

**S**trategies  
**T**o  
**A**chieve  
**M**athematics  
**S**uccess

Name \_\_\_\_\_



# TABLE OF CONTENTS

## Expressions and Equations

<b>Lesson 1</b>	Exponents . . . . .	4
<b>Lesson 2</b>	Square Roots . . . . .	14
<b>Lesson 3</b>	Solve Two-Step Equations . . . . .	24
<b>Lesson 4</b>	Two-Step Equations with Rational Numbers . . . . .	34
<b>Lesson 5</b>	Linear and Nonlinear Equations . . . . .	44
<b>Lesson 6</b>	Slope . . . . .	54
<b>Lesson 7</b>	Graph Linear Equations . . . . .	64
<b>Lesson 8</b>	Solve Systems Graphically . . . . .	74
<b>Lesson 9</b>	Solve Systems Algebraically . . . . .	84

## Plane Geometry

<b>Lesson 10</b>	Special Pairs of Angles . . . . .	94
<b>Lesson 11</b>	Angle Sums . . . . .	104
<b>Lesson 12</b>	Triangle Similarity . . . . .	114

## Linear Measurement and Area

<b>Lesson 13</b>	Pythagorean Theorem . . . . .	124
<b>Lesson 14</b>	Distance Formula . . . . .	134

## Statistics

<b>Lesson 15</b>	Mean, Median, Range . . . . .	144
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## Graphs

<b>Lesson 16</b>	Scatter Plots . . . . .	154
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# Lesson 8 SOLVE SYSTEMS GRAPHICALLY

## PART ONE: Learn About Systems of Equations



How can you find the solution of a system of equations from a graph?

### Explore

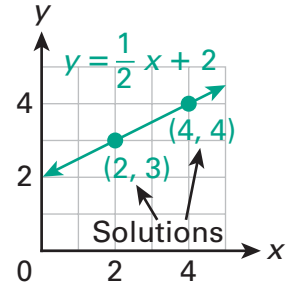
The graph of a **linear equation** is a line formed by the **ordered pairs**  $(x, y)$  that are **solutions of the equation**.

$$(2, 3): 3 = \frac{1}{2}(2) + 2 \quad (4, 4): 4 = \frac{1}{2}(4) + 2$$

$$3 = 1 + 2 \quad 4 = 2 + 2$$

A **system of linear equations** is a set of two or more linear equations.

How can you use a graph to find the solution of a system of equations?



### Think

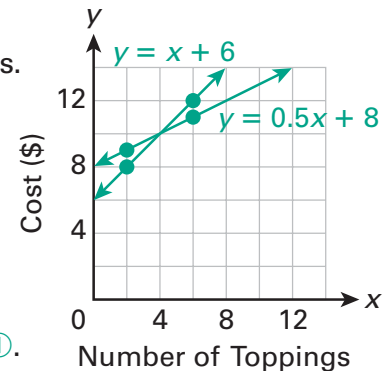
This system shows the costs of a pizza at two pizza shops;  $y$  = cost in dollars and  $x$  = number of toppings.

- ①  $y = x + 6$
- ②  $y = 0.5x + 8$

Graph both equations by plotting points. Choose values for  $x$ , and then use the equation to find the corresponding  $y$ -values.

$(2, \underline{8})$  and  $(6, \underline{12})$  are solutions of equation ①.

$(2, \underline{9})$  and  $(6, \underline{11})$  are solutions of equation ②.

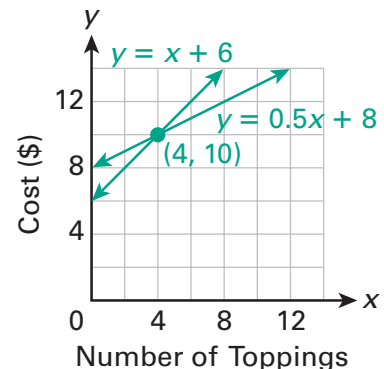


### Connect

The solution of a system is an ordered pair  $(x, y)$  that is a solution of each equation. To find the solution using a graph, find the point where the lines **intersect**, or meet.

The solution of the system is  $(4, 10)$ .

So, a pizza with 4 toppings costs \$10 at both pizza shops.



### Let's Talk

How could you use the graph to decide which pizza shop to choose?



## Think It Through

Fill in the blanks as you solve the problem.

One gym charges a \$60 initiation fee, plus \$20 per month. Another gym charges \$40 per month with no initiation fee. This system shows the membership fees at the two gyms, where  $x$  represents the number of months and  $y$  represents the cost in dollars.

①  $y = 20x + 60$

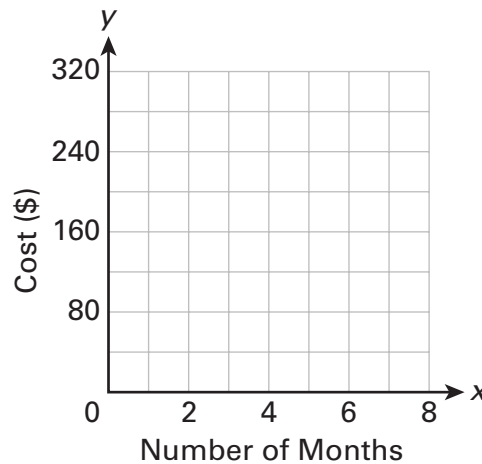
②  $y = 40x$

For how many months of membership is the cost the same at both gyms? What is the cost?

- Graph both lines by plotting points. Use the equation to find the  $y$ -value for each given value of  $x$ .

(2, \_\_\_\_\_) and (6, \_\_\_\_\_) are solutions of equation ①.

(2, \_\_\_\_\_) and (6, \_\_\_\_\_) are solutions of equation ②.



- Find the point where the lines intersect. The solution of the system is (\_\_\_\_\_, \_\_\_\_\_).

**Solution:** A \_\_\_\_\_-month membership costs \_\_\_\_\_ at both gyms.

Check your solution by substituting the coordinates of the point of intersection into each equation. If both equations are true, then the solution is correct.



## Your Turn

Now, use what you know to solve this problem.

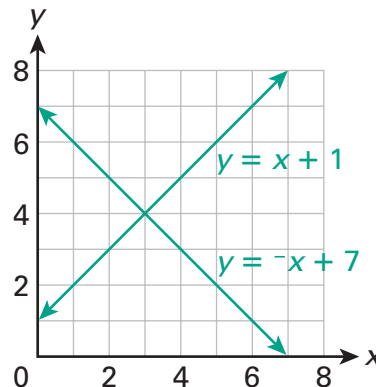
- What is the solution of the system of equations shown in the graph?

Solution of system:  
(\_\_\_\_\_, \_\_\_\_\_)

How do you know?

\_\_\_\_\_  
\_\_\_\_\_

Check your solution.





**How can you tell from a graph that a linear system has no solution?**

**Explore**

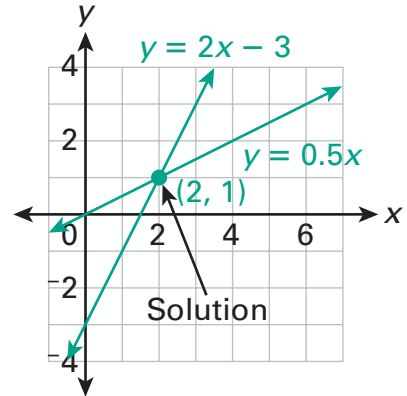
A solution of a linear system of equations is an ordered pair that is a solution of each equation.

$$y = 2x - 3 \quad y = 0.5x$$

$$1 = 2(2) - 3 \quad 1 = 0.5(2)$$

$$1 = 1 \quad \checkmark \quad 1 = 1 \quad \checkmark$$

The point (2, 1) satisfies both equations.



When the graphs of two linear equations intersect at a point, the system has exactly one solution.

Is it possible for a linear system to have no solution?

**Think**

This system of equations represents two friends making bracelets. The number of months is  $x$ , and the number of bracelets is  $y$ .

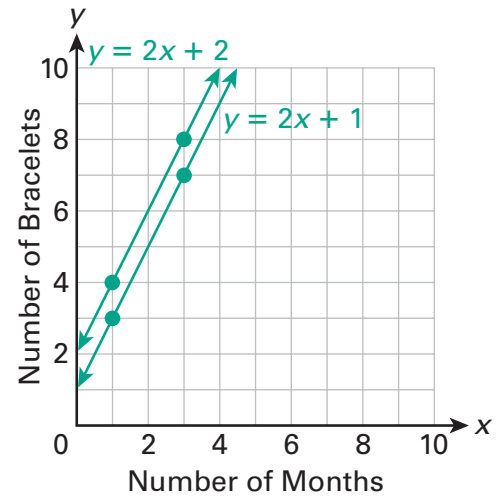
- ①  $y = 2x + 1$
- ②  $y = 2x + 2$

Try to solve the system. Will the friends ever have the same number of bracelets?

Graph both equations by plotting points.

(1, 3) and (3, 7) are solutions of equation ①.

(1, 4) and (3, 8) are solutions of equation ②.



**Connect**

These lines are **parallel**. They do not intersect.

So, this system has no solution.

The two friends will never have the same number of bracelets.

**Let's Talk**

Both of equations ① and ② contain  $2x$ . What does this mean in the context of this problem?





**Fill in the blanks as you solve the problem.**

Isabel has \$20. Caroline has \$15. Each girl is saving \$10 every month. This system shows the savings of each girl, where  $x$  represents the number of months and  $y$  is the amount of savings.

①  $y = 10x + 20$   
 ②  $y = 10x + 15$

After how many months will they have the same amount of money?

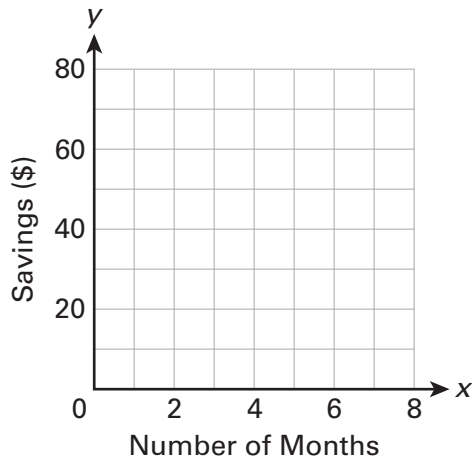
■ Graph both lines by plotting points.

(2, \_\_\_\_\_) and (5, \_\_\_\_\_) are solutions for equation ①.

(2, \_\_\_\_\_) and (5, \_\_\_\_\_) are solutions for equation ②.

■ Do the lines intersect? \_\_\_\_\_

They are \_\_\_\_\_.



**Solution:** After how many months will they have the same amount of money?

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If two lines are parallel, the lines do not intersect, and there are no solutions of the system.

If two lines lie on top of each other, the lines **coincide**, and there are an infinite number of solutions of the system.

Otherwise, there is exactly one solution of the system.



**Your Turn**

Now, use what you know to solve this problem.

2. Graph this system of equations to find the solution.

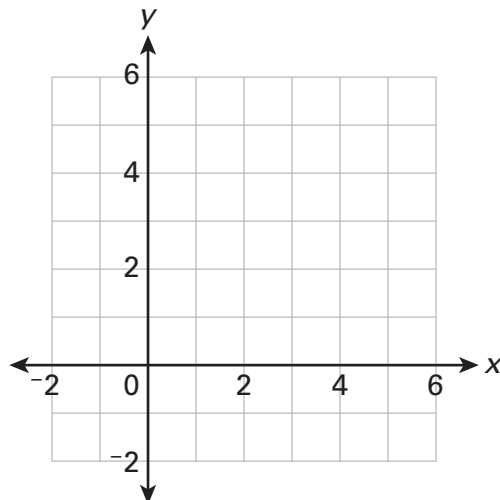
①  $y = -x + 3$   
 ②  $y = -x + 5$

Solution of system:

\_\_\_\_\_

How do you know?

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



## PART THREE: Choose the Right Answer

Solve the problem. Then read why each answer choice is correct or not correct.

**Solve**

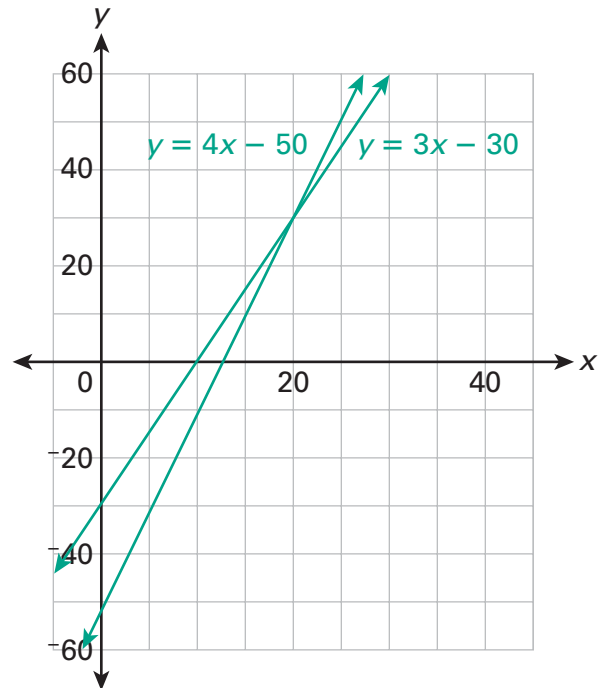
The system shows the profit earned by two different T-shirt vendors, where  $x$  represents the number of T-shirts sold and  $y$  represents the total profit.

①  $y = 4x - 50$

②  $y = 3x - 30$

How many T-shirts must be sold by each company for their profits to be equal?

- Ⓐ 12
- Ⓑ 20
- Ⓒ 30
- Ⓓ 50



**Check**

Check whether you chose the correct answer.

The lines intersect at  $(20, 30)$ . So,  $(20, 30)$  is the solution of the system. The variable  $x$  represents the number of T-shirts, so the  $x$ -value at the intersection point is the number of T-shirts the companies must sell for their profits to be equal.

The  $x$ -value at the point of intersection is 20.

So, the correct answer is Ⓑ.

Why are the other answer choices not correct?

Ⓐ 12	This is the product of the $x$ -coefficients in each equation.
Ⓒ 30	The $y$ -value in each ordered pair is the total profit, not the number of T-shirts sold.
Ⓓ 50	This is the sum of the $x$ - and $y$ -values at the point of intersection.

## Your Turn

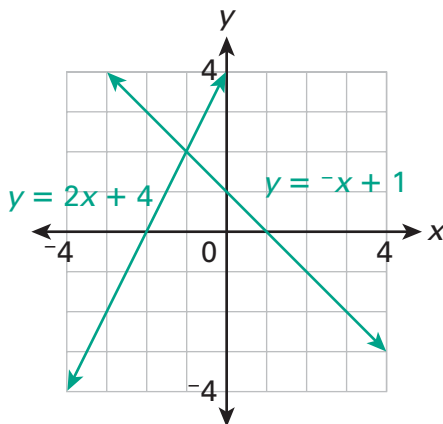
Solve each problem. Use the hints to avoid mistakes.



- To find the solution of a system, find the point where the lines intersect.
- If the lines are parallel, they do not intersect. There is no solution of the system of equations.
- If the lines coincide, there are an infinite number of solutions of the system of equations. The solutions are represented by the infinite number of points on the coinciding lines.

Use the following information for problems 3 and 4.

The graph shows a system of equations.



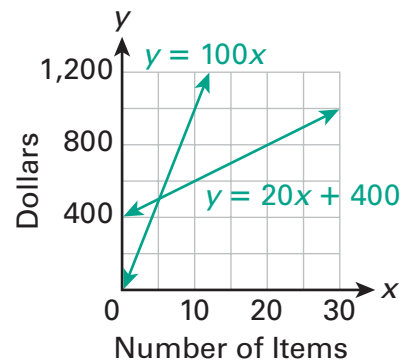
3. How many solutions does the system have?

- (A) 0 solutions
- (B) 1 solution
- (C) 2 solutions
- (D) an infinite number of solutions

4. Which ordered pair represents a solution of the system?

- (A)  $(-2, 0)$
- (B)  $(-1, 2)$
- (C)  $(0, 1)$
- (D)  $(2, -1)$

5. A company's production costs is given by  $y = 20x + 400$ , where  $x$  is the number of items made and  $y$  is the total cost. The company's money earned is given by  $y = 100x$ , where  $x$  is the number of items sold and  $y$  is the total money earned.



How many items must be sold for money earned to equal production costs?

- (A) 5
- (B) 20
- (C) 450
- (D) 500

6. If a system of equations has no solution, which is true?

- (A) There is only one equation in the system.
- (B) The graphs of the equations intersect.
- (C) The graphs of the equations are parallel.
- (D) The graphs of the equations coincide.



Study the model. It is a good example of a written answer.

### Student Model

Show

The system shows the cell phone usage for two friends, where  $x$  represents the number of days in the month that have passed, and  $y$  represents the number of minutes remaining for the month.

①  $y = 500 - 30x$

②  $y = 400 - 30x$

After how many days will both friends have the same number of minutes remaining? (If there is no solution, write "no solution.")

Show each step. Then explain how you found the solution.

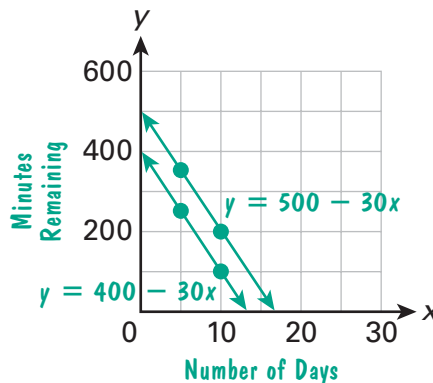
Find two points for each equation.

$x$	$500 - 30x$	$y$
5	$500 - 30(5)$	350
10	$500 - 30(10)$	200

$x$	$400 - 30x$	$y$
5	$400 - 30(5)$	250
10	$400 - 30(10)$	100

Use the points to graph each line.

The lines are parallel.  
They do not intersect at any point.



Solution: no solution

Explain

Explanation:

I used each equation to find ordered pairs, and then I graphed the two lines. I used the number of days on the  $x$ -axis and the number of minutes remaining on the  $y$ -axis. The lines are parallel and do not intersect, so there is no solution of the system.

The student shows each step.

The student correctly answers the question asked.

The student gives important details about how to find the solution.

The student uses the math words *ordered pairs*, *graph*, *axis*, *parallel*, and *intersect*.

**Your Turn**

Solve the problem. Use what you learned from the model.

7. The system shows the number of downloads for two videos, where  $x$  represents the number of days and  $y$  represents the total number of downloads.

①  $y = 100 + 50x$

②  $y = 200 + 25x$

After how many days will both videos have been downloaded the same number of times? (If there is no solution, write "no solution.")

Show each step. Then explain how you found the solution.

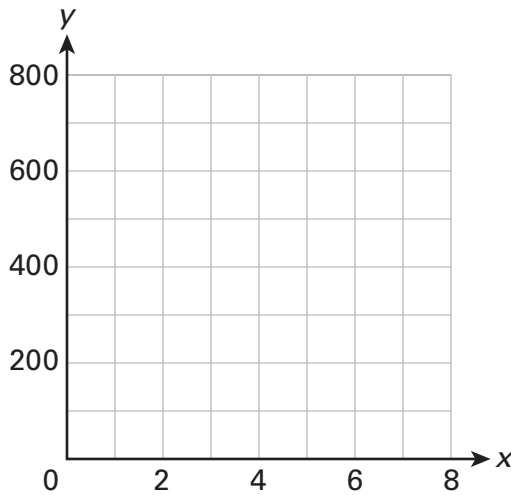
**CHECKLIST**

Did you . . .

- show each step?
- answer the question asked?
- give important details?
- use math words?

$x$	$100 + 50x$	$y$

$x$	$200 + 25x$	$y$



**Solution:** \_\_\_\_\_

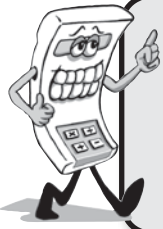
**Explanation:**

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



As you solve systems of equations using graphs, remember to

- graph each equation and determine if the lines intersect.
- find the coordinates of the intersection point.
- think about what is represented by the variables  $x$  and  $y$ .

**Solve each problem.**

8. April graphs a system of equations that show the costs of two cell phone plans, where  $x$  is the number of minutes and  $y$  is the cost of the plan. The lines intersect at  $(25, 2.25)$ . For how many minutes of use do the plans have the same cost?

- (A) 2.25 min                      (C) 9 min  
 (B) 2.5 min                        (D) 25 min

9. If a system of linear equations has an infinite number of solutions, which must be true?

- (A) There is only one equation in the system.  
 (B) The graphs of the equations intersect.  
 (C) The graphs of the equations are parallel.  
 (D) The graphs of the equations coincide.

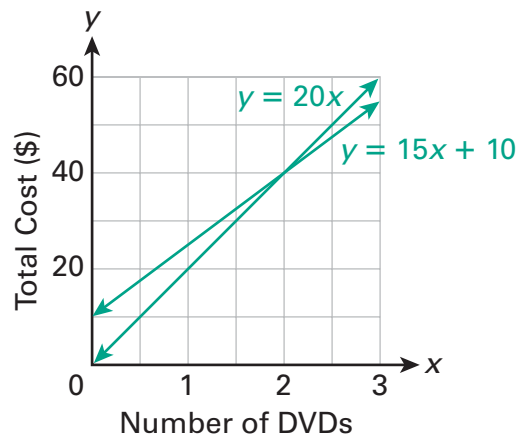
10. The graphs of the equations in this system are parallel. Which is true?

- ①  $y = 3x - 5$   
 ②  $y = 3x + 1$

- (A) The system has no solution.  
 (B) The system has more than one solution.  
 (C)  $(-5, 1)$  is a solution of the system.  
 (D) Both equations have the same  $y$ -value when  $x = 3$ .

**Use the following information for problems 11 and 12.**

The graph represents the cost of ordering multiple DVDs from two different websites.



11. What does the point  $(1, 20)$  represent?

- (A) 1 DVD costs \$20 at both websites.  
 (B) 1 DVD costs \$20 at one website.  
 (C) 20 DVDs cost \$1 at both websites.  
 (D) 20 DVDs cost \$1 at one website.

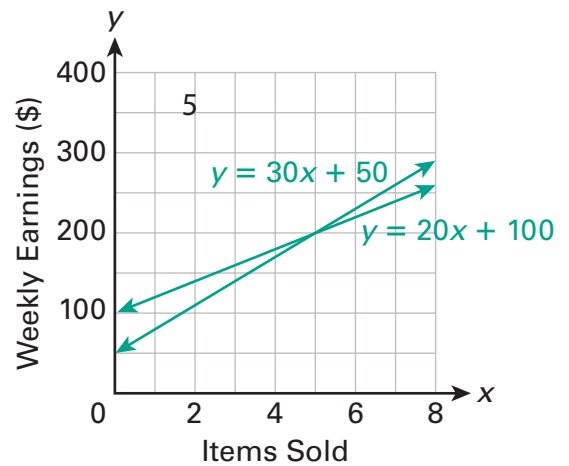
12. What is the solution of the system?

- (A)  $(0, 10)$   
 (B)  $(2, 4)$   
 (C)  $(2, 40)$   
 (D) no solution

13. The ordered pair (5, 20) is a solution of a system of linear equations. Which is true of the system?

- Ⓐ The graphs of the equations do not intersect.
- Ⓑ The system has 5 equations and their graphs intersect 20 times.
- Ⓒ The graphs of the equations intersect at the point (5, 20).
- Ⓓ The graphs of the equations intersect when the  $y$ -value is 5.

14. The graph shows the weekly earnings for two salespeople, where  $x$  is the number of items sold and  $y$  is the weekly earnings.



Write a sentence to interpret the solution of the system.

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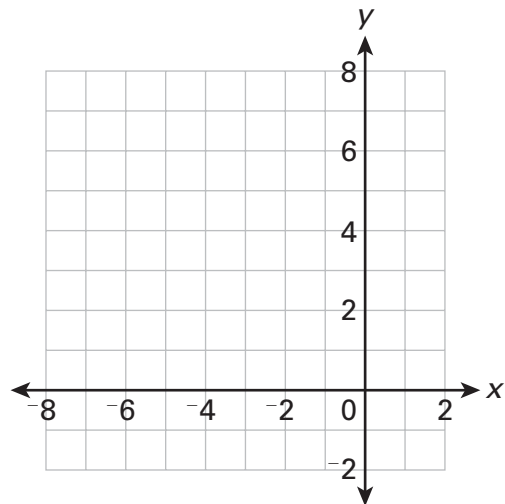


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15. What is the solution of this system?  
(If there is no solution, write "no solution.")

- ①  $y = 0.5x + 6$
- ②  $y = -x$

Show each step. Then explain how you found the solution.



**Solution:** \_\_\_\_\_

**Explanation:**

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