Lesson 16

Solving Problems with Systems of Equations

Goals

- Calculate the solution to a system of equations in context, and present (using words and other representations) the solution method.
- Create a system of equations to solve a problem in context.
- Critique (orally) peer solutions to a system of equations.

Learning Target

I can use a system of equations to represent a real-world situation and answer questions about the situation.

Lesson Narrative

In this lesson students work in groups as they apply what they have learned to solve three problems with different structures and create a new problem similar in structure to one of the systems they solved. Groups trade problems, prepare well-explained solutions, and take turns sharing their solutions with the class. While groups share, ask other students to interpret particular aspects of the presentation, such as the slope of a graph, the coefficient of a variable, or the solution to a system, in terms of the context of the problem.

Student Learning Goal

Let's solve some gnarly problems.

Lesson Timeline

5 min	35 min
Warm-up	Activity 1

Access for Students with Diverse Abilities

- Representation (Activity 1)

Access for Multilingual Learners

- MLR8: Discussion Supports (Activity 1)

Instructional Routines

- MLR8: Discussion Supports

Required Materials

Materials to Gather

- Tools for creating a visual display: Activity 1

Required Preparation

Lesson:
Provide each group of 2 with the tools for making a visual display.

Inspire Math

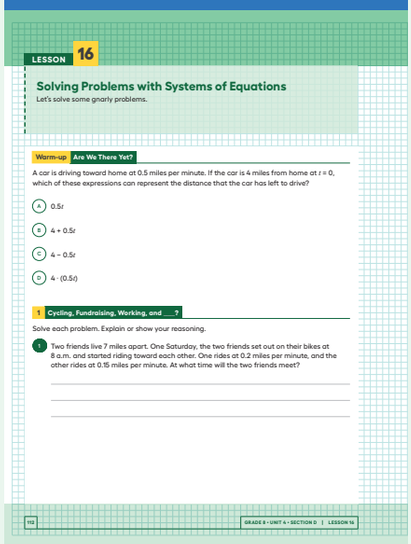
Supply and Demand video

Go Online
Before the lesson, show this video to review the real-world connection.

ilclass.com/l/614236

Please log in to the site before using the QR code or URL.

Student Workbook



LESSON 16

Solving Problems with Systems of Equations

Let's solve some gnarly problems.

Warm-up Are We There Yet?

A car is driving toward home at 0.5 miles per minute. If the car is 4 miles from home at $t = 0$, which of these expressions can represent the distance that the car has left to drive?

A. $0.5t$

B. $4 + 0.5t$

C. $4 - 0.5t$

D. $4 \cdot (0.5t)$

1 Cycling, Fundraising, Working, and ___?

Solve each problem. Explain or show your reasoning.

1. Two friends live 7 miles apart. One Saturday, the two friends set out on their bikes at 8 a.m. and started riding toward each other. One rides at 0.2 miles per minute, and the other rides at 0.15 miles per minute. At what time will the two friends meet?

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Warm-up

Are We There Yet?

5 min

Activity Narrative

The purpose of this *Warm-up* is to get students to reason about representing a context about distance as an expression. For students who use the equation $d = rt$ to choose their answer, encourage them to explain how each part of the expression matches the context.

Launch

Give students 2 minutes of quiet work time, and follow that with a whole-class discussion.

Student Task Statement

A car is driving toward home at 0.5 miles per minute. If the car is 4 miles from home at $t = 0$, which of these expressions can represent the distance that the car has left to drive?

A. $0.5t$

B. $4 + 0.5t$

C. $4 - 0.5t$

D. $4 \cdot (0.5t)$

$4 - 0.5t$ represents the distance the car has left to drive toward home. Because $0.5t$ represents the distance traveled toward home, subtracting that from the 4 miles the car is from home will give us the distance left to drive.

Activity Synthesis

Invite students to share their selections and to explain their reasoning. After each explanation ask the rest of the class if they agree or disagree and how the context is represented in the expression.

Activity 1

Cycling, Fundraising, Working, and ___?

35 min

Activity Narrative

In this activity, students reason about situations involving two different relationships between the same two quantities. Then they invent their own problem of the same type. Although students are encouraged by the language of the activity to use a system of equations to solve the problems, they may elect to use a different representation to explain their thinking.

As students work through the first three problems, notice the ways in which students reason about the problems with and without systems of equations. Identify some groups with particularly compelling or clear reasoning, and ask them to share later.

Launch

Arrange students in groups of 2. Provide tools for creating a visual display.

After students have completed the first three problems, select previously identified groups to share their solutions. Bring out why these solutions are particularly good (for example, greater clarity or efficiency), and discuss the connections between them, particularly the connections between groups that did and did not use systems of equations where possible. Next, have students begin the second part of the activity, in which they write their own problem to trade with another group.

Student Task Statement

Solve each problem. Explain or show your reasoning.

1. Two friends live 7 miles apart. One Saturday, the two friends set out on their bikes at 8 a.m. and started riding toward each other. One rides at 0.2 miles per minute, and the other rides at 0.15 miles per minute. At what time will the two friends meet?

   The friends will meet at 8:20 a.m.

   Sample reasoning: $\begin{cases} y = 0.2x \\ y = -0.15x + 7 \end{cases}$

2. Students are selling school spirit gear for a fundraiser. Bracelets with the school mascot on them cost $1 each, and shirts with the school crest cost $10 each. They sold 100 items and made $307. How many bracelets did they sell?

   They sold 77 bracelets.

   Sample reasoning: $\begin{cases} x + 10y = 307 \\ x + y = 100 \end{cases}$

3. Jada earns $7 per hour mowing her neighbors' lawns. Andre gets paid $5 per hour for the first hour of babysitting and $8 per hour for any additional hours he babysits. What is the number of hours they both can work so that they get paid the same amount?

   Jada and Andre will both earn 21 dollars for working 3 hours.

   Sample reasoning: $\begin{cases} y = 7x \\ y = 5 + 8(x - 1) \end{cases}$

Instructional Routines

MLR8: Discussion Supports

ilclass.com/r/10695617

Please log in to the site before using the QR code or URL.

Access for Students with Diverse Abilities (Activity 1, Launch)

Representation: Access for Perception.
Provide appropriate reading accommodations and supports to ensure student access to written directions, word problems, and other text-based content.
Supports accessibility for: Language

Access for Multilingual Learners (Activity 1, Launch)

MLR8: Discussion Supports.
During group presentations, invite the student(s) who are not speaking to follow along and point to the corresponding parts of the display.
Advances: Speaking, Representing

Building on Student Thinking

If students struggle to write a system of equations, ask them to identify any unknown quantities in the problem and assign variables to them. Then ask them if there are ways to describe the relationships between the variables. If students still struggle to think about the relationships, ask them about some possible values for each of the variables, including some that make sense (such as 20 grapefruits) and some that do not (such as 1,000 grapefruits). To help students understand the relationships between variables, have them explain why some values are not possible.

Student Workbook


1 Cycling, Fundraising, Working, and ?

2 Students are selling school spirit gear for a fundraiser. Bracelets with the school mascot on them cost $1 each, and shirts with the school crest cost $10 each. They sold 100 items and made $307. How many bracelets did they sell?

3 Jada earns $7 per hour mowing her neighbors' lawns. Andre gets paid $5 per hour for the first hour of babysitting and $8 per hour for any additional hours he babysits. What is the number of hours they both can work so that they get paid the same amount?

4 Pause here so your teacher can review your work. Then, invent another problem that is like one of these, but with different numbers. Solve your problem.

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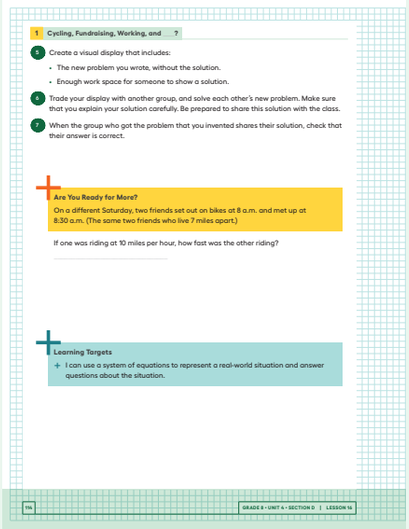
Student Workbook


1 Cycling, Fundraising, Working, and ?

5 Create a visual display that includes:
- The new problem you wrote, without the solution.
- Enough work space for someone to show a solution.

6 Trade your display with another group, and solve each other's new problem. Make sure that you explain your solution carefully. Be prepared to share this solution with the class.

7 When the group who got the problem that you invented shares their solution, check that their answer is correct.

Are You Ready for More?

On a different Saturday, two friends set out on bikes at 8 a.m. and met up at 8:30 a.m. (The same two friends who live 7 miles apart.)

If one was riding at 10 miles per hour, how fast was the other riding?

Learning Targets

+ I can use a system of equations to represent a real-world situation and answer questions about the situation.

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4. Pause here so your teacher can review your work. Then, invent another problem that is like one of these, but with different numbers. Solve your problem.

Answers vary.

5. Create a visual display that includes:

- The new problem you wrote, without the solution.
- Enough work space for someone to show a solution.

Answers vary.

6. Trade your display with another group, and solve each other's new problem. Make sure that you explain your solution carefully. Be prepared to share this solution with the class.

Answers vary.

7. When the group who got the problem that you invented shares their solution, check that their answer is correct.

Answers vary.

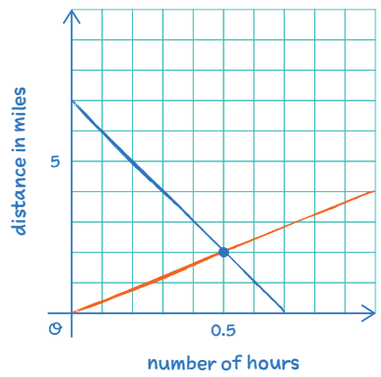
Are You Ready for More?

On a different Saturday, two friends set out on bikes at 8 a.m. and met up at 8:30 a.m. (The same two friends who live 7 miles apart.) If one was riding at 10 miles per hour, how fast was the other riding?

The other friend is riding 4 miles per hour.

Sample reasoning: 10 miles an hour is equivalent to 5 miles in a half hour. The first friend will be at mile 2 in a half hour because $2 = -10(0.5) + 7$. The second friend will arrive at mile 2 in a half hour which is equivalent to 4 miles an hour. This situation can be represented by the system:

$$\begin{cases} y = -10x + 7 \\ y = 4x \end{cases}$$



Activity Synthesis

Most of the discussions happen within and between groups, but the last question requires a whole-class discussion. Have each group share the peer-generated question that they were assigned and its solution. Although the group that wrote the question will be responsible for confirming the answer, encourage all students to listen to the reasoning that each group used.

Alternatively, after groups have checked the work of the group that solved their problem, have students complete a gallery walk to see all the created problems. Ask students to look for situations similar to theirs and to identify the most common solution methods used. After the gallery walk, select a few groups to share a problem and how they solved it.