Lesson 8.1

Systems of Linear Equations and Graphs

- Solve problems that involve systems of linear equations in two variables graphically

May 15-5:17 PM

8.1 Systems of Linear Equations and Graphs

Investigate Ways to Represent Linear Systems

How can you compare and analyse cell phone plan options?

- Plan A costs $0.30 per minute.
- Plan B costs $15 one time plus $0.10 per minute.

1. Create tables of values to show the cost of each option for up to 100 min. Use intervals of 10 min. Graph the data from both tables.

Plan A   Plan B

May 15-5:23 PM

2. From the graph, explain the cost of each plan as the number of minutes increases.

3. What is the significance of the point of intersection of the lines? Explain the connection between this point on the graph and the tables of values you created.

4. Which cell phone plan do you think is the better option? Justify your choice.

May 15-5:33 PM

Link the Ideas

A system of linear equations is often referred to as a linear system. It can be represented graphically in order to make comparisons or solve problems. The point of intersection of two lines on a graph represents the solution to the system of linear equations.

May 15-5:34 PM

Example 1 Represent Systems of Linear Equations

Nadia has saved $16, and her sister Lucia has saved $34. They have just started part- time jobs together. Each day that they work, Nadia adds $5 to her savings, while Lucia adds $2. The girls want to know if they will ever have the same amount of money. If so, what will the amount be and on what day?

Use a Graph

The girls draw graphs on the same grid. This enables them to compare the linear relationships for their savings.

Nadia's and Lucia's Savings

Lucia's Savings

same amount, $46, on day 6
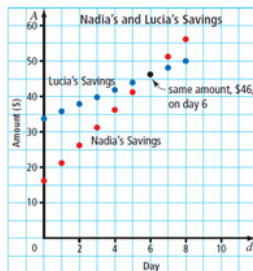
Why are the points not joined on this graph?

Nadia's Savings

The intersection point of the two relationships is (6, 46). This means the girls will have the same amount of money, $46, on day 6.
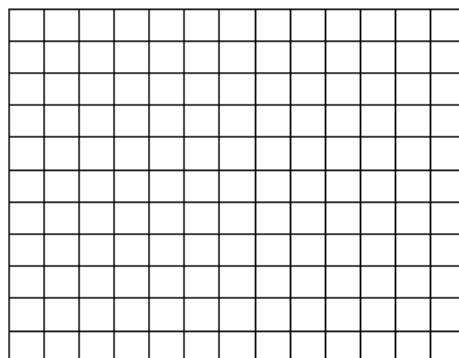
Verify the Solution

$$A = 5d + 16 \qquad A = 2d + 34$$

May 15-5:36 PM

Your Turn

Julie earns $ 40 plus $ 10 per hour. Carmen earns $ 50 plus $ 8 per hour.

a) Represent the linear system relating the earnings graphically.

b) Identify the solution to the linear system and explain what it represents.

May 15-5:39 PM

Example 2 Solve a Linear System Graphically

a)   Consider the system of linear equations $2x + y = 2$ and $x - y = 7$. Identify the point of intersection of the lines by graphing.

b)   Verify the solution.

Solution

a) **Method 1: Use Slope- Intercept Form**
Rearrange each equation into slope- intercept form by isolating y. Identify the y- intercept and slope to draw the graph.
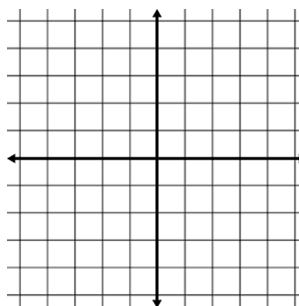
May 15-5:42 PM

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b) **Verify** the solution

1. Verify the solution (3, −4) **by substituting** the values of x and y into each equation.

In 2x + y = 2:

Left Side	Right Side
	2

Left Side = Right Side

In x − y = 7:

Left Side	Right Side
	7

Left Side = Right Side

Since the ordered pair (3, −4) satisfies both equations, it is the solution to the linear system.

2. **Verify using technology**

May 23-7:23 PM

Your Turn

For each system of linear equations, verify whether the given point is a solution. Explain what the results would show on a graph.

a) $3x - y = 2$
  $x + 4y = 32$

  $(2, 5)$

b) $2x + 3y = -12$
  $4x - 3y = -6$

  $(-3, -2)$

May 23-7:29 PM

Example 3 Solve a Problem Involving a Linear System

The Skyride is a red aerial tram that carries passengers up Grouse Mountain in Vancouver, BC. The Skyride travels from an altitude of about 300m to an altitude of 1100m. The tram can make the trip up or down in 5 min and can carry 100 passengers.

There is also a blue tram that can carry 45 passengers. This tram is approximately 8 min to travel up or down the mountain. Each tram travels at a constant speed.

a) Create a graph to represent the altitudes of the trams if the red tram starts at the top and the blue tram starts at the base.

b) Explain the meaning of the point of intersection.

Solution

a) Organize the information before graphing.

Tram	Start		End		Representation on a Graph
	Time	Altitude	Time	Altitude	
Red	0 min	m	5 min	m	Line segment joining the points (0, 1100) and (5, 300)
Blue	0 min	m	8 min	m	Line segment joining the points (0, 300) and (8, 1100)

Label time from 0 min to 10 min on the horizontal axis. Label altitude on the vertical axis, up to 1200m. Graph a line segment for each tram using the start and end points

b)

May 23-7:34 PM

Solution

a) Organize the information before graphing.

| Tram | Start | | End | | Representation on a Graph |
	Time	Altitude	Time	Altitude	
Red	0 min	1100 m	5 min	300 m	Line segment joining the points (0, 1100) and (5, 300)
Blue	0 min	300 m	8 min	1100 m	Line segment joining the points (0, 300) and (8, 1100)

Label time from 0 min to 10 min on the horizontal axis. Label altitude on the vertical axis, up to 1200 m. Graph a line segment for each tram using the start and end points.
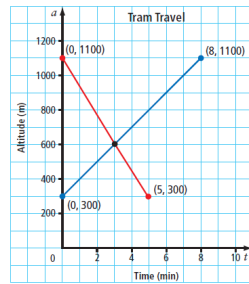
b) At the point of intersection, the two trams will have the same altitude at the same time. The lines appear to intersect at approximately (3, 600). Therefore, after about 3 min, the two trams will pass each other at about 600 m in altitude.

May 25-8:27 AM

Homework: Page 426 #3, 5, 7- 11, 15, 17, 20

May 23-7:45 PM