central angle of a sector** (p. 779) An angle formed by two radii of a circle. *See also* sector.

**circle** (p. 601) The set of all points $(x, y)$ that are equidistant from a fixed point, called the center of the circle. The distance $r$ between the center of the circle and any point $(x, y)$ on the circle is the radius.
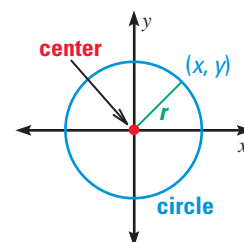
**coefficient** (p. 13) When a term is the product of a number and a power of a variable, such as $2x$ or $4x^3$, the number is the coefficient of the power. The coefficient of $2x$ is 2.

**coefficient matrix** (p. 216) The coefficient matrix of the linear system $ax + by = e, cx + dy = f$ is $\begin{bmatrix} a & b \\ c & d \end{bmatrix}$.

**combination** (p. 708) A selection of $r$ objects from a group of $n$ objects where the order is not important. The number of combinations of $r$ objects taken from a group of $n$ distinct objects is denoted $_nC_r$.

**common difference** (p. 659) The constant difference between consecutive terms of an arithmetic sequence.

**common logarithm** (p. 487) The logarithm with base 10. It is denoted by $\log_{10}$ or simply by log.

**common ratio** (p. 666) The constant ratio between consecutive terms of a geometric sequence.

**complement** (p. 726) The complement of event $A$, denoted $A'$, consists of all outcomes that are not in $A$.

**completing the square** (p. 282) A process in which you write an expression of the form $x^2 + bx$ as the square of a binomial by adding the square of half the $x$-coefficient to the expression: $x^2 + bx + \left(\dfrac{b}{2}\right)^2 = \left(x + \dfrac{b}{2}\right)^2$. The process can be used to solve any quadratic equation.

**complex conjugates** (p. 274) Two complex numbers of the form $a + bi$ and $a - bi$. The product of complex conjugates is always a real number.

**complex fraction** (p. 564) A fraction that contains a fraction in its numerator or denominator.

**complex number** (p. 272) A number $a + bi$ where $a$ and $b$ are real numbers and $i$ is the imaginary unit. The number $a$ is the real part of the complex number, and the number $bi$ is the imaginary part.

**complex plane** (p. 273) A coordinate plane where each point $(a, b)$ represents a complex number $a + bi$. The complex plane has a horizontal real axis and a vertical imaginary axis.

**composition** (p. 416) The composition of the function $f$ with the function $g$ is $h(x) = f(g(x))$. The domain of $h$ is the set of all $x$-values such that $x$ is in the domain of $g$ and $g(x)$ is in the domain of $f$.
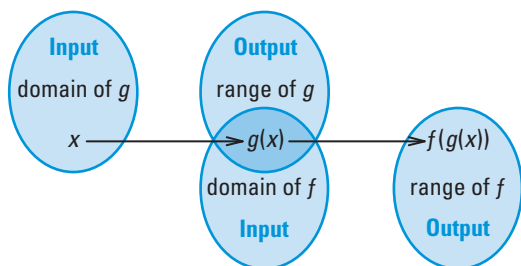


**compound event** (p. 724) The union or intersection of two events.

**compound inequality** (p. 43) Two simple inequalities joined by "and" or "or."

**conditional probability** (p. 732) The probability that event $B$ will occur depending on whether event $A$ has occurred. This is called the conditional probability of $B$ given $A$ and is written $P(B\,|\,A)$.

**conic** (p. 623) *See* conic section.

**conic section** (p. 623) A curve formed by the intersection of a plane and a double-napped cone. Examples include parabolas, circles, ellipses, and hyperbolas.

**constant of variation** (pp. 94, 534) The nonzero constant (usually denoted $k$) in a direct variation equation ($y = kx$), an inverse variation equation $\left(y = \dfrac{k}{x}\right)$, or a joint variation equation ($z = kxy$).

**constant term** (pp. 13, 329) A term that has no variable part, such as $-4$ or 2. *See also* polynomial function.

**constraints** (p. 163) In linear programming, the linear inequalities that form a system. *See also* linear programming.

**coordinate** (p. 3) The number that corresponds to a point on a number line.

**coordinate plane** (p. 67) A plane divided into four quadrants by the $x$-axis and the $y$-axis. It is used to plot ordered pairs of the form $(x, y)$.
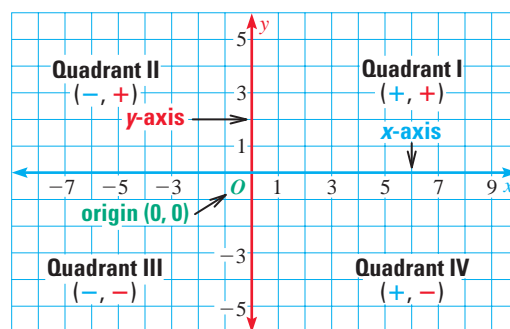


**cosecant function** (p. 769) If $\theta$ is an acute angle of a right triangle, the cosecant of $\theta$ is $\csc \theta = \dfrac{\text{hyp}}{\text{opp}}$ where $hyp$ represents the length of the hypotenuse and $opp$ represents the length of the side opposite $\theta$.

**cosine function** (p. 769) If $\theta$ is an acute angle of a right triangle, the cosine of $\theta$ is $\cos \theta = \dfrac{\text{adj}}{\text{hyp}}$ where $adj$ represents the length of the side adjacent to $\theta$ and $hyp$ represents the length of the hypotenuse.

**cotangent function** (p. 769) If $\theta$ is an acute angle of a right triangle, the cotangent of $\theta$ is $\cot \theta = \dfrac{\text{adj}}{\text{opp}}$ where $adj$ represents the length of the side adjacent to $\theta$ and $opp$ represents the length of the side opposite $\theta$.

**coterminal angles** (p. 777) Two angles in standard position with terminal sides that coincide.

**co-vertices of an ellipse** (p. 609) The points of intersection of an ellipse and the line perpendicular to the major axis at the center. *See also* ellipse.

**Cramer's rule** (p. 216) A method for solving a system of linear equations which uses determinants of matrices.

**cross multiplying** (p. 569) A method of solving a simple rational equation for which each side of the equation is a single rational expression. Equal products are formed by multiplying the numerator of each expression by the denominator of the other.

**cubic function** (p. 329) A polynomial function of degree 3.

**cycle** (p. 831) The shortest repeating portion of a periodic function.

## D

**decay factor** (p. 476) The quantity $1 - r$ in the exponential decay model $y = a(1 - r)^t$ where $a$ is the initial amount and $r$ is the percent decrease expressed as a decimal.

**degree of a polynomial** (p. 329) *See* polynomial function.

**dependent events** (p. 732) Two events such that the occurrence of one affects the occurrence of the other. *See also* conditional probability.

**dependent variable** (p. 69) The output variable in an equation, which depends on the value of the input variable. *See also* independent variable.

**determinant** (p. 214) A real number associated with any square matrix $A$, denoted by det $A$ or by $|A|$. The determinant of a $2 \times 2$ matrix is the difference of the products of the entries on the diagonals.

**dimensions of a matrix** (p. 199) The number $m$ of rows of a matrix by the number $n$ of columns of the matrix, written $m \times n$.

**directrix of a parabola** (p. 595) *See* parabola.

**direct variation** (p. 94) Two variables $x$ and $y$ show direct variation provided $y = kx$ where $k$ is a nonzero constant.

**discriminant of a general second-degree equation** (p. 626) The expression $B^2 - 4AC$ for the equation $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$. Used to determine which type of conic the equation represents.

**discriminant of a quadratic equation** (p. 293) The expression $b^2 - 4ac$ for the quadratic equation $ax^2 + bx + c = 0$; also the expression under the radical sign in the quadratic formula. Used to find the number and type of solutions of a quadratic equation.

**distance formula** (p. 589) The distance $d$ between the points $(x_1, y_1)$ and $(x_2, y_2)$ is $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$.

**domain of a relation** (p. 67) The set of input values for a relation.

## E

**eccentricity of a conic section** (p. 639) The eccentricity of a hyperbola or an ellipse is $e = \dfrac{c}{a}$ where $c$ is the distance from each focus to the center and $a$ is the distance from each vertex to the center. The eccentricity of a parabola is $e = 1$. The eccentricity of a circle is $e = 0$.

**ellipse** (p. 609) The set of all points $P$ such that the sum of the distances between $P$ and two distinct fixed points, called foci, is a constant.

The ellipse shown below has a horizontal major axis.



$d_1 + d_2 = \text{constant}$
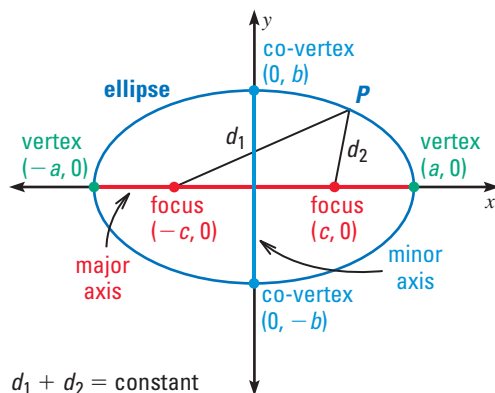
**end behavior** (p. 331) The behavior of the graph of a function as $x$ approaches positive infinity or negative infinity.

**entries of a matrix** (p. 199) The numbers in a matrix.

**equal matrices** (p. 199) Matrices that have the same dimensions and equal entries in corresponding positions.

**equation** (p. 19) A statement in which two expressions are equal.

**equation in two variables** (p. 69) An equation such as $y = 2x - 7$.

**equivalent algebraic expressions** (p. 13) Expressions that have the same value for all values of their variable(s).

**equivalent equations** (p. 19) Equations that have the same solutions.

**Euler number** (p. 480) *See* natural base $e$.

**expected value** (p. 753) A collection of outcomes is partitioned into $n$ events, no two of which have any outcomes in common. The probabilities of the $n$ events occurring are $p_1, p_2, p_3, \ldots, p_n$ where $p_1 + p_2 + p_3 + \cdots + p_n = 1$. The values of the $n$ events are $x_1, x_2, x_3, \ldots, x_n$. The expected value, $V$, of the collection of outcomes is the sum of the products of the events' probabilities and their values:
$$V = p_1x_1 + p_2x_2 + p_3x_3 + \cdots + p_nx_n.$$

**experimental probability** (p. 717) A calculation of the probability of an event based on performing an experiment, conducting a survey, or looking at the history of an event.

**explicit rule** (p. 681) A rule for a sequence that gives $a_n$ as a function of the term's position number $n$ in the sequence.

**exponent** (p. 11) The number in a power that represents the number of times the base is used as a factor. The exponent of the expression $2^5$ is the number 5. *See also* base of a power *and* power.

**exponential decay function** (p. 474) A function of the form $f(x) = ab^x$ where $a > 0$ and $0 < b < 1$.

**exponential function** (p. 465) A function that involves the expression $b^x$ where the base $b$ is a positive number other than 1.

**exponential growth function** (p. 466) A function of the form $f(x) = ab^x$ where $a > 0$ and $b > 1$.

**extraneous solution** (p. 439) A solution of a transformed equation that is not a valid solution of the original equation.

## F

**factor by grouping** (p. 346) A method used to factor some polynomials with pairs of terms that have a common monomial factor: $ra + rb + sa + sb = r(a + b) + s(a + b)$ $= (r + s)(a + b)$.

**factorial** (p. 681) The expression $n!$ is read "$n$ factorial" and represents the product of all integers from 1 to $n$. Example: $4! = 4 \cdot 3 \cdot 2 \cdot 1 = 24$.

**factoring** (p. 256) A process used to write a polynomial as a product of other polynomials having equal or lesser degree. Example: $x^2 + 8x + 15 = (x + 3)(x + 5)$.

**fair game** (p. 753) A game for which the expected value is 0.

**feasible region** (p. 163) In linear programming, the graph of the system of constraints. *See also* linear programming.

**finite differences** (p. 380) The first-order differences of a polynomial function $f(x)$ are found by subtracting function values for equally spaced $x$-values. The second-order differences are found by subtracting consecutive first-order differences. The third-order differences are found by subtracting consecutive second-order differences, and so on.

**finite sequence** (p. 651) A sequence that has a last term.

**foci of a hyperbola** (p. 615) *See* hyperbola.

**foci of an ellipse** (p. 609) *See* ellipse.

**focus of a parabola** (p. 595) *See* parabola.

**frequency distribution** (p. 448) A table that shows the frequencies for the intervals into which data are grouped.

**frequency of a periodic function** (p. 833) The reciprocal of the period. Frequency is the number of cycles per unit of time.

**frequency of data values** (p. 448) The number of data values in an interval. *See also* frequency distribution.

**function** (p. 67) A relation with exactly one output for each input.

**function notation** (p. 69) Use of the symbol $f(x)$ for the dependent variable of a function. For example, the linear function $y = mx + b$ can be written $f(x) = mx + b$.

**function of two variables** (p. 171) A relationship in which one variable depends on two other variables. A linear equation in $x$, $y$, and $z$ can be written as a function of two variables by solving for $z$ and then replacing $z$ with $f(x, y)$.

## G

**general second-degree equation in $x$ and $y$** (p. 626) The form $Ax^2 + Bxy + Cy^2 + Dx + Ey + F = 0$.

**geometric probability** (p. 718) A type of probability found by calculating a ratio of two lengths, areas, or volumes.

**geometric sequence** (p. 666) A sequence in which the ratio of any term to the previous term is constant.

**geometric series** (p. 668) The expression formed by adding the terms of a geometric sequence.

**graph of an equation in two variables** (p. 69) The collection of all points $(x, y)$ whose coordinates are solutions of the equation.

**graph of an inequality in one variable** (p. 41) All points on a real number line that correspond to solutions of the inequality.

**graph of an inequality in two variables** (p. 108) The graph of all solutions of the inequality.

**graph of a real number** (p. 3) The point on a number line that corresponds to a real number.

**graph of a system of linear inequalities** (p. 156) The graph of all solutions of the system.

**growth factor** (p. 467) The quantity $1 + r$ in the exponential growth model $y = a(1 + r)^t$ where $a$ is the initial amount and $r$ is the percent increase expressed as a decimal.

## H

**half-planes** (p. 108) The two regions of a coordinate plane that are separated by the boundary line of an inequality. One region contains the points that are solutions of the inequality, and the other region contains the points that are not.

**histogram** (p. 448) A special type of bar graph in which data are grouped into intervals of equal width.

**hyperbola** (pp. 540, 615) The set of all points $P$ such that the difference of the distances from $P$ to two fixed points, called the foci, is constant. The hyperbola below has a horizontal transverse axis.
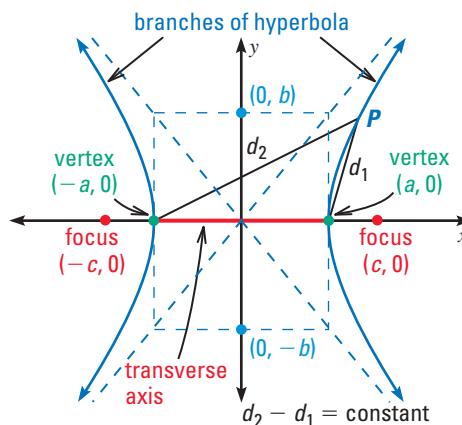


The graphs of rational functions of the form $y = \dfrac{a}{x - h} + k$ are hyperbolas.

**hypothesis testing** (p. 741) A three-step procedure from statistics for testing a claim. (1) State the hypothesis you are testing. The hypothesis should make a statement about some statistical measure (mean, standard deviation, or proportion) of a population. (2) Collect data from a random sample of the population and compute the statistical measure of the sample. (3) Assume that the hypothesis is true and calculate the resulting probability of obtaining the sample statistical measure or a more extreme sample statistical measure. If this probability is small, you should reject the hypothesis.

# I

**identity** (p. 13) A statement such as $7x + 4x = 11x$ that equates two equivalent expressions.

**identity matrix** (p. 223) The $n \times n$ matrix that has 1's on the main diagonal and 0's elsewhere. The $2 \times 2$ identity matrix is $\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$.

**imaginary number** (p. 272) A complex number $a + bi$ where $b \neq 0$.

**imaginary unit $i$** (p. 272) The imaginary unit $i$ is defined as $i = \sqrt{-1}$, so that $i^2 = -1$.

**independent events** (p. 730) Two events such that the occurrence of one has no effect on the occurrence of the other.

**independent variable** (p. 69) The input variable in an equation. *See also* dependent variable.

**index of a radical** (p. 401) The integer $n$ (greater than 1) in the expression $\sqrt[n]{a}$.

**infinite sequence** (p. 651) A sequence that continues without stopping.

**initial side of an angle** (p. 776) You can generate any angle by fixing one ray, called the initial side, and rotating the other ray, called the terminal side, about the vertex.
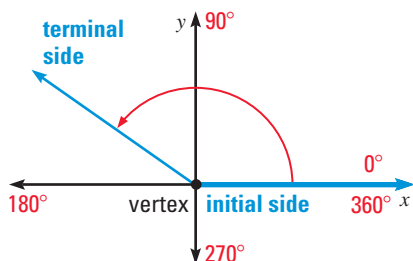


**intercept form of a quadratic function** (p. 250) The form $y = a(x - p)(x - q)$ where the $x$-intercepts of the graph are $p$ and $q$ and the axis of symmetry is halfway between $(p, 0)$ and $(q, 0)$.

**inverse cosine function** (p. 792) If $-1 \leq a \leq 1$, then the inverse cosine of $a$ is $\cos^{-1} a = \theta$ where $\cos \theta = a$ and $0 \leq \theta \leq \pi$ (or $0° \leq \theta \leq 180°$).

**inverse functions** (p. 422) A relation and its inverse relation whenever both relations are functions. Functions $f$ and $g$ are inverses of each other provided $f(g(x)) = x$ and $g(f(x)) = x$. *See also* inverse relation.

**inverse matrices** (p. 223) Two $n \times n$ matrices are inverses of each other if their product (in both orders) is the $n \times n$ identity matrix. *See also* identity matrix.

**inverse relation** (p. 422) A relation that maps the output values of an original relation back to their original input values. The graph of an inverse relation is the reflection of the graph of the original relation, with $y = x$ as the line of reflection.

**inverse sine function** (p. 792) If $-1 \leq a \leq 1$, then the inverse sine of $a$ is $\sin^{-1} a = \theta$ where $\sin \theta = a$ and $-\frac{\pi}{2} \leq \theta \leq \frac{\pi}{2}$ (or $-90° \leq \theta \leq 90°$).

**inverse tangent function** (p. 792) If $a$ is any real number, then the inverse tangent of $a$ is $\tan^{-1} a = \theta$ where $\tan \theta = a$ and $-\frac{\pi}{2} < \theta < \frac{\pi}{2}$ (or $-90° < \theta < 90°$).

**inverse variation** (p. 534) Two variables $x$ and $y$ show inverse variation provided $y = \frac{k}{x}$ where $k$ is a nonzero constant.

# J

**joint variation** (p. 536) A relationship that occurs when a quantity varies directly as the product of two or more other quantities. For instance, if $z = kxy$ where the constant $k \neq 0$, then $z$ varies jointly with $x$ and $y$.

# L

**law of cosines** (p. 807) If $\triangle ABC$ has sides of length $a$, $b$, and $c$ as shown below, then $a^2 = b^2 + c^2 - 2bc \cos A$, $b^2 = a^2 + c^2 - 2ac \cos B$, and $c^2 = a^2 + b^2 - 2ab \cos C$.
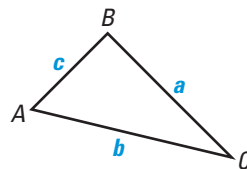


**law of sines** (p. 799) If $\triangle ABC$ has sides of length $a$, $b$, and $c$ as shown above, then $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$.

**leading coefficient** (p. 329) *See* polynomial function.

**like radicals** (p. 408) Two radical expressions that have the same index and the same radicand.

**like terms** (p. 13) Terms that have the same variable part, such as $3x^2$ and $-5x^2$.

**linear equation in one variable** (p. 19) An equation that can be written in the form $ax = b$ where $a$ and $b$ are constants and $a \neq 0$.

**linear equation in three variables** (p. 171) An equation of the form $ax + by + cz = d$ where $x$, $y$, and $z$ are variables and $a$, $b$, and $c$ are not all zero. The solution of a linear equation in three variables is an ordered triple $(x, y, z)$, and the graph is a plane.

**linear function** (p. 69) A function of the form $y = mx + b$ where $m$ and $b$ are constants. The graph of a linear function is a line.

**linear inequality in one variable** (p. 41) An inequality such as $x \leq 1$ or $2n - 3 > 9$. Note that an inequality symbol is placed between two expressions.

**linear inequality in two variables** (p. 108) An inequality that can be written in one of the following forms: $Ax + By < C, Ax + By \leq C, Ax + By > C$, or $Ax + By \geq C$.

**linear programming** (p. 163) The process of optimizing a linear objective function subject to a system of linear inequalities called constraints. The graph of the system of constraints is called the feasible region.

**local maximum** (p. 374) The $y$-coordinate of a turning point of the graph of a function if the point is higher than all nearby points.

**local minimum** (p. 374) The $y$-coordinate of a turning point of the graph of a function if the point is lower than all nearby points.

**logarithm of $y$ with base $b$** (p. 486) Let $b$ and $y$ be positive numbers with $b \neq 1$. The logarithm of $y$ with base $b$ is denoted by $\log_b y$ and is defined as $\log_b y = x$ if and only if $b^x = y$. The expression $\log_b y$ is read as "log base $b$ of $y$."

**logistic growth function** (p. 517) A function of the form $y = \dfrac{c}{1 + ae^{-rx}}$ where $a$, $c$, and $r$ are all positive constants. Used to model real-life quantities whose growth levels off because the rate of growth changes—from an increasing growth rate to a decreasing growth rate.

**lower quartile** (p. 447) The median of the lower half of a data set. *See also* box-and-whisker plot.

**M**

**major axis of an ellipse** (p. 609) The line segment joining the vertices of an ellipse. *See also* ellipse.

**mathematical model** (p. 12) A mathematical representation of a real-life situation.

**matrix** (p. 199) A rectangular arrangement of numbers in rows and columns.

**matrix of constants** (p. 230) The matrix of constants of the linear system $ax + by = e, cx + dy = f$ is $\begin{bmatrix} e \\ f \end{bmatrix}$.

**matrix of variables** (p. 230) The matrix of variables of the linear system $ax + by = e, cx + dy = f$ is $\begin{bmatrix} x \\ y \end{bmatrix}$.

**mean** (p. 445) The sum of $n$ numbers divided by $n$. Also called *average*.

**measures of central tendency** (p. 445) Three commonly used statistics: the mean, the median, and the mode of a set of numbers.

**measures of dispersion** (p. 446) Commonly used statistics that tell you how spread out the data are. They include the range and the standard deviation.

**median** (p. 445) The middle number when $n$ numbers are written in order. (If $n$ is even, the median is the mean of the two middle numbers.)

**midpoint formula** (p. 590) The midpoint of the line segment joining $A(x_1, y_1)$ and $B(x_2, y_2)$ is $M\left(\dfrac{x_1 + x_2}{2}, \dfrac{y_1 + y_2}{2}\right)$. Each coordinate of $M$ is the mean of the corresponding coordinates of $A$ and $B$.

**minor axis of an ellipse** (p. 609) The line segment joining the co-vertices of an ellipse. *See also* ellipse.

**mode** (p. 445) The number or numbers that occur most frequently in a set of $n$ numbers. There may be one mode, no mode, or more than one mode.

**monomial** (p. 257) An expression with one term, such as $7x$.

**mutually exclusive events** (p. 724) Events $A$ and $B$ are mutually exclusive if the intersection of $A$ and $B$ is empty.

**N**

**natural base $e$** (p. 480) An irrational number defined as follows: As $n$ approaches $+\infty$, the value of $\left(1 + \dfrac{1}{n}\right)^n$ approaches $e \approx 2.718281828459$.

**natural logarithm** (p. 487) The logarithm with base $e$. It can be denoted by $\log_e$, but it is more often denoted by ln.

**negative correlation** (p. 100) The relationship between paired data when $y$ tends to decrease as $x$ increases, as shown by a scatter plot where the plotted points generally fall from left to right.

**normal curve** (p. 746) A smooth, symmetrical, bell-shaped curve that can model normal distributions and approximate some binomial distributions. *See also* normal distribution *and* binomial distribution.

**normal distribution** (p. 746) A distribution for which the mean and the standard deviation determine the following areas under a normal curve. (1) The total area under the curve is 1. (2) 68% of the area lies within 1 standard deviation of the mean. (3) 95% of the area lies within 2 standard deviations of the mean. (4) 99.7% of the area lies within 3 standard deviations of the mean. *See also* normal curve.

**$n$th root of $a$** (p. 401) For an integer $n$ greater than 1, if $b^n = a$, then $b$ is an $n$th root of $a$. Written as $\sqrt[n]{a}$.

**numerical expression** (p. 11) An expression that consists of numbers, operations, and grouping symbols.

**O**

**objective function** (p. 163) In linear programming, the linear function that is optimized. *See also* linear programming.

**octants** (p. 170) *See* three-dimensional coordinate system.

**opposite** (p. 5) The opposite, or additive inverse, of any number $a$ is $-a$.

**optimization** (p. 163) A process in which you find the maximum or minimum value of some variable quantity. One type of optimization process is linear programming.

**ordered pair** (p. 67) A pair of numbers of the form $(x, y)$ that represents a point in the coordinate plane.

**ordered triple** (p. 170) A set of three numbers of the form $(x, y, z)$ that represents a point in space. *See also* three-dimensional coordinate system.

**order of operations** (p. 11) A set of rules that gives the order in which operations should be performed when evaluating expressions.

**origin of a coordinate plane** (p. 67) The point $(0, 0)$ where the $x$-axis and $y$-axis intersect on a coordinate plane. *See also* coordinate plane.

**origin of a real number line** (p. 3) The point labeled $O$ on a real number line.

# P

**parabola** (pp. 249, 595) The set of all points equidistant from a point called the focus and a line called the directrix. The focus lies on the axis of symmetry, and the directrix is perpendicular to the axis of symmetry.



The graph of a quadratic function $y = ax^2 + bx + c$ is a parabola.

**parallel lines** (p. 77) Two lines in a plane that do not intersect.

**parameter** (p. 813) A variable, usually denoted $t$, upon which two other variables depend. *See also* parametric equations.

**parametric equations** (p. 813) Equations that express two variables in terms of a third variable, called the parameter.

**Pascal's triangle** (p. 710) An arrangement of the values of $_nC_r$ in a triangular pattern in which each row corresponds to a value of $n$. Each number other than 1 in Pascal's triangle is the sum of the two numbers directly above it.



**period** (p. 831) The horizontal length of each cycle of a periodic function.

**periodic function** (p. 831) A function whose graph has a repeating pattern that continues indefinitely.

**permutation** (p. 703) An ordering of objects. The number of permutations of $r$ objects taken from a group of $n$ distinct objects is denoted $_nP_r$.

**perpendicular lines** (p. 77) Two lines in a plane that intersect to form a right angle.

**piecewise function** (p. 114) A function represented by a combination of equations, each corresponding to a part of the domain. Example: $f(x) = \begin{cases} 2x - 1, \text{ if } x \leq 1 \\ 3x + 1, \text{ if } x > 1 \end{cases}$

**polynomial function** (p. 329) A function of the form $f(x) = a_n x^n + a_{n-1} x^{n-1} + \cdots + a_1 x + a_0$ where $a_n \neq 0$, $a_0, a_1, a_2, \ldots a_n$ are real numbers, and the exponents are all whole numbers. For this polynomial function, $a_n$ is the leading coefficient, $a_0$ is the constant term, and $n$ is the degree.

**polynomial long division** (p. 352) A method used to divide polynomials similar to the way you divide numbers.

**positive correlation** (p. 100) The relationship between paired data when $y$ tends to increase as $x$ increases, as shown by a scatter plot where the plotted points generally rise from left to right.

**power** (p. 11) An expression such as $2^5$, which represents $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$.

**power function** (p. 415) A function of the form $y = ax^b$ where $a$ is a real number and $b$ is a rational number.

**probability** (p. 716) A number between 0 and 1 that indicates the likelihood an event will occur.

**pure imaginary number** (p. 272) A complex number $a + bi$ where $a = 0$ and $b \neq 0$.

# Q

**quadrantal angle** (p. 785) An angle in standard position with its terminal side on an axis. Examples: 0°, 90°, 180°, and 270°.

**quadrants** (p. 67) The four regions that result when the $x$-axis and $y$-axis divide a coordinate plane. *See also* coordinate plane.

**quadratic equation in one variable** (p. 257) An equation that can be written in the form $ax^2 + bx + c = 0$ where $a \neq 0$.

**quadratic form** (p. 346) The form $au^2 + bu + c$ where $u$ is any expression in $x$.

**quadratic formula** (p. 291) A formula that gives the solutions of any quadratic equation. If $a$, $b$, and $c$ are real numbers with $a \neq 0$, the solutions of $ax^2 + bx + c = 0$ are $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$.

**quadratic function** (p. 249) A function of the form $y = ax^2 + bx + c$ where $a \neq 0$.

**quadratic inequality in one variable** (p. 301) An inequality of the form $ax^2 + bx + c < 0$, $ax^2 + bx + c > 0$, $ax^2 + bx + c \leq 0$, or $ax^2 + bx + c \geq 0$.

**quadratic inequality in two variables** (p. 299) An inequality of the form $y < ax^2 + bx + c$, $y > ax^2 + bx + c$, $y \leq ax^2 + bx + c$, or $y \geq ax^2 + bx + c$.

**quartic function** (p. 329) A polynomial function of degree 4.

# R

**radian** (p. 777) In a circle with radius $r$ and center at the origin, one radian is the measure of an angle in standard position whose terminal side intercepts an arc of length $r$.

**radical** (p. 264) An expression of the form $\sqrt{s}$ or $\sqrt[n]{s}$ where $s$ is a number or expression.

**radical function** (p. 431) A function that contains a radical, such as $y = \sqrt{x}$ or $y = \sqrt[3]{x}$.

**radical symbol** (p. 264) The symbol $\sqrt{\phantom{x}}$ or $\sqrt[n]{\phantom{x}}$, which denotes a square root or $n$th root, respectively.

**radicand** (p. 264) The number or expression beneath a radical sign. The radicand of $\sqrt{5}$ is 5 and the radicand of $\sqrt[3]{7x}$ is $7x$.

**radius of a circle** (p. 601) The distance from the center of a circle to a point on the circle, or the line segment that connects the center of a circle to a point on the circle. *See also* circle.

**range of a relation** (p. 67) The set of output values for a relation.

**range of data values** (p. 446) The difference between the greatest and least data values.

**rational function** (p. 540) A function of the form $f(x) = \dfrac{p(x)}{q(x)}$ where $p(x)$ and $q(x)$ are polynomials and $q(x) \neq 0$.

**rationalizing the denominator** (p. 265) The process of eliminating a radical in the denominator of a fraction by multiplying both the numerator and the denominator by an appropriate radical.

**reciprocal** (p. 5) The reciprocal, or multiplicative inverse, of any nonzero real number $a$ is $\dfrac{1}{a}$.

**recursive rule** (p. 681) A rule for a sequence that gives the beginning term or terms of a sequence and then a recursive equation that tells how $a_n$ is related to one or more preceding terms.

**reference angle** (p. 785) If $\theta$ is an angle in standard position, its reference angle is the acute angle $\theta'$ formed by the terminal side of $\theta$ and the $x$-axis. An example is shown.
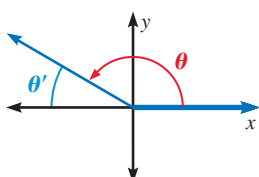


**relation** (p. 67) A mapping, or pairing, of input values with output values.

**relatively no correlation** (p. 100) The relationship between paired data when a scatter plot of the data shows no linear pattern.

**repeated solution** (p. 366) For the equation $f(x) = 0$, $k$ is a repeated solution if and only if the factor $(x - k)$ has degree greater than 1 when $f$ is factored completely.

# S

**scalar** (p. 200) A real number by which you multiply a matrix.

**scalar multiplication** (p. 200) The process of multiplying each entry in a matrix by a scalar.

**scatter plot** (p. 100) A graph of ordered pairs used to determine whether there is a relationship between paired data.

**scientific notation** (p. 325) A number is expressed in scientific notation if it is in the form $c \times 10^n$ where $1 \leq c < 10$ and $n$ is an integer.

**secant function** (p. 769) If $\theta$ is an acute angle of a right triangle, the secant of $\theta$ is $\sec \theta = \dfrac{\text{hyp}}{\text{adj}}$ where *hyp* represents the length of the hypotenuse and *adj* represents the length of the side adjacent to $\theta$.

**sector** (p. 779) A region of a circle that is bounded by two radii and an arc of the circle.
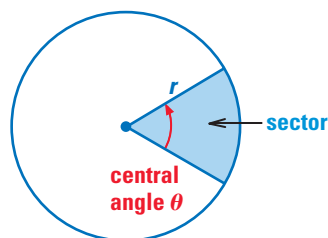


**sequence** (p. 651) A function whose domain is a set of consecutive integers. The domain gives the relative position of each term of the sequence: 1st, 2nd, 3rd, and so on. The range gives the terms of the sequence.

**series** (p. 653) The expression that results when the terms of a sequence are added.

**sigma notation** (p. 653) *See* summation notation.

**simplest form of a radical** (p. 408) A radical expression after you apply the properties of radicals, remove any perfect $n$th powers, and rationalize any denominators.

**simplified form of a rational expression** (p. 554) A rational expression in which the numerator and denominator have no common factors (other than $\pm 1$).

**sine function** (p. 769) If $\theta$ is an acute angle of a right triangle, the sine of $\theta$ is $\sin \theta = \dfrac{\text{opp}}{\text{hyp}}$ where *opp* represents the length of the side opposite $\theta$ and *hyp* represents the length of the hypotenuse.

**skewed distribution** (p. 740) A distribution that is not symmetric. *See also* symmetric distribution.

**slope** (p. 75) The ratio of vertical change (the rise) to horizontal change (the run) for a nonvertical line. The slope of a nonvertical line passing through the points $(x_1, y_1)$ and $(x_2, y_2)$ is $m = \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{\text{rise}}{\text{run}}$.
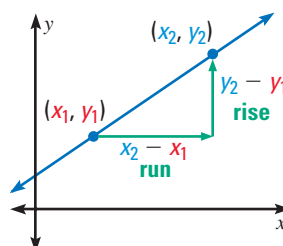
**slope-intercept form** (p. 82) A linear equation written in the form $y = mx + b$ where $m$ is the slope and $b$ is the $y$-intercept of the line.

**solution of an equation in one variable** (p. 19) A number that, when substituted for the variable, makes the equation a true statement.

**solution of an equation in two variables** (p. 69) An ordered pair $(x, y)$ that makes the equation a true statement when the values of $x$ and $y$ are substituted in the equation.

**solution of an inequality in one variable** (p. 41) A value of the variable that makes the inequality true.

**solution of an inequality in two variables** (p. 108) An ordered pair $(x, y)$ that, when $x$ and $y$ are substituted in the inequality, gives a true statement.

**solution of a system of linear equations** (p. 139) An ordered pair $(x, y)$ that satisfies each equation of the system.

**solution of a system of linear inequalities** (p. 156) An ordered pair that is a solution of each inequality in the system.

**solution of a system of three linear equations** (p. 177) An ordered triple $(x, y, z)$ that is a solution of all three equations of the system.

**solving a right triangle** (p. 770) Finding all missing side lengths and angle measures of a right triangle.

**square root** (p. 264) A number $r$ is a square root of a number $s$ if $r^2 = s$.

**standard deviation** (p. 446) The typical difference (or *deviation*) between the mean and a data value. The standard deviation $\sigma$ of $x_1, x_2, \ldots, x_n$ is
$$\sigma = \sqrt{\frac{(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2 + \cdots + (x_n - \bar{x})^2}{n}}.$$

**standard form of a complex number** (p. 272) The form $a + bi$ where $a$ and $b$ are real numbers and $i$ is the imaginary unit.

**standard form of a linear equation** (p. 84) A linear equation written in the form $Ax + By = C$ where $A$ and $B$ are not both zero.

**standard form of a polynomial function** (p. 329) The form of a polynomial function when the terms are written in descending order of exponents from left to right.

**standard form of a quadratic equation** (p. 257) The form $ax^2 + bx + c = 0$ where $a \neq 0$.

**standard form of a quadratic function** (p. 250) The form $y = ax^2 + bx + c$ where $a \neq 0$.

**standard form of the equation of a circle** (pp. 601, 623) If a circle has center $(h, k)$ and radius $r$, its equation is $(x - h)^2 + (y - k)^2 = r^2$. *See also* circle.

**standard form of the equation of a hyperbola** (p. 615) If a hyperbola has center $(h, k)$, its equation is as follows:
$$\frac{(x - h)^2}{a^2} - \frac{(y - k)^2}{b^2} = 1 \text{ (horizontal transverse axis) or}$$
$$\frac{(y - k)^2}{a^2} - \frac{(x - h)^2}{b^2} = 1 \text{ (vertical transverse axis).}$$
*See also* hyperbola.

**standard form of the equation of an ellipse** (p. 609) If an ellipse has center $(h, k)$ and major and minor axes of lengths $2a$ and $2b$, where $a > b > 0$, its equation is as follows:
$$\frac{(x - h)^2}{a^2} + \frac{(y - k)^2}{b^2} = 1 \text{ (horizontal major axis) or}$$
$$\frac{(x - h)^2}{b^2} + \frac{(y - k)^2}{a^2} = 1 \text{ (vertical major axis).} \textit{ See also} \text{ ellipse.}$$

**standard form of the equation of a parabola** (pp. 596, 623) If a parabola has vertex $(h, k)$, its equation is as follows: $(y - k)^2 = 4p(x - h)$ (horizontal axis) or $(x - h)^2 = 4p(y - k)$ (vertical axis).

**standard position of an angle** (p. 776) In a coordinate plane, the position of an angle whose vertex is at the origin and whose initial side is the positive $x$-axis. *See also* initial side of an angle.

**statistics** (p. 445) Numerical values used to summarize and compare sets of data.

**step function** (p. 115) A piecewise function whose graph resembles a set of stair steps. *See also* piecewise function.

**summation notation** (p. 653) Notation for a series that uses the uppercase Greek letter sigma, $\Sigma$. For example, you can write $3 + 6 + 9 + 12 + 15 = \sum_{i=1}^{5} 3i$ where $i$ is the index of summation, 1 is the lower limit of summation, and 5 is the upper limit of summation.

**symmetric distribution** (p. 740) A distribution in which the left half of the histogram representing the distribution is a mirror image of the right half.

**synthetic division** (p. 353) A method used to divide a polynomial by an expression of the form $x - k$.

**synthetic substitution** (p. 330) A method used to evaluate a polynomial function.

**system of linear inequalities in two variables** (p. 156) A system made up of two linear inequalities in two variables. *See also* linear inequality in two variables.

**system of three linear equations** (p. 177) A system made up of three linear equations in three variables. *See also* linear equation in three variables.

**system of two linear equations** (p. 139) Two equations of the form $Ax + By = C$ and $Dx + Ey = F$ where $x$ and $y$ are variables, $A$ and $B$ are not both zero, and $D$ and $E$ are not both zero.

**T**

**tangent function** (p. 769) If $\theta$ is an acute angle of a right triangle, the tangent of $\theta$ is $\tan \theta = \dfrac{\text{opp}}{\text{adj}}$ where *opp* represents the length of the side opposite $\theta$ and *adj* represents the length of the side adjacent to $\theta$.

**terminal side of an angle** (p. 776) *See* initial side of an angle.

**terms of an expression** (p. 13) The parts of an algebraic expression that are added together. The terms of $2x + 3$ are $2x$ and 3. The terms of $2x - 3 = 2x + (-3)$ are $2x$ and $-3$.

**terms of a sequence** (p. 651) For a sequence of numbers, the numbers in the sequence are called terms. *See also* sequence.

**theoretical probability** (p. 716) When all outcomes are equally likely, the theoretical probability that an event $A$ will occur is $P(A) = \dfrac{\text{number of outcomes in } A}{\text{total number of outcomes}}$. The theoretical probability of an event is often simply called the probability of the event.

**three-dimensional coordinate system** (p. 170) A coordinate system determined by three mutually perpendicular axes. When taken pairwise, these axes form three coordinate planes that divide space into eight parts called octants. A point in space is represented by an ordered triple of the form $(x, y, z)$. The ordered triples $(-5, 3, 4)$, $(0, 0, 0)$, and $(2, -2, -3)$ are plotted below.
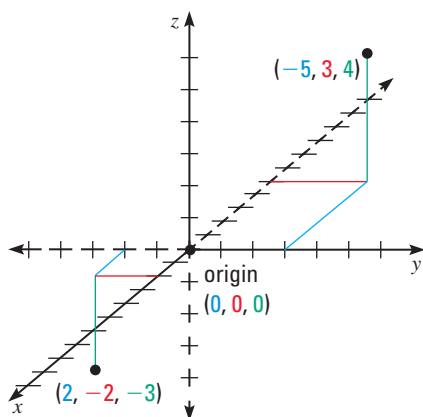


**transverse axis of a hyperbola** (p. 615) The line segment joining the vertices of a hyperbola. *See also* hyperbola.

**trigonometric identity** (p. 848) A trigonometric equation that is true for all domain values.

**trinomial** (p. 256) An expression with three terms, such as $x^2 + 8x + 15$.

## U

**upper quartile** (p. 447) The median of the upper half of a data set. *See also* box-and-whisker plot.

## V

**value of an expression** (p. 12) The result when the variables in an algebraic expression are replaced by numbers and the expression is simplified.

**value of a variable** (p. 12) Any number used to replace a variable.

**variable** (p. 12) A letter that is used to represent one or more numbers.

**verbal model** (p. 33) A word equation that represents a real-life problem.

**vertex form of a quadratic function** (p. 250) The form $y = a(x - h)^2 + k$ where the vertex of the graph is $(h, k)$ and the axis of symmetry is $x = h$.

**vertex of an absolute value graph** (p. 122) The corner point of the graph of an absolute value function.
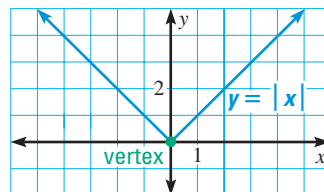


**vertex of a parabola** (pp. 249, 595) The point on a parabola that lies on the axis of symmetry. This point is the lowest or highest point on a parabola with a vertical axis of symmetry and the leftmost or rightmost point on a parabola with a horizontal axis of symmetry. *See also* parabola.

**vertices of a hyperbola** (p. 615) The points of intersection of a hyperbola and the line through the foci of the hyperbola. *See also* hyperbola.

**vertices of an ellipse** (p. 609) The points of intersection of an ellipse and the line through the foci of the ellipse. *See also* ellipse.

## X

**$x$-axis** (p. 67) The horizontal axis in the coordinate plane. *See also* coordinate plane.

**$x$-coordinate** (p. 67) The first number in an ordered pair.

**$x$-intercept of a line** (p. 84) The $x$-coordinate of the point where a line intersects the $x$-axis. Given an equation of the line, it is the value of $x$ when $y = 0$.

## Y

**$y$-axis** (p. 67) The vertical axis in the coordinate plane. *See also* coordinate plane.

**$y$-coordinate** (p. 67) The second number in an ordered pair.

**$y$-intercept** (p. 82) If the graph of an equation intersects the $y$-axis at the point $(0, b)$, then the number $b$ is the $y$-intercept of the graph. Given an equation of the graph, it is the value of $y$ when $x = 0$.

## Z

**$z$-axis** (p. 170) A vertical line through the origin and perpendicular to the $xy$-coordinate plane in a three-dimensional coordinate system. *See also* three-dimensional coordinate system.

**zero of a function** (p. 354) A number $k$ is a zero of a function $f$ if $f(k) = 0$.