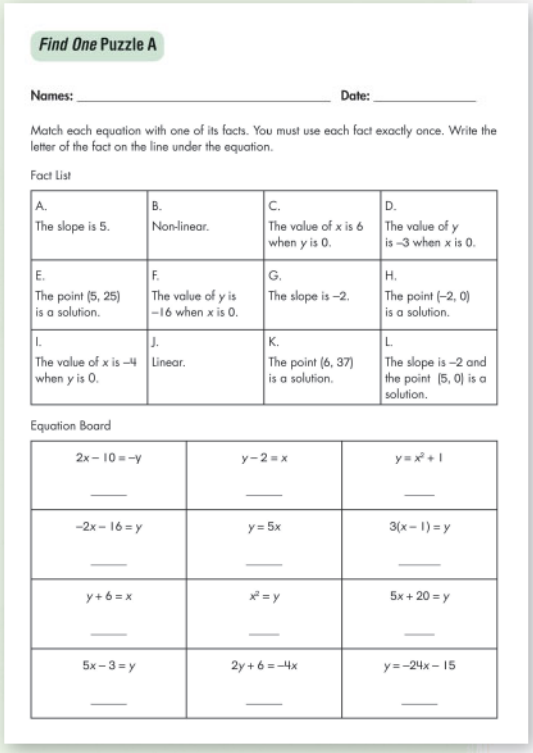
Extension

Create linear equations which, when graphed, create a square (or another predetermined two-dimensional shape) on the coordinate grid.

Find One

Why This Game or Puzzle?

As eighth graders study linear functions, they learn to identify slopes and other important features on a graph, such as when an *x*- or *y*-value is zero. They also need to apply what they have learned about equations to transform them into the more familiar slope-intercept form. In this puzzle, students are given a variety of facts, such as: *The value of y is –3 when x is 0*, *The slope is 5*, or *Non linear*. Students must match each of the facts with exactly one equation. Though the puzzle primarily provides practice with aspects of linear functions, it also requires the puzzler to reason deductively and narrow the decision space – that is, decide which facts can be immediately eliminated or identified for consideration. This problem-solving strategy, identified by George Polya in his seminal book on problem solving, *How to Solve It* (1957), is still relevant today.



Find One Puzzle A

Names: _____ Date: _____

Match each equation with one of its facts. You must use each fact exactly once. Write the letter of the fact on the line under the equation.

Fact List

A. The slope is 5.	B. Non-linear.	C. The value of x is 6 when y is 0.	D. The value of y is –3 when x is 0.
E. The point (5, 25) is a solution.	F. The value of y is –16 when x is 0.	G. The slope is –2.	H. The point (–2, 0) is a solution.
I. The value of x is –4 when y is 0.	J. Linear.	K. The point (6, 37) is a solution.	L. The slope is –2 and the point (5, 0) is a solution.

Equation Board

$2x - 10 = -y$ _____	$y - 2 = x$ _____	$y = x^2 + 1$ _____
$-2x - 16 = y$ _____	$y = 5x$ _____	$3(x - 1) = y$ _____
$y + 6 = x$ _____	$x^2 = y$ _____	$5x + 20 = y$ _____
$5x - 3 = y$ _____	$2y + 6 = -4x$ _____	$y = -24x - 15$ _____

Two puzzles are provided. The equations in Puzzle A are less complex, and Puzzle B includes references to *y*-intercepts.

Math Focus

- Determining if a given point is a solution to an equation
- Interpreting the slope-intercept form of an equation
- Identifying equations of functions as linear or non linear

Materials Needed

- 1 *Find One* Puzzle A or B per pair (pages A-120 or A-121)
- Optional: 1 *Find One* Directions per group (page A-119)

Directions

Goal: Use components of a linear equation to match it with exactly one fact.

- Each fact in the list matches one or more of the equations on the equation board.
- Write the letter corresponding to each fact on a blank beneath one of its matching equations on the board.
- Write the facts so that each equation gets one and only one match.
- Be sure to check your work.

How It Looks in the Classroom

Discussing the "do now" task on the board (Figure 8.9) allows this eighth-grade class to focus on the math involved in the puzzle they will be working on in groups during today's lesson.

Given: The linear equation: $y = 3x - 5$
True or false:

- The slope of the line is $\frac{1}{3}$.
- The point (3, 4) is a solution to the equation.
- The line crosses the y-axis above the x-axis.
- The graph of the line shows a decreasing rate.
- The y-value is 5 when $x = 0$.

Figure 8.9 "Do now" task

The teacher asks the students to first think independently and to then discuss their answers with their groups. Each group is then assigned a statement from the given list and asked to present to the class why it chose true or false. Rafi's group has not yet reached an agreement about its answer to the last statement, so the group decides to present its dilemma to the class. He explains, "Most of us think that the answer is true, but Alexia thinks that it's false. We think that it's true because there is a 5 on the end of the equation. Alexia says that it's a negative 5. We're not sure how to figure out which is right." As students offer their suggestions for how to reach a solution, Joshua points out that there is another way to find the answer. "We looked more at the $x = 0$ statement. We substituted 0 for x and solved for y, and found that $y = -5$. So we think that statement is false." Rafi remarks that he now agrees with Alexia's answer and likes the strategy that Joshua had to offer.

The teacher asks the students to consider each of the true/false statements again, this time finding a different way than they found before to explain why they think a statement is true or false. The connection between their work in the introductory activity and in the *Find One* puzzle will become more apparent to the students as they work on the puzzle in their small groups.

Tips from the Classroom

- In our field testing, most students began by making random choices and then realized that their choices were not going to allow them to match each fact with exactly one equation. As

they persevered, they began to make lists or to recognize facts with fewer matching equations (such as *Non linear*).

- A few students became impatient with the number of times they had to erase. It helped them to list all the choices for each equation and then cross out their initial choices as appropriate. Others preferred to cut apart the facts and move them around as they made choices.

What to Look For

- What problem-solving strategies do students use? Do they make lists? Do they use guess and check or elimination strategies?
- Do students immediately recognize the two non linear equations in Puzzle A? What other ways are puzzlers finding to be efficient?
- What partial understandings do you observe? For example, in Puzzle B, do students understand that if the *y*-variables have coefficients other than 1, they'll need to do some computation before identifying the slope?
- What strategies or conversations do you want shared with the class when you debrief?

Variations

- This puzzle could also be a game. Cut apart the facts to use as cards. To play the game, students deal all the cards, and on each turn, a team places a fact on one of the equations on the shared equation board. Only one card may be placed on each equation. Teams alternate turns. The game ends when a player cannot place a card. The team with the fewest cards left in its hand wins.
- You can replace the *y*-intercept language in Puzzle B with *The value of y is… when x is 0*. Or, you could incorporate the *x*-intercept to replace facts that read *The value of x is … when y is 0*.

Exit Card Choices

- Create a set of two coordinate points that could be used to make a line with a slope of 4. Explain your reasoning.
- Which clue was the most helpful to you in the beginning? Why? Which clue was the least helpful to you in the beginning? Why?

Some students only identified the clues without explaining why they were or were not helpful. The student work shown in Figure 8.10 provides a concise response that addresses both questions.

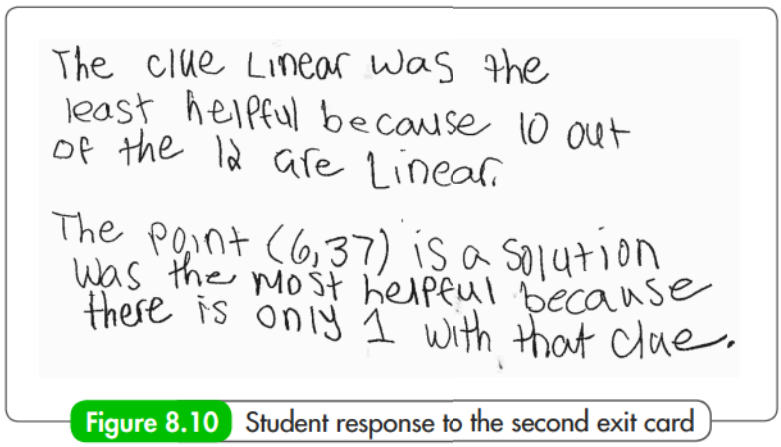


Figure 8.10 Student response to the second exit card

Extension

Give each student group a fact card from one of the puzzles and post the equations around the classroom. Have each student group write their names next to any equation that the fact card matches. Show students a list of all the facts from the puzzle and have them try to identify, based on where names are written, who had which fact.

Find One Directions

Materials Needed

- 1 *Find One* Puzzle A or B per pair (pages A-120 or A-121)
- Optional: 1 *Find One* Directions per group

Directions

Goal: Use components of a linear equation to match it with exactly one fact.

- Each fact in the list matches one or more of the equations on the equation board.
- Write the letter corresponding to each fact on a blank beneath one of its matching equations on the board.
- Write the facts so that each equation gets one and only one match.
- Be sure to check your work.

Find One Puzzle A

Names: _____ **Date:** _____

Match each equation with one of its facts. You must use each fact exactly once. Write the letter of the fact on the line under the equation.

Fact List

A. The slope is 5.	B. Non linear.	C. The value of x is 6 when y is 0.	D. The value of y is –3 when x is 0.
E. The point (5, 25) is a solution.	F. The value of y is –16 when x is 0.	G. The slope is –2.	H. The point (–2, 0) is a solution.
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Equation Board

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$-2x - 16 = y$ _____	$y = 5x$ _____	$3(x - 1) = y$ _____
$y + 6 = x$ _____	$x^2 = y$ _____	$5x + 20 = y$ _____
$5x - 3 = y$ _____	$2y + 6 = -4x$ _____	$y = -24x - 15$ _____

Find One Puzzle B

Names: _____ **Date:** _____

Match each linear equation with one of its facts. You must use each fact exactly once. Write the letter of the fact on the line under the equation.

Fact List

A. The point (2, 6) is a solution.	B. The value of x is 3 when y is 0.	C. The slope is 3.	D. The y-intercept is 0.
E. The slope is negative.	F. The points (8, –33) and (2, –3) are solutions.	G. The y-intercept is 1.	H. The value of x is $-\frac{4}{3}$ when y is 0.
I. The y-intercept is 12.	J. The slope is $\frac{3}{2}$.	K. The value of y is $\frac{7}{2}$ when x is 0.	L. The point (7, 34) is a solution.

Equation Board

$3x + 1 = y$ _____	$3x - 2y = 0$ _____	$y = \frac{3}{4x} + 1$ _____
$x = \frac{-y}{15} + 2$ _____	$y = 3x$ _____	$-(5x - y) = -1$ _____
$\frac{-y}{4} + 3 = x$ _____	$2y + 3x = 0$ _____	$-3x + 12 = y$ _____
$-5x + 7 = y$ _____	$x = \frac{(2y - 7)}{3}$ _____	$y = \frac{4}{3x} + 12$ _____