Using a Session

Teacher's Guide

i-Ready Classroom Mathematics lessons consist of three types of sessions: Explore, Develop, and Refine. The following is a walkthrough of the planning and support features within the Teacher's Guide for a Develop session. You will find many of the same features in the Explore and Refine sessions.

Lesson Overview provides information for use in planning whole class instruction, small group differentiation, and independent learning opportunities.

MATH FOCUS sets learning expectations for students' conceptual understanding and how they demonstrate that understanding.

Objectives
Content Objectives identify the mathematical learning goals for the lesson, while **Language Objectives** identify how students use language to show or develop their understanding of those goals.

Prior Knowledge identifies key skills students will build on during the lesson and presents an opportunity to monitor understanding and identify students' learning needs.

Learning Progression provides information on how the content fits across and within grade levels—what students previously learned, what they are learning now, and what they will be learning next, setting context for the mathematics of the lesson.

LESSON 13

Overview | Solve Systems of Linear Equations Algebraically

MATH FOCUS

Focus Standards

8.EE.C.8 Analyze and solve pairs of simultaneous linear equations.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection.

See Unit 3 Overview for developing and applied standards.

STANDARDS FOR MATHEMATICAL PRACTICE (SMP)

SMP 1, 2, 3, 4, 5, and 6 are integrated into the Try-Discuss-Connect routine.*

This lesson provides additional support for:

3 Construct viable arguments and critique the reasoning of others.

4 Model with mathematics.

7 Look for and make use of structure.

* See page 1o to learn how every lesson includes these SMP.

Objectives

Content Objectives

- Estimate the solution of a system of linear equations by graphing.
- Use substitution and elimination to solve systems of linear equations.
- Determine whether a system of linear equations has one solution, no solution, or infinitely many solutions.
- Identify efficient ways to solve a system of linear equations.

Language Objectives

- Justify solutions for systems of linear equations by referring to graphs and checking if solutions are reasonable.
- Respond to clarifying questions about the processes of substitution and elimination during partner and class discussions.
- Explain why systems of linear equations have one, infinitely many, or no solutions using precise mathematical language.
- Describe and evaluate methods of solving a system of equations using lesson vocabulary when speaking and writing.
- Listen for understanding by asking clarifying questions or requesting more information during partner and class discussions.

Prior Knowledge

- Understand the definition of a system of linear equations.
- Graph a system of linear equations to determine its solution.
- Solve an equation for one variable in terms of another.

Vocabulary

Math Vocabulary

There is no new vocabulary. Review the following key terms.

coefficient a number that is multiplied by a variable.

system of linear equations a group of related equations in which a solution makes all the equations true at the same time. A system of equations can have zero, one, or infinitely many solutions.

Academic Vocabulary

algebraically in a way that involves variables and the rules of algebra.

eliminate to remove or get rid of.

substitution the process of replacing one thing with another that is equivalent.

Learning Progression

Earlier in Grade 8, students graphed linear equations and rewrote them in slope-intercept form.

In the previous lesson, students learned about systems of linear equations. They graphed both equations of a system and identified any points of intersection. They determined whether a system had zero, one, or infinitely many solutions by graphing and by considering the values of m and b in the slope-intercept form of the equations.

In this lesson, students will use the substitution and elimination methods to solve systems of linear equations. They will understand how the graph of a system can help them estimate the solution before finding the exact solution algebraically. They will recognize that when an algebraic solution leads to an equation that is never true, the system has no solution, and when it leads to an equation that is always true, the system has infinitely many solutions.

Later in Grade 8, students will learn how to write systems of equations to model both mathematical and real-world problems. Then they will apply the skills learned in this lesson to solve the systems.

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LESSON 13
Overview

Pacing Guide

Items marked with [icon] are available on the Teacher Toolbox.

	MATERIALS	DIFFERENTIATION
SESSION 1 Explore Solving Systems of Linear Equations Algebraically (35–50 min)		
• **Start** (5 min) • **Try It** (5–10 min) • **Discuss It** (10–15 min) • **Connect It** (10–15 min) • **Close: Exit Ticket** (5 min) **Additional Practice** (pages 285–286)	Presentation Slides	**PREPARE** Interactive Tutorial **RETEACH or REINFORCE** Visual Model
SESSION 2 Develop Solving Systems of Linear Equations by Substitution (45–60 min)		
• **Start** (5 min) • **Try It** (10–15 min) • **Discuss It** (10–15 min) • **Connect It** (15–20 min) • **Close: Exit Ticket** (5 min) **Additional Practice** (pages 291–292)	**Math Toolkit** graph paper, straightedges Presentation Slides	**RETEACH or REINFORCE** Hands-On Activity **Materials** For each pair: algebra tiles (at least 10 each of *x*- and *y*-tiles and 20 1-tiles) **REINFORCE** Fluency & Skills Practice **EXTEND** Deepen Understanding
SESSION 3 Develop Solving Systems of Linear Equations by Elimination (45–60 min)		
• **Start** (5 min) • **Try It** (10–15 min) • **Discuss It** (10–15 min) • **Connect It** (15–20 min) • **Close: Exit Ticket** (5 min) **Additional Practice** (pages 297–298)	**Math Toolkit** graph paper, straightedges Presentation Slides	**RETEACH or REINFORCE** Visual Model **Materials** For display: a large four-quadrant coordinate plane **REINFORCE** Fluency & Skills Practice **EXTEND** Deepen Understanding
SESSION 4 Develop Determining When a System Has Zero or Infinitely Many Solutions (45–60 min)		
• **Start** (5 min) • **Try It** (10–15 min) • **Discuss It** (10–15 min) • **Connect It** (15–20 min) • **Close: Exit Ticket** (5 min) **Additional Practice** (pages 303–304)	**Math Toolkit** graph paper, straightedges Presentation Slides	**RETEACH or REINFORCE** Visual Model **Materials** For display: a large four-quadrant coordinate plane **REINFORCE** Fluency & Skills Practice **EXTEND** Deepen Understanding
SESSION 5 Refine Solving Systems of Linear Equations Algebraically (45–60 min)		
• **Start** (5 min) • **Monitor & Guide** (15–20 min) • **Group & Differentiate** (20–30 min) • **Close: Exit Ticket** (5 min)	**Math Toolkit** Have items from previous sessions available for students. Presentation Slides	**RETEACH** Hands-On Activity **Materials** For each pair: algebra tiles (at least 10 each of *x*- and *y*-tiles and 20 1-tiles) **REINFORCE** Problems 4–8 **EXTEND** Challenge **PERSONALIZE** i-Ready
Lesson 13 Quiz or **Digital Comprehension Check**		**RETEACH** Tools for Instruction **REINFORCE** Math Center Activity **EXTEND** Enrichment Activity

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Pacing Guide provides session-by-session pacing to support planning for daily instruction and practice.

PREPARE students for the lesson content with *Interactive Tutorials*.

Additional Practice is for use as in-class small group work, after-class work, or at-home learning.

REINFORCE understanding with *Fluency & Skills Practice, Apply It* problems, and differentiated *Math Center Activities. Hands-On Activities* and *Visual Models* may also be useful in reinforcing mathematical concepts.

RETEACH mathematical concepts using *Hands-On Activities* and *Visual Models. Tools for Instruction* also provide targeted skills instruction.

Optional Add-On: **PERSONALIZE** resources provide students with opportunities to strengthen grade-level skills by working on their personalized path with *i-Ready* Online Instruction or to build fluency skills with interactive Learning Games.

The **Lesson Quiz** or **Digital Comprehension Check** assesses students' progress toward mastery of lesson content and is a way to identify where reteaching is needed.

EXTEND mathematical concepts with *Deepen Understanding, Challenge Activities,* and *Enrichment Activities.*

Teacher's Guide *continued*

Purpose provides a roadmap of what students will be learning and doing across the session.

START establishes a clear and accessible entry point for each session, engaging students mathematically with prerequisite content. It is frequently an opportunity to have students engage in conversations about mathematics, answering questions such as, *Which would you rather?* and *Which one doesn't belong?*

DEVELOP ACADEMIC LANGUAGE supports all students in understanding and using academic language at the word, sentence, and discourse levels.

Make Sense of the Problem uses a language routine to help students understand the problem. See the Integrating Mathematics and Language section on the Teacher Toolbox (under the Program Implementation tab) for tips on integrating language routines, teacher moves, and conversation tips during instruction.

LESSON 13 | SESSION 2

Develop Solving Systems of Linear Equations by Substitution

Purpose
- **Develop** strategies for solving a system of linear equations by substituting for one of the variables.
- **Recognize** how to use substitution efficiently to solve systems of linear equations.

START CONNECT TO PRIOR KNOWLEDGE

Which One Doesn't Belong?

A $y = 5$	B $x = 8$
C $y = 4x + 2$	D $2x + y = -1$

Possible Solutions

A is the only equation for a horizontal line.

B is the only equation for a vertical line.

C is the only equation written in $y = mx + b$ form where m is not 0.

D is the only equation for a line with a negative slope.

WHY? Support students' facility with connecting linear equations and their graphs.

DEVELOP ACADEMIC LANGUAGE

WHY? Support understanding of *solved for* in mathematical language.

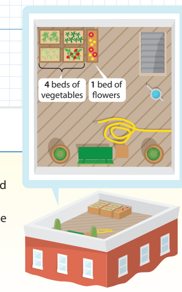
HOW? During Model It, display: *You can rewrite the second equation so both equations are solved for v.* Underline *solved for* and ask students what this phrase is asking them to do. Explain that *solving for* a variable means that you find the value of the variable. Have students share what other variable you could solve for in Model It.

TRY IT SMP 1, 2, 4, 5, 6

Make Sense of the Problem
See ***Connect to Culture*** to support student engagement. Before students work on Try It, use **Co-Craft Questions** to help them make sense of the problem. After the problem is read aloud, have students respond to: *What is the situation about?* Ask students to suggest questions that might be asked about the situation. Display students' questions. If time allows at the end of the session, choose one or two of the questions to answer.

LESSON 13 | SESSION 2

Develop Solving Systems of Linear Equations by Substitution



Read and try to solve the problem below.

The residents of a downtown apartment building are starting a rooftop garden. They will plant 4 beds of vegetables for every 1 bed of flowers, plus have 5 extra beds of vegetables. They plan to plant a total of 30 garden beds. In the system of equations shown, v is the number of vegetable beds and f is the number of flower beds.

$v = 4f + 5$

$v + f = 30$

How many vegetable beds and how many flower beds will be in the rooftop garden?

TRY IT **Math Toolkit** graph paper, straightedges

Possible work:

SAMPLE A

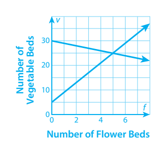
The lines seem to intersect at (5, 25).

Check both equations.

$25 = 4(5) + 5$ TRUE

$25 + 5 = 30$ TRUE

There will be 25 vegetable beds and 5 flower beds in the rooftop garden.



SAMPLE B

For every flower bed, there are 4 vegetable beds, plus there are an extra 5 vegetable beds.

1 flower bed: 4 veg. beds + 5 veg. beds ⟶ 10 garden beds

3 flower beds: 12 veg. beds + 5 veg. beds ⟶ 20 garden beds

5 flower beds: 20 veg. beds + 5 veg. beds ⟶ 30 garden beds

Check $v = 25$ and $f = 5$ make other equation true: $25 = 4(5) + 5$ TRUE

There will be 25 vegetable beds and 5 flower beds in the rooftop garden.

DISCUSS IT

Ask: How did you use the equations given in the problem?

Share: I began by . . .

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DISCUSS IT SMP 2, 3, 6

Support Partner Discussion
After students work on Try It, encourage them to respond to Discuss It with a partner. If students need support in getting started, prompt them to ask each other questions such as:
- *Did you graph the equations? How did this help you?*
- *What strategy did you use to find v and f values that worked in both equations?*

Error Alert If students solve the problem by graphing and get the wrong solution, then their graphs may be incorrect or inaccurate. You might suggest that students write both equations in slope-intercept form and use the values of m and b to make their graphs. Remind students that when they find a solution to a system using a graph, they should always check their solution in both original equations. Graphs can provide an estimate or a check on a solution but should not be the only method used.

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Support Partner Discussion provides teachers with prompts to help students engage in meaningful peer discourse.

Error Alert draws attention to frequently made errors in procedure or calculation and provides on-the-spot remediation.

Select and Sequence Student Strategies

Select 2–3 samples that represent the range of student thinking in your classroom. Here is one possible order for class discussion:

- bar models used to solve
- graph used to estimate the solution and guess-and-check used to refine
- logical reasoning and guess-and-check used to find solution
- substitution used to solve system

Facilitate Whole Class Discussion

Call on students to share selected strategies. Encourage students who share to explain how their approach is the same as a previous one, and how it is different.

Guide students to **Compare and Connect** the representations. If an explanation is unclear, ask students to rephrase what was said and confirm with the speaker.

ASK *How did the strategies ensure that the values of v and f are solutions to both equations?*

LISTEN FOR For the graph, (f, v) was on both lines. For guess-and-check, the values of v and f were chosen to satisfy the first equation, then they were checked to see if they satisfied the second. For the equations, one equation was used to find an expression to substitute into the other.

Model It

If students presented these models, have students connect these models to those presented in class.

If no student presented at least one of these models, have students first analyze key features of the models, and then connect them to the models presented in class.

ASK *How are the solutions in the Model Its similar?*

LISTEN FOR In both, one equation is used to find an expression equal to v and that expression is substituted for v in the other equation to get an equation that only has f.

For the bar model method, prompt students to connect the model to the algebraic steps.

- *How do the first two bar models show the equations in the system?*
- *How does the last model show the substitution?*

For the algebraic method, prompt students to discuss how substitution was used.

- *Why can the expressions be set equal to each other?*

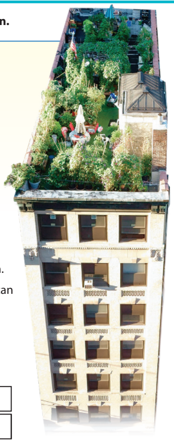
Explore different ways to solve a system of equations by substitution.

The residents of a downtown apartment building are starting a rooftop garden. They will plant 4 beds of vegetables for every 1 bed of flowers, plus have 5 extra beds of vegetables. They plan to plant a total of 30 garden beds. In the system of equations shown, v is the number of vegetable beds and f is the number of flower beds.

$v = 4f + 5$

$v + f = 30$

How many vegetable beds and how many flower beds will be in the rooftop garden?



Model It

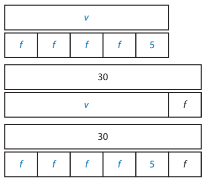
You can substitute an expression from one equation into the other equation.

Since $v = 4f + 5$, you can substitute $4f + 5$ for v in the other equation. You can also show this using bar models.

$v = 4f + 5$

$v + f = 30$

$v + f = 30 \longrightarrow 4f + 5 + f = 30$



Model It

You can rewrite the second equation so both equations are solved for v.

$v + f = 30 \longrightarrow v = -f + 30$

The system is now: $v = 4f + 5$

$v = -f + 30$

Set the two expressions for v equal to each other.

$4f + 5 = -f + 30$

DIFFERENTIATION | EXTEND

SMP 3

Deepen Understanding
Justifying Substitution Choices

Point out that the second Model It solves the *second* equation for v and then substitutes the resulting expression for v into the *first* equation.

ASK *What do you get if you substitute the expression for v back into the second equation instead? Why?*

LISTEN FOR You get $-f + 30 + f = 30$, which simplifies to $30 = 30$. This is a true statement, which just confirms that you wrote the equation correctly. If you substitute a true value of v in the original equation, you would expect a true statement.

ASK *Does this substitution help you find the solution to the system? Why?*

LISTEN FOR It does not help you find a solution because you are working with just one equation. You are not taking both equations of the system into account.

Select and Sequence Student Strategies gives a range of possible strategies—from concrete to representational to abstract—for use in monitoring student work and facilitating discourse. This information can be used to make decisions about which models and strategies, including misconceptions, to share and discuss as a class.

ASK/LISTEN FOR are mathematical discourse questions followed by expected student responses that support whole class discussion.

As students share their thinking, these discourse questions can be used to make connections between student approaches and different models and representations, prompt justifications and critiques of approaches and solutions, and check conceptual understanding.

SMPs are infused throughout the instructional model.

Deepen Understanding is a consistent opportunity to build understanding of a key lesson concept by extending mathematical discourse. The content connects a particular aspect of lesson learning to an SMP, showing how it might look in the classroom.

Teacher's Guide *continued*

Monitor and Confirm Understanding identifies important student understanding and supports teachers in ensuring that students have made sense of mathematical learning goals.

Facilitate Whole Class Discussion provides questions and facilitation moves that help teachers guide discussions that illuminate the mathematical ideas of the lesson. Connect It questions prompt students to make connections among representations or solutions and to articulate a generalization of the key mathematical concept in the lesson.

Hands-On Activities and **Visual Models** occur consistently at strategic points in the lesson after teachers have gauged students' understanding through observation and their work on questions in the Student Worktext. The activities support students who are unsure of the concept and provide an opportunity for small group reteaching while other students work independently. Use of concrete objects lets students access understanding in a different way. A suggestion for where in the lesson to implement this activity is indicated by a blue line. In this example, the recommended time is after discussing problem 3.

LESSON 13 | SESSION 2 ■ ■ □ □ □

Develop Solving Systems of Linear Equations by Substitution

CONNECT IT

SMP 2, 4, 5, 6

Remind students that the linear equations and the relationship between them are the same in each representation. Explain that they will now use the representations to understand how to use substitution to solve systems of linear equations.

Before students begin to record and expand on their work in Model It, tell them that problems 2 and 3 will prepare them to provide the explanation asked for in problem 4.

Monitor and Confirm Understanding 1 – 2

- $v = 4f + 5$ means that there are 4 vegetable beds for every flower bed, plus 5 more.
- $v + f = 30$ means that the total number of vegetable and flower beds together is 30.
- Since *v* and *f* each mean the same thing in both equations, one equation can be solved for *v* in terms of *f* and then that expression can be substituted for *v* in the other equation.
- Once the value of *f* is found, it can be substituted into either original equation to find *v*.
- There are 5 flower beds and 25 vegetable beds.

Facilitate Whole Class Discussion

3 Listen for understanding that you can choose to solve either equation for either variable, but that you must substitute the resulting expression into the other equation.

ASK *Why might you decide to avoid solving the equation $v = 4f + 5$ for f?*

LISTEN FOR First, this equation is already solved for *v*, so you can use it without calculating further. Second, since *f* has a coefficient of 4, the expression equivalent to *f* will involve division by 4. That will make the calculations more complicated.

4 Look for the idea that substitution will always work to solve a system of linear equations.

ASK *Why can you always solve one equation for one variable and substitute the expression for that variable into the other equation?*

LISTEN FOR The variables mean the same thing in both equations. So, when I rewrite one equation as a variable equal to an expression, I know that variable in the other equation is also equal to the expression.

5 **Reflect** Have all students focus on the strategies used to solve the Try It. If time allows, have students discuss their ideas with a partner.

CONNECT IT

➤ **Use the problem from the previous page to help you understand how to use substitution to solve a system of equations.**

1 Explain what $v = 4f + 5$ and $v + f = 30$ tell you about the situation.

$v = 4f + 5$: There are 4 vegetable beds for every flower bed plus 5 more.
$v + f = 30$: There are 30 garden beds altogether (vegetable and flower).

2 **a.** Look at both **Model Its**. You started with a system of two equations in two variables. In each case you end up with a single one-variable equation, $4f + 5 + f = 30$ and $4f + 5 = -f + 30$. How did this happen?

Possible answer: *v* and *f* mean the same thing in both equations. If one equation is written as *v* equal to an expression in *f*, I can replace *v* in the other equation (or bar model) with this equivalent expression. This combines both equations into one equation in one variable, *f*.

b. How many flower beds will there be in the garden? How many vegetable beds? Explain how you know.

5 flower beds; 25 vegetable beds; Possible explanation: I solved one of the one-variable equations for *f*. Then I substituted this value into one of the original equations and solved for *v*.

3 Solve $v + f = 30$ for *f*. Use this result to solve the system by substituting for *f*. Does it matter into which equation or for which variable you substitute when solving a system of equations? Explain.

$f = 30 - v$; $f = 5$, $v = 25$; No; Possible explanation: The solutions will be the same, but one choice may have fewer steps or simpler calculations.

4 Do you think using substitution will always work when solving a system of equations? Explain.

Possible answer: Yes. I can always solve one equation for one of the variables. I can then substitute that expression for the variable into the other equation without changing the value of either variable.

5 **Reflect** Think about all the models and strategies you have discussed today. Describe how one of them helped you better understand how to solve the **Try It** problem.

Responses will vary. Check student responses.

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DIFFERENTIATION | RETEACH or REINFORCE

Hands-On Activity

Use a model to understand substitution.

If students are unsure about how to solve a system of equations by substitution, then use this activity to help them gain a better understanding.

Materials For each pair: algebra tiles (at least 10 each of *x*- and *y*-tiles and 20 1-tiles)

- Display the system $y = 3 + x$ and $y + 3x = 11$. Have pairs model both equations using their algebra tiles. Ask: *Does either model show a variable tile alone on one side?* [Yes; The first model, $y = 3 + x$, has the *y*-tile alone on one side.]
- Ask: *How can you use the first model to find a group of tiles to substitute for y in the second model?* [You can replace the *y*-tile with an *x*-tile and three 1-tiles.] Have students perform the substitution. Point out that the new model has only one variable, *x*. Have students use the model to solve for *x*. [$x = 2$]
- Ask: *How can you now find y?* [I can substitute 2 for *x* in either original equation; $y = 5$.]
- If time allows, have students solve the first equation to find tiles equivalent to *x*, and to substitute those tiles in the second equation and solve the system again.

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Apply It

For all problems, encourage students to use a model to support their thinking. Allow some leeway in precision; for example, when graphing a system of linear equations in the coordinate plane, the lines likely will not be perfectly accurate. Remind students to check any solutions obtained by graphing by either substituting the solutions into both equations or by using another solution method.

6 You might ask students to suggest another possible way to start solving the system. Some students may want to complete the solution process. The solution is $\left(2\frac{3}{10}, -\frac{17}{20}\right)$.

7 Students may solve for f in terms of t and write $f = -t + 7$. They would then use substitution to obtain $6t + 3(-t + 7) = 27$. Here is a sample solution of this equation:

$$\begin{aligned} 6t + 3(-t + 7) &= 27 \\ 6t - 3t + 21 &= 27 \\ 3t + 21 &= 27 \\ 3t &= 6 \\ t &= 2 \end{aligned}$$

The value of $t = 2$ can be substituted into either original equation to find $f = 5$.

Apply It

➤ **Use what you learned to solve these problems.**

6 Tara begins solving the system below. What do you think her next step will be?

$$\begin{aligned} 6x + 8y &= 7 \\ -2x + 4y &= -8 \longrightarrow -2x = -4y - 8 \\ & \qquad\qquad\quad x = 2y + 4 \end{aligned}$$

Possible answer: Substitute $2y + 4$ for x in $6x + 8y = 7$ and solve for y.

7 A football team scores 7 times and earns 27 points. All their points come from 6-point touchdowns and 3-point field goals.

Let t be the number of touchdowns and f be the number of field goals. The equation $t + f = 7$ represents the number of times the team scores. The equation $6t + 3f = 27$ represents the total number of points scored. How many touchdowns and how many field goals does the team make? Show your work.

Possible work:

$$\begin{aligned} t + f &= 7 \\ t &= -f + 7 \end{aligned} \qquad \begin{aligned} 6(-f + 7) + 3f &= 27 \\ -6f + 42 + 3f &= 27 \\ -3f &= -15 \\ f &= 5 \end{aligned} \qquad \begin{aligned} t + f &= 7 \\ t + 5 &= 7 \\ t &= 2 \end{aligned}$$

SOLUTION The team makes 2 touchdowns and 5 field goals.

8 Solve this system of equations. Show your work.

$$\begin{aligned} 3x &= 6y - 21 \\ 6x - 9y &= -30 \end{aligned}$$

Possible work:

$3x = 6y - 21 \longrightarrow x = 2y - 7$

$$\begin{aligned} 6(2y - 7) - 9y &= -30 \\ 12y - 42 - 9y &= -30 \\ 3y &= 12 \\ y &= 4 \end{aligned} \qquad \begin{aligned} 6x - 9y &= -30 \\ 6x - 9(4) &= -30 \\ 6x - 36 &= -30 \\ 6x &= 6 \\ x &= 1 \end{aligned}$$

SOLUTION (1, 4)

CLOSE EXIT TICKET

8 Students' solutions should show an understanding of:

- how to use substitution to solve a system of linear equations.
- the idea that once the value of one variable is found, it can be substituted into either original equation to find the value of the other variable.

Common Misconception If students only find the value of one of the variables, ask them to tell you what their answer means. Help students conclude that one value is not the complete answer; the solution to a system of equations is an ordered pair. Then ask them how they can find the value of the other variable.

Apply It explanations include alternate approaches to solving the problem.

CLOSE: EXIT TICKET is a quick formative assessment of each day's learning and serves as an indicator of students' progress toward mastery or partial mastery of the learning goal of the session.

Common Misconception identifies misconceptions that can be addressed in whole class discussion as students are prompted to explain their reasoning.

Teacher's Guide *continued*

Additional Practice can be used as in-class small group work, after-class work, or at-home learning.

Problem Notes provide insights into alternate solution strategies and student understandings. Problems are labeled as *Basic*, *Medium*, and *Challenge* to support independent practice that can be differentiated as needed.

Fluency & Skills Practice provides ongoing opportunities for students to accurately, flexibly, and efficiently practice mathematical procedures and operations. This can be used as in-class small group work, after-class work, or at-home learning. Student pages are available on the Teacher Toolbox.

LESSON 13 | SESSION 2 ■ ■ □ □ □

Practice Solving Systems of Linear Equations by Substitution

Problem Notes

Assign **Practice Solving Systems of Linear Equations by Substitution** as extra practice in class or as homework.

1. Students may also describe solving $2y = -2 - 5x$ for y since the term with the variable y is isolated. If they do so, they will get $y = -1 - \frac{5}{2}x$. They can then substitute $-1 - \frac{5}{2}x$ for y into the first equation to get $x + \left(-1 - \frac{5}{2}x\right) = 1$ and solve for x. ***Challenge***

2. Because the first equation has s isolated on one side, it is efficient to substitute $t + 5$ for s in the second equation. However, students may use another method. For example, they may use the first equation to write $t = s - 5$, and then substitute $s - 5$ for t in the second equation. ***Medium***

LESSON 13 | SESSION 2 Name:

Practice Solving Systems of Linear Equations by Substitution

➤ **Study the Example showing how to solve a system of equations by substitution. Then solve problems 1–3.**

Example

What is the solution to the system of equations?

$x + y = 1$

$2y = -2 - 5x$

Solve the first equation for x. Then substitute the expression into the second equation.

$x + y = 1$	$2y = -2 - 5(-y + 1)$	$x + y = 1$
$x = -y + 1$	$2y = -2 + 5y - 5$	$x + \frac{7}{3} = 1$
	$7 = 3y$	$x = -\frac{4}{3}$
	$\frac{7}{3} = y$	

1. Describe a different way to use substitution to solve the problem in the Example.
   Possible answer: Solve the first equation for y to get $y = -x + 1$. Then substitute $-x + 1$ into the second equation to get $-2x + 2 = -2 - 5x$ and solve for x.

2. Antonio is a set designer. He is gluing ribbon on 4 square and 2 triangular posters to be used as stage props in an upcoming play. Use the system of equations to find s, the amount of ribbon needed for a square poster, and t, the amount of ribbon needed for a triangular poster. Show your work.

   $s = t + 5$

   $4s + 2t = 110$

   Possible work:

   $4(t + 5) + 2t = 110$ $\quad s = t + 5$
   $4t + 20 + 2t = 110$ $\quad s = 15 + 5$
   $6t = 90$ $\quad s = 20$
   $t = 15$

   SOLUTION 20 in. for a square poster and 15 in. for a triangular poster

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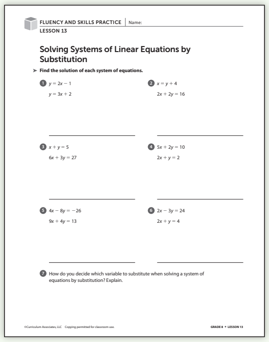
Fluency & Skills Practice

Solving Systems of Linear Equations by Substitution

In this activity, students solve systems of linear equations using substitution.



Additional Practice

3 **a.** The solution on the student page is efficient, but there are other possibilities as well. For example, students may solve the second equation for x and substitute the resulting expression into the first equation. ***Medium***

b. Students might see that they can isolate the expression $3x$ on one side of each equation, to get $3x = 11 + 4y$ and $3x = 2 - 2y$. They can then set the right sides of these two equations equal, writing $11 + 4y = 2 - 2y$. ***Challenge***

c. Students should note the second equation gives x in terms of y. They can immediately use substitution to solve. ***Basic***

LESSON 13 | SESSION 2

3 What is the solution of each system of equations? Show your work.

a. $-6x - 5y = 6$

$4x + y = 3$

Possible work:

$$4x + y = 3 \qquad y = -4x + 3$$

$$-6x - 5y = 6$$
$$-6x - 5(-4x + 3) = 6$$
$$-6x + 20x - 15 = 6$$
$$14x = 21$$
$$x = \frac{3}{2}$$

$$4x + y = 3$$
$$4\left(\frac{3}{2}\right) + y = 3$$
$$6 + y = 3$$
$$y = -3$$

SOLUTION $\left(1\frac{1}{2}, -3\right)$

b. $3x - 4y = 11$

$3x + 2y = 2$

Possible work:

$$3x + 2y = 2$$
$$2y = -3x + 2$$
$$y = -\frac{3}{2}x + 1$$

$$3x - 4\left(-\frac{3}{2}x + 1\right) = 11$$
$$3x + 6x - 4 = 11$$
$$9x - 4 = 11$$
$$9x = 15$$
$$x = \frac{5}{3}$$

$$3\left(\frac{5}{3}\right) + 2y = 2$$
$$5 + 2y = 2$$
$$2y = -3$$
$$y = -\frac{3}{2}$$

SOLUTION $\left(\frac{5}{3}, -\frac{3}{2}\right)$

c. $8x + 9y = 20$

$x = -3y$

Possible work:

$$8x + 9y = 20$$
$$8(-3y) + 9y = 20$$
$$-24y + 9y = 20$$
$$-15y = 20$$
$$y = -\frac{4}{3}$$

$$x = -3y$$
$$x = -3\left(-\frac{4}{3}\right)$$
$$x = 4$$

SOLUTION $\left(4, -\frac{4}{3}\right)$

DIFFERENTIATION | ENGLISH LANGUAGE LEARNERS

Use with **Session 3** **Model It**

MATH TERMS

A *variable* is a letter that stands for an unknown number.

Like terms are terms that have the same variable or no variable.

Opposite numbers are the same distance from 0 on the number line but in opposite directions.

Levels 1–3: Reading/Speaking

Help students understand Model It by reading it aloud. Explain that both Model Its use a process called *elimination* and that elimination is a way to remove a variable term. Clarify by erasing something. Reread the first Model It and display *Elimination gives you a ____ for ____* and have students complete it. Then reread the second Model It and do the same. Review the Math Terms. Have pairs read the two solutions together and point out examples of the Math Terms. Then have pairs describe a solution using *eliminate* and *elimination*.

Levels 2–4: Speaking/Listening

Help students understand Model It by having partners take turns reading aloud each problem. Modify **Say It Another Way** by having students discuss words and phrases before rephrasing. Display the Math Terms and ask students for examples. Help them connect *eliminate* with *elimination*. Guide students to explain that the word *opposites* refers to terms with opposite numbers as the coefficient.

Guide students to underline words that signal a sequence (*first, then*) or a result (*so*). Have partners share the words they underlined with each other.

Levels 3–5: Speaking/Listening

Help students understand Model It by having them discuss how the lesson vocabulary and Math Terms relate to the problem. Ask students to explain the mathematical meaning of *opposites*.

Point out that sentences often include signal words to help readers identify the cause, sequence, or results of something, for example, *because, first, next, then, finally, so,* and *as a result*. Ask students to discuss the meaning of signal words in Model It.

Have partners take turns rephrasing each Model It, being careful to express the sequence or results with these signal words or others.

DIFFERENTIATION | ENGLISH LANGUAGE LEARNERS suggests ways teachers can scaffold or amplify language in the next session so English Learners can access and engage with grade-level mathematics.