- Two nonvertical lines that have the same slope and different *y*-intercepts are parallel, while two nonvertical lines whose slopes are negative reciprocals of each other are perpendicular. Working in small groups, have students analyze several appropriate linear equations to help them discover the "rules" for the slopes of parallel and perpendicular lines.
- Have students work together to create a matching game in which a linear equation must be paired with its related graph. Each student can write a linear equation and its graph on separate index cards. Put these cards together, shuffle them up, display them face-down on a flat surface, and students can use their memories and what they know about slope to turn over and match the correct pairs.
- A **scatter plot** is a coordinate-plane graph in which sets of data, represented by the quantities *x* and *y*, are plotted as ordered pairs. A **best-fit line** is a line drawn very close to most of the data points. When *x* and *y* have a **positive correlation**, *y* increases as *x* increases, and a line drawn through the points has a positive slope. When *x* and *y* have a **negative correlation**, *y* decreases as *x* increases, and a line drawn through the points has a negative slope. Have students use data from the United States Census Bureau or another source to make scatter plots. Then, discuss the type of correlation displayed and the slope of the best-fit line.
- Have students explore the graphs of linear equations at **www.shodor.org/interactivate/activities/SlopeSlider**. This activity allows students to examine how adjusting the values for the slope and *y*-intercept alter the graph of a linear equation in the form $y = mx + b$. There are also activities to help students gain confidence with using the coordinate plane.
- Have students seek real-world applications of linear equations and slope by conducting research and generating a list of careers that would require an understanding of these algebraic concepts.

Suggested Internet Resources

Periodically, Internet Resources are updated on our web site at www.LibraryVideo.com.

- **www.regentsprep.org/Regents/math/math-topic.cfm?TopicCode=glines**
  This web site from the Oswego City School District offers lessons, practice questions for students and teacher resources about the graphs of linear equations.
- **www.usatoday.com/educate/mathtoday/index.htm**
  Study scatter plots and linear equations in real-world contexts with the "Heat Index" and "Lost in Space" lessons from this USA Today Education web site.

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- **www.nsa.gov/teachers/teach00006.cfm**
  The Mathematics Education Partnership Program offers learning units for all areas of math, including the "Detective Slope" activity in the High School Geometry section.

Suggested Print Resources

- Kaplan, Robert and Ellen Kaplan. *The Art of the Infinite: The Pleasures of Mathematics*. Oxford University Press, New York, NY; 2003.
- The Math Forum. *Dr. Math Explains Algebra: Learning Algebra Is Easy! Just Ask Dr. Math!* John Wiley & Sons, Incorporated, Hoboken, NJ; 2003.
- Muschla, Judith A. and Gary Robert Muschla. *Algebra Teacher's Activities Kit: 150 Ready-to-Use Activities with Real-World Applications*. John Wiley & Sons, Incorporated, Hoboken, NJ; 2003.
- Wingard-Nelson, Rebecca. *Algebra I and Algebra II*. Enslow Publishers, Berkeley Heights, NJ; 2004.

TEACHER'S GUIDE

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Algebra for Students™

Linear Equations & Slope

Grades 7-12

In algebra, students are challenged to make a leap, from the concrete world of numbers and real objects, to an abstract one of letters and symbols. *Algebra for Students* is designed to help students to become more comfortable in the abstract world of algebra through the exploration of problems in the real world, from using a system of linear equations to calculate the cost of a sushi roll to using a quadratic function to describe the path of a kicked football. Animated graphics, real-life locales and vibrant young hosts help to explain math concepts, highlight multiple ways of approaching a problem, illustrate common pitfalls to avoid and tackle some typical test questions.

This guide provides a program overview, background knowledge needed for understanding, vocabulary, discussion questions and activities, tips for using a calculator, as well as print and Internet resources to supplement the teaching of targeted algebra concepts.

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Program Overview

Linear functions model many real-life situations, like the relationship between the duration and cost of a rock-climbing lesson. A linear function is a function whose graph is a straight line and has a constant rate of change. A linear equation is often written to describe the information found on the graph of a linear function. Linear equations are first degree polynomial equations that can be expressed in the form $y = mx + b$, which is known as slope-intercept form since m represents the slope and b is the y-intercept, the point at which a graph of the equation crosses the y-axis.

The slope of a line is the ratio of the change in y-values, or rise, to the corresponding change in x-values, or run, of points on the graph of the line. The value of the slope describes the appearance of the line. When a line has a positive slope, it goes up and to the right, while a line with a negative slope goes down and to the left. A horizontal line has a slope equal to zero, while a vertical line has no slope, sometimes referred to as an undefined slope.

One way to graph a linear equation is to create a table of x-values and y-values based on the equation, convert those values into ordered pairs, and plot those ordered pairs on a coordinate grid. For a linear equation written in slope-intercept form, $y = mx + b$, the value of b indicates the y-intercept, which is plotted on the coordinate grid, and other points on the line are plotted based on the y-intercept using the value of m, the slope.

Background

Before studying the content discussed in the video, students should already be able to:

- Identify the parts of the Cartesian coordinate system.
- Plot points in the coordinate plane.
- Perform calculations with integers.
- Substitute values into an algebraic equation.

Vocabulary

linear function — A function whose graph is a straight line and has a constant rate of change.

***y*-intercept —** The y-value in an ordered pair that describes the point at which a graph crosses the y-axis. For example, since the graph of the function $y = 2x + 3$ intersects the y-axis at (0,3), the y-intercept is 3.

linear equation — A first degree polynomial equation that can be expressed in the form $y = mx + b$, where m is the slope and b is the y-intercept.

constant — A known quantity that stays the same.

variable — A symbol, usually a letter, that represents a number or set of numbers that can change.

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coefficient — A numerical factor multiplied by a variable or variables in an expression.

slope — The ratio of the change in y-values to the corresponding change in x-values of points on the graph of a line. For two points (x_1,y_1) and (x_2,y_2), the formula for the slope (m) of the line containing the points is $m = \frac{y_2 - y_1}{x_2 - x_1}$ (sometimes written as $m = \frac{\text{rise}}{\text{run}}$).

rise — The change in y-values of two points on the graph of a line.

run — The change in x-values of two points on the graph of a line.

slope-intercept form — A linear equation written in the form $y = mx + b$.

Pre-viewing Discussion

- Review graphing in the coordinate plane. Discuss how to plot ordered pairs on a four-quadrant coordinate grid and how to read information from a four-quadrant coordinate graph. Have students contribute to a list of DOs and DON'Ts for graphing and post this in the classroom for quick reference.
- Give students algebraic expressions to simplify based on given values of the variables, and have students solve simple and multi-step algebraic equations.
- Write the word "slope" on the board and have students discuss the meaning of the word and examples of where and how it is used in real-life situations.

Problems

1. A shop offers a bicycle rental for $6 per hour plus a $2 equipment fee for a helmet.
   (a) Write a linear equation for the total cost of a bicycle rental.
   (b) Find the total cost of a five-hour bicycle rental.
2. A line passes through the points (2,5) and (0,-1). Write the equation of the line in slope-intercept form.

Solutions

1. (a) Let x equal the number of hours the bicycle is rented and y equal the total cost of a bicycle rental. The total cost of a bicycle rental equals $6 multiplied by the number of hours the bicycle is rented, or $6x$, plus an equipment fee of $2. Thus, the linear equation for the total cost of a bicycle rental is $y = 6x + 2$.

   (b) Use the linear equation $y = 6x + 2$ to calculate the total cost of a five-hour bicycle rental:

   $$y = 6x + 2$$
   $$y = 6(5) + 2$$
   $$y = 30 + 2$$
   $$y = 32$$

   The total cost of a five-hour bicycle rental is $32.

2. To write the equation of the line in slope-intercept form, $y = mx + b$, first calculate m, the slope of the line, using the points (2,5) and (0,-1):

   $$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1 - 5}{0 - 2} = \frac{-6}{-2} = 3$$

   The slope of the line is 3.

   The line crosses the y-axis at the point (0,-1), so b, the y-intercept, is -1.

   The equation of the line is $y = 3x - 1$.

Using a Calculator

A graphing calculator can quickly and accurately graph many different kinds of equations, including linear equations. Have students practice graphing linear equations on their graphing calculators, and show them how zooming in or out, as well as setting the graph parameters, can help obtain the best view of a graph. Graphing calculators also permit students to examine the graphs of several equations simultaneously, thereby allowing them to investigate the similarities and differences among multiple linear equations. The following keys are very helpful:

- The (Y=) key allows you to enter one or more than one equation for graphing. When starting a new problem, be sure to clear any existing equations from the Y= list.
- The (TRACE) key allows you to move a cursor along the line of a graph. The location of the cursor on the graph appears at the bottom of the screen.
- The (ZOOM) menu allows you to adjust your view of the graph by zooming in or out.
- The (WINDOW) feature, found on many graphing calculators, allows you to customize your view of a graph by setting the minimum and maximum x and y values as well as the scale for each axis.

Try graphing different linear equations, including those with zero slope or no slope.

Different calculators sometimes require different keys or key strokes to perform an operation. Encourage students to practice performing different functions on their calculators. Getting to know how their own calculator works is an important part of being a savvy algebra student.

Follow-up Discussion & Activities

- Discuss with students the various ways to write a linear equation: point-slope form, slope-intercept form, and standard form. Write several linear equations on the board and have students rewrite the equations in the various linear equation forms, comparing and contrasting the different forms and indicating when it would be advantageous to use each form.
- Slope refers to the steepness of a line or object. Have students investigate the slopes of various objects, like a flight of stairs, a handicapped access ramp or even a mountain, by measuring the rise and the run and calculating the slope.

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