Using a Calculator

If students are using the graphing method to solve systems of linear equations, the graphing calculator is a useful tool and an alternative to paper-and-pencil graphing.

When the coordinates of the solution to a system of linear equations are not integers, a graphing calculator can accurately approximate the coordinates. The following keys are very helpful in finding these coordinates:

- The (TRACE) key allows you to move a cursor along the lines of the system. The location of the cursor on the graph appears at the bottom of the screen.
- The (TABLE) feature organizes the data from the graph into a table.
- The (CALC) menu, found on many graphing calculators, has an option that will let students find the intersection of two functions.

Try graphing different systems, including special types of systems, such as systems with no solution and systems with an infinite number of solutions.

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 calculators work is an important part of being a savvy algebra student.

Suggested Internet Resources

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

- **www.wtamu.edu/academic/anns/mps/math/mathlab/col_algebra/col_alg_tut51_sysprob.htm**
  This tutorial from West Texas A&M University offers step-by-step instructions on how to solve systems of linear inequalities.
- **www.algebralab.org/studyaids/studyaid.aspx**
  This web site has tutorials in many areas of mathematics, including several for solving systems of linear equations in the "Linear Equations" section.
- **www.regentsprep.org/Regents/math/ALGEBRA/AE3/indexAE3.htm**
  This web site from the Oswego City School District offers lessons, practice questions for students, and teacher resources about solving systems of linear equations.

TEACHER'S GUIDE

Suggested Print Resources

- Derbyshire, John. *Unknown Quantity: A Real and Imaginary History of Algebra*. National Academies Press, Washington, D.C.; 2006.
- Great Source Education Group. *Algebra to Go: A Mathematics Handbook*. Great Source Education Group, Wilmington, MA; 2000.
- 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.

TEACHER'S GUIDE

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TEACHER'S GUIDE

Algebra for Students™

Systems of Linear Equations

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

Systems of linear equations are used to model many real-life situations. A system of linear equations consists of two or more linear equations that contain the same variables and share a common solution. One method of solving a system of linear equations is by graphing, either by hand or on a graphing calculator. When the two linear equations are graphed on the same coordinate grid, the point where the two lines intersect is the solution to the system.

Substitution and elimination are two other methods of solving a system of linear equations. In substitution, first, one equation in the system is rewritten so one variable is expressed in terms of the other variable. Then, the rewritten equation is substituted into the other equation, and the result is simplified. In elimination, addition or subtraction is used to combine the equations in the system in order to eliminate one variable. The value of the remaining variable is calculated and substituted into one of the original equations to determine the value of the other variable.

Systems of linear equations may have zero, one or many solutions. When the graph of a system of linear equations is two intersecting lines, the system has one solution. A system whose graph has identical lines has an infinite number of solutions, while a system whose graph has parallel lines has no solution.

Background

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

- Understand that converting one unit to another is helpful when solving some mathematical problems.
- Use slope-intercept form to graph a linear equation.
- Manipulate equations to isolate one variable in terms of the other.
- Recognize the standard form of a linear equation.

Vocabulary

linear equation — A first degree polynomial equation that can be expressed in the form $y = mx + b$. A linear equation represents a function whose graph is a straight line and has a constant rate of change.

standard form — A linear equation written in the form $Ax + By = C$, where A, B and C are all real numbers, A is usually a positive integer, and A and B are not both zero.

system of linear equations — Two or more linear equations that contain the same variables and share a common solution.

substitution method — A method of solving a system of linear equations that involves rewriting one equation so that one variable is expressed in terms of the other variable, then substituting the first equation into the second equation.

elimination method — A method of solving a system of linear equations that involves using addition or subtraction to combine the equations in the system in order to eliminate one variable.

Pre-viewing Discussion

- Word problems often contain values expressed in different units. Present students with a variety of problems and ask them to express their answers using units other than the original units given in the problem. Discuss why units are important in calculations, then review with them common unit conversions, like converting feet into miles, hours into minutes or seconds, and cups or pints into quarts or gallons.
- An important skill used in solving systems of linear equations is the ability to manipulate an equation so the variable x or y is isolated on one side of the equation. Give students several linear equations and formulas and ask them to express the equation or formula in terms of one variable.
- Review slope-intercept form with students. Give them linear equations to rearrange into slope-intercept form and graph on the coordinate plane.

Problems

Complementary angles are two angles whose measures have the sum of 90°. Angles x and y are complementary, and the measure of angle x is 20° less than the measure of angle y.

1. Write a system of linear equations describing the situation.
2. Calculate the measures of angles x and y by solving the system of linear equations.

Solutions

1. Since the sum of the measures of angles x and y is 90°, one equation in the system is $x + y = 90$. Since the measure of angle x equals the measure of angle y minus 20°, the other equation in the system is $x = y - 20$. The system of linear equations is:

   $x + y = 90$

   $x = y - 20$

2. The second equation of the system already has angle x in terms of angle y, so the value of y can be obtained by substituting the second equation into the first equation and simplifying:

$$\begin{aligned} x + y &= 90 \\ (y - 20) + y &= 90 \\ 2y - 20 &= 90 \\ +20 &= +20 \\ \frac{2y}{2} &= \frac{110}{2} \\ y &= 55 \end{aligned}$$

   To obtain the value of x, substitute the value of y into the second equation:

   $x = y - 20 = 55 - 20 = 35$

   The measure of angle x is 35°, and the measure of angle y is 55°.

Follow-up Discussion & Activities

- Have students make a chart for quick reference containing some of the special vocabulary describing systems of equations. The graphs of a **consistent** system of equations either intersect or coincide. A consistent system with one solution, represented graphically by two intersecting lines, is **independent**, while a consistent system with an infinite number of solutions, represented graphically by the same line, is **dependent**. The graphs of an **inconsistent** system of equations are parallel, and the system has no solution.
- You can tell a system of linear equations has no solution when the graphs of the equations are parallel. Write a system on the board that has no solution. Discuss with students how, without graphing, they can tell if a system has no solution. Then, ask students to give additional examples of systems with no solutions. They can check these by entering them into a graphing calculator.
- Graphing, substitution or elimination? Poll the class to determine their preferred method of solving systems of linear equations. Is their preferred strategy applicable only in certain situations? Explain when each method is most useful and when it is least useful. Use this information to make a master list featuring the different methods and when they are most helpful.
- Businesses can use systems of linear equations to determine their break-even point — the point at which their income equals their expenses. Have students work in small groups to develop a business plan and calculate their break-even point to determine the amount of sales required before their business would become profitable. Have students analyze this data to determine if their plans are realistic. Is the amount of sales needed to cover expenses reasonable? As an extension, have students conduct research to determine the break-even point for a local business or for a school or club fundraiser.
- A system of linear equations can be made up of two *or more* linear equations. Challenge students to create and solve a system of three linear equations. Have them show their work and describe the strategies and methods they used.
- Have students seek real-world applications of systems of linear equalities by conducting research and generating a list of careers that would require an understanding of this algebraic concept.