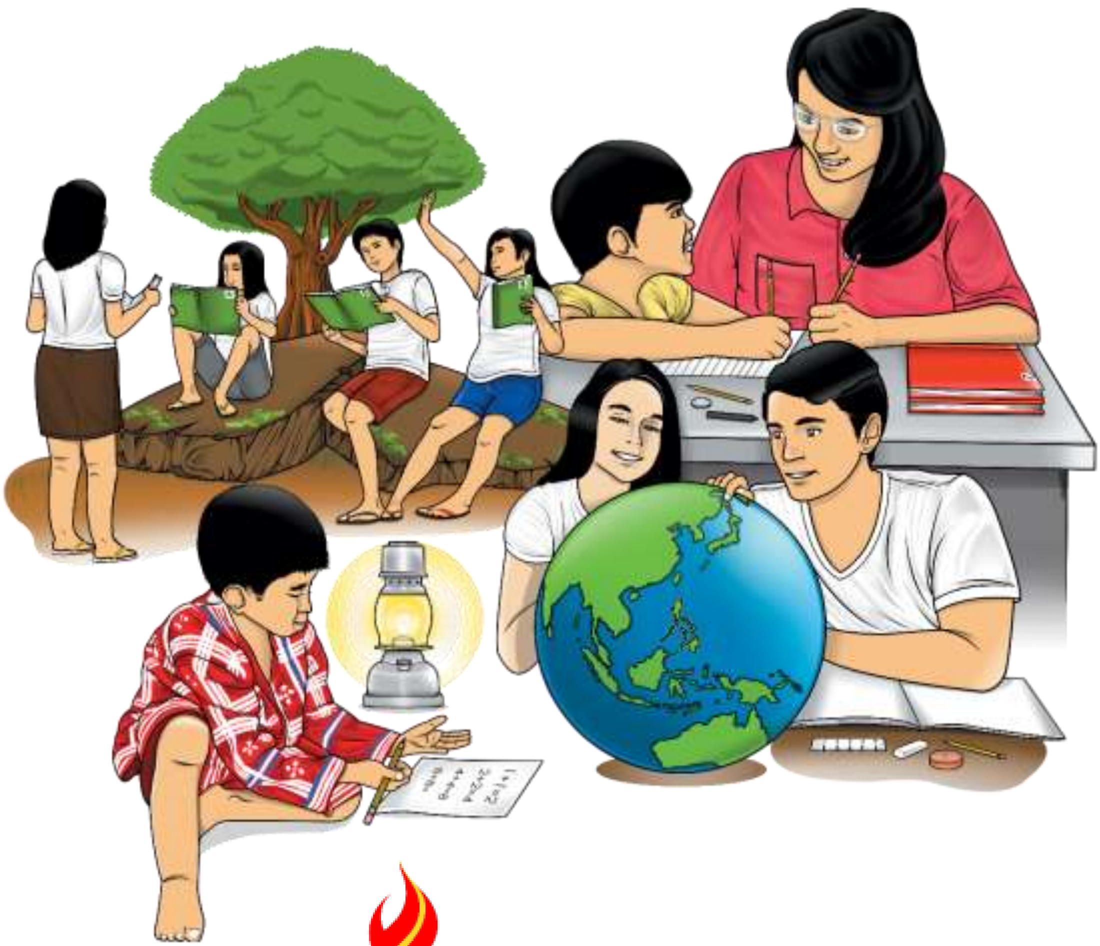
8

Mathematics

Quarter 1 – Module 16:
Solving Systems of Linear Equations in Two Variables



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Mathematics

Quarter 1 – Module 16:
“Solving Systems of Linear Equations in Two Variables”

DepED
DEPARTMENT OF EDUCATION

Introductory Message

This Self-Learning Module (SLM) is prepared so that you, our dear learners, can continue your studies and learn while at home. Activities, questions, directions, exercises, and discussions are carefully stated for you to understand each lesson.

Each SLM is composed of different parts. Each part shall guide you step-by-step as you discover and understand the lesson prepared for you.

Pre-tests are provided to measure your prior knowledge on lessons in each SLM. This will tell you if you need to proceed on completing this module or if you need to ask your facilitator or your teacher's assistance for better understanding of the lesson. At the end of each module, you need to answer the post-test to self-check your learning. Answer keys are provided for each activity and test. We trust that you will be honest in using these.

In addition to the material in the main text, Notes to the Teacher are also provided to our facilitators and parents for strategies and reminders on how they can best help you on your home-based learning.

Please use this module with care. Do not put unnecessary marks on any part of this SLM. Use a separate sheet of paper in answering the exercises and tests. And read the instructions carefully before performing each task.

If you have any questions in using this SLM or any difficulty in answering the tasks in this module, do not hesitate to consult your teacher or facilitator.

Thank you.

What I Need to Know

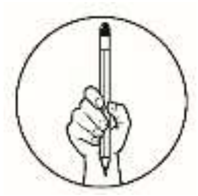
This module was designed and written with you in mind. It is here to help you solve problems involving systems of linear equations in two variables using graphical and algebraic (substitution and elimination) methods. Throughout this module, you will be provided with varied activities to process your knowledge and skills acquired, deepen, and transfer your understanding of the algebraic methods of solving systems of linear equations in two variables. The lessons are arranged to follow the standard sequence of the course. But the order in which you read them can be changed to correspond with the textbook you are now using.

This module contains:

Lesson 1: Solving Problems Involving Systems of Linear Equation in Two Variables

After going through this module, you are expected to:

1. solve systems of linear equations in two variables by substitution and elimination methods;
2. solve problems involving systems of linear equations in two variables by graphing, substitution and elimination; and
3. determine the most efficient method in solving system of linear equations in two variables.



What I Know

Directions: Read the questions carefully and choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. What do you call the process of adding the equations to eliminate either x or y from the system of linear equations?

   A. cancellation
   B. elimination
   C. graphing
   D. substitution

2. Determine which coordinates satisfy the system $\begin{cases} 5x + y = 14 \\ 4x - y = 4 \end{cases}$.

   A. $(-4,\ 6)$
   B. $(4, -2)$
   C. $(2, 4)$
   D. $(6, 4)$

3. Is the ordered pair $(2, 0)$ a solution to the system of linear equations $\begin{cases} x + 2y = 2 \\ 2x - y = 4 \end{cases}$?

   A. No, $(2, 0)$ is not a solution.
   B. Yes, (2, 0) completely satisfies the system.
   C. The given is NOT a system of linear equation.
   D. There is not enough data given to solve the system.

4. What do you call the process of solving one of the equations for one variable and replacing the resulting expression to the other equation to solve for the other variable without changing the value of the original expression?

   A. elimination
   B. graphing
   C. substitution
   D. transformation

5. What is the first step to solve this system of linear equations $\begin{cases} 5x - 3y = -2 \\ 4x + 3y = 20 \end{cases}$ by elimination?

   A. Add the 2 equations.
   B. Subtract the 2 equations.
   C. Multiply the second equation by 3.
   D. Multiply the first equation by $\frac{1}{5}$.

6. Which of the following is the most efficient method to use in solving the system of linear equations $\begin{cases} 4x + y = 5 \\ 2x - y = 1 \end{cases}$?

   A. cancellation
   B. elimination
   C. graphing
   D. substitution

7. What is the value of y in the system of linear equations $\begin{cases} x+3y=2 \\ 2x+2y=8 \end{cases}$?

A. -5
B. -1
C. 1
D. 5

8. Using the elimination method, what is the value of variable x in this system of linear equations $\begin{cases} x-2y=6 \\ x+2y=12 \end{cases}$?

A. $x=-6$
B. $x=3$
C. $x=9$
D. $x=18$

9. In this system of linear equations $\begin{cases} 3x+6y=6 \\ 6x-12y=24 \end{cases}$, what should we multiply to equation 1 so that the coefficients of x in both equations will become opposites?

A. -3
B. -2
C. 2
D. 3

10. Which ordered pair is the solution to this system of linear equations $\begin{cases} x+5y=4 \\ -x-2y=5 \end{cases}$?

A. $(-11,3)$
B. $(11,-3)$
C. $(-1,\ 3)$
D. $(3,-11)$

11. Gio was asked by his teacher to solve the system of linear equations $\begin{cases} x+2y=5 \\ y=x-4 \end{cases}$.
He then presented his solution in the following manner:

	$x+2y$	$=$	5	*Given (Equation 1)*
Step 1.	$x+2x-4$	$=$	5	*Substitute for y:* $y=x-4$
Step 2.	$3x-4$	$=$	5	*Combine like terms*
Step 3.	$3x-4+4$	$=$	$5+4$	*Add 4 to both sides*
Step 4.	$3x$	$=$	9	*Simplify*
Step 5.	$\frac{1}{3}(3x)$	$=$	$\frac{1}{3}(9)$	*Multiply both sides by* $\frac{1}{3}$
Step 6.	x	$=$	3	*Solve for x*

What was Gio's computational error?

A. In Step 1, Gio wrongly substituted the value of y. It should have been $\boldsymbol{x}+2(x-4)=5$.
B. In Step 3, Gio wrongly added 4 to both sides of the equation. It should have been $3x-4-\ 4=5-4$.
C. In Step 5, Gio wrongly multiplied $\frac{1}{3}$ to both sides of the equation. It should have been $3(3x)=3\,(9)$.

D. Gio did not commit any computational error. All the steps are performed logically and accurately.

12. Below are the steps in solving problems involving systems of linear equations in two variables. Which of the following is arranged in a chronological order?

I. Read and understand the problem.
II. Check to see if all information is used correctly and that the answer makes sense
III. Translate the facts into a system of linear equations.
IV. Solve the system of equations using one of the methods in solving system of linear equations.

A. I, II, III, and IV
B. I, II, IV and III
C. II, I, III and IV
D. I, III, IV and II

13. Clarissa has 2 apples and 3 oranges with a total cost of P105.00 while her friend has 1 apple and 4 oranges cost P90.00. Which of the following steps would be the best way to begin with in finding the cost of an apple and the cost of an orange?

$$2x + 3y = 105 \quad \text{(equation 1)}$$
$$x + 4y = 90 \quad \text{(equation 2)}$$

A. Multiply equation 2 by -2.
B. Multiply equation 1 by 4 and 2.
C. Add equation 1 and 2.
D. Multiply equation 2 by 2 and add.

14. A farm-to-market road (FMR) is soon to be constructed in one of the secluded barangays of Surigao del Sur. To ensure the maximum number of farmers to benefit the project, the Department of Agricultural (DA) in coordination with the Local Government Unit (LGU) and the residents of the barangay mapped the area where the road will be constructed. They mapped Road A to be on the line $x + y = 4$ and Road B on the line $-x + y = 6$. The two roads will cross at the existing barangay road. What are the coordinates of the intersection of Roads A and B?

A. $(5, -1)$
B. $(1, 5)$
C. $(-1, 5)$
D. $(1, 5)$

15. Four years ago, Luna was 6 times as old as her cousin, six years ago, her age was 2 years more than eight times her cousin's age. How old is Luna?

A. 20 years old
B. 25 years old
C. 30 years old
D. 40 years old

Lesson 1 Solving Problems Involving Systems of Linear Equations in Two Variables

In the previous module, you learned about solving systems of linear equations in two variables by graphical method. How did you find the lesson? Was it easy to determine the ordered pair that satisfies both equation? Have you ever wondered if there are other ways of finding the solutions of the system of equations other than graphing?

Let us start this lesson by reactivating your knowledge in solving linear equations for a given variable.

What's In

Activity 1: Transform Me!

Directions: Express each equation in terms of the indicated variable then answer the questions that follow. The first item is done for you.

Original Equation	Transformed Equation
1. $x + y = 2$	$x = -y + 2$
2. $x - y = \frac{2}{3}$	$x =$ ____________
3. $3x + 2y = 6$	$x =$ ____________
4. $\frac{1}{4}x + y = 2$	$y =$ ____________
5. $4x - 3y = -33$	$y =$ ____________

Questions:

1. Was it easy to solve for one variable in terms of the other?

2. In Item No. 4, was it easy to solve for y in terms of x? How would it be different if you were asked to solve for x in terms of y?
3. If you will graph the equation in Item No. 5 in one Cartesian Plane, would it be easy for you to locate the points? Why or why not?

What's New

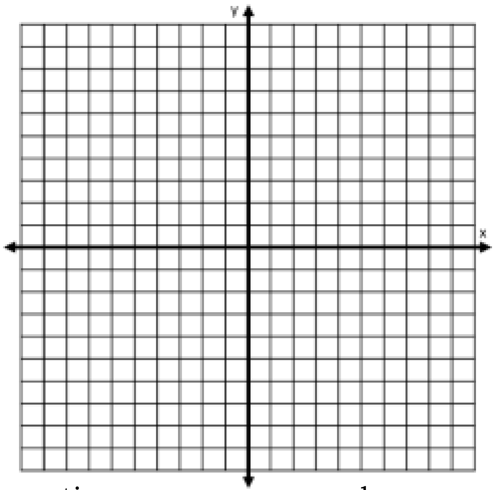
Activity 2: Charlie's Candies

Directions: Read and analyze the problem below. Solve for what is asked by answering the guide questions that follows.

Charlie bought 12 candies and pay P20.00 for it. Orange flavored candies cost P1.00 each and mint candies cost P2.00 each, given the system of linear equation below find the number of orange flavored candies and mint candies he bought.

$$\begin{cases} x + y = 12 & Equation\ 1 \\ x + 2y = 20 & Equation\ 2 \end{cases}$$

Guide Questions:



1. In the given Cartesian Plane, graph the two linear equations provided in the problem. (You can make use of Module 15 as your reference in graphing).

   1.1 Find the point of intersection of the two graphs. What do you think does this point represents?

2. Transform equation 1 into $y = mx + b$.

   2.1 Find the coordinate that satisfies the equation by replacing the corresponding variables from equation 1 to equation 2.

   2.2 Did you get the same coordinates with your answer in 1.1?

3. Subtract Equation 2 from Equation 1. What is the result?

   3.1 Did you arrive with the same x and y values from items 1.1 and 2.1?

4. By answering the questions above, have you identified how many orange flavored candies and mint candies Charlie bought?

What is It

Solving Systems of Linear Equations in Two Variables by Substitution

There are several methods for solving system of linear equations other than graphing. One of these is the **substitution** method. When using the **substitution method,** we use the fact that if two expressions y and x are of equal value $x = y$, then x may replace y or vice versa in another expression without changing the value of the expression.

Below are the illustrative examples to help you solve systems of linear equations in two variables using substitution method.

Illustrative example1

Solve the system by substitution: $\begin{cases} x + y = 3 & \textit{Equation } 1 \\ y = x - 1 & \textit{Equation } 2 \end{cases}$

Step 1. Solve an equation for one variable.

$\boldsymbol{y}$	$=$	$\boldsymbol{x - 1}$	*Equation 2 is already solved for y in terms of x*

Step 2. Substitute the value $x - 1$ for y in Equation 1 to solve for x.

$\boldsymbol{x + y}$	$=$	3	*Given (Equation 1)*
$x + (x - 1)$	$=$	3	*Substitute $(x - 1)$ for y*
$(x + x) - 1$	$=$	3	*Associative Property of Addition*
$2x - 1$	$=$	3	*Combine like terms*
$2x - 1 + 1$	$=$	$3 + 1$	*Add 1 (the additive inverse of -1) to both sides of the equation; Addition Property of Equality*
$2x$	$=$	4	*Simplify*
$\frac{1}{2}(2x)$	$=$	$(4)\frac{1}{2}$	*By Multiplication Property of Equality, multiply both sides by 1/2 (the multiplicative inverse of 2)*
$\boldsymbol{x}$	$=$	$\boldsymbol{2}$	*Simplify*

Step 3. To find the value of y, substitute the value of x obtained in Step 2 in either of the original equations. For this example, we use equation 2 since y is already expressed in terms of x:

$$\boldsymbol{y} = \boldsymbol{x - 1}$$ *Given (Equation 2)*

$$y = 2 - 1$$ Substitute 2 to x in the equation

$$\boxed{y = 1}$$ *Simplify*

Therefore, the ordered pair obtained is $(2, 1)$.

Step 4. Check if the obtained value of x and y in Step 3 satisfies both equation 1 and equation 2.

For equation 1:	For equation 2:
$x + y = 3$	$y = x - 1$
$2 + 1 = 3$	$1 = 2 - 1$
$3 = 3$ ✓	$1 = 1$ ✓

Both values of x and y satisfy both of the equations; hence, the ordered pair $(2, 1)$ is a solution to the system of linear equations $\begin{cases} x + y = 3 \\ y = x - 1 \end{cases}$.

Illustrative example 2: Solve the system $\begin{cases} y = 2x + 5 \\ 2x = y + 3 \end{cases}$

Step 1. Solve an equation for one variable.

$$y = 2x + 5$$ *Equation 1 is already solved for y in terms of x*

Step 2. Substitute the expression $(2x + 5)$ for y in the other linear equation to find x.

$2x = y + 3$	*Given (Equation 2)*
$2x = (2x + 5) + 3$	*Substitute the value of y obtained in Step 1*
$2x = 2x + 8$	*Combine like terms*
$2x - 2x = 2x + 8 - 2x$	*Add $(-2x)$ to both sides by Addition Property of equality*
$\mathbf{0} = \mathbf{8}$	***FALSE***

The result $\mathbf{0} = \mathbf{8}$ is a false statement. This means that for any values of x and y, there is no ordered pair (x, y) that would satisfy the system of equations. Hence, the system has **no solution**.

Illustrative Example 3:

Solve the system of linear equations $\begin{cases} x + y = 3 \\ 3x + 3y = 9 \end{cases}$.

Step 1. Solve an equation for one variable.

$x + y = 3 \quad \Rightarrow \quad y = -x + 3$ *Solve for y in terms of x*

Step 2. Substitute the value $-x + 3$ in Step 1 for y in Equation 2 and solve for x.

$3x + 3y$	=	9	*Given (Equation 2)*
$3x + 3(-x + 3)$	=	9	*Substitute the value of y obtained in Step 1*
$3x - 3x + 9$	=	9	*Distributive Property*
9	=	**9**	***TRUE***

Notice that in Step 2, the resulting equation $9 = 9$ is a true statement. Since the statement is true for any value of x and y, this means that the system has **infinitely many solutions**.

Solving Systems of Linear Equations in Two Variables by Elimination

Another method of solving systems of linear equations in two variables is the **elimination method**. The objective of this method is to eliminate one of the variables in the equation to find the value of the other variable. This can be done by addition or subtraction.

However, in some instances, addition or subtraction cannot be directly performed to eliminate either of the variables. Hence, either one or both equations in the system has to be multiplied first with a number in order to obtain numerical coefficients of one variable which are opposites or additive inverses.

For your guide, consider the examples below.

Illustrative Example 1: Solve the systems of equation by elimination: $\begin{cases} x + y = 3 \\ x - y = 1 \end{cases}$

Step 1. Write the equations in the standard form $Ax + By = C$. If the given equations are already in standard form, proceed to Step 2.

Note that each equation in the system is already in the form $Ax + By = C$, hence, proceed to Step 2.

Step 2. Add or subtract the equations to eliminate one variable, and then solve for the value of the other variable. In this example, note that the y-terms of both equations 1 and 2 have opposite numerical coefficients, 1 and -1. Hence, addition can be used.

$x+y$	$=$	3	*Given (Equation 1)*
$x-y$	$=$	1	*Given (Equation 2)*
$2x+0$	$=$	4	*Eliminate y by addition*
$2x$	$=$	4	*Additive Identity*
$\frac{1}{2}(2x)$	$=$	$\frac{1}{2}(4)$	*By Multiplication Property of Equality, multiply both sides of the equation by 1/2*
$\boldsymbol{x}$	$=$	$\mathbf{2}$	*By simplification*

Step 3. Substitute the value of x in either of the equations and solve for the value of y.

$x+y$	$=$	3	*Given (Equation 1)*
$2+y$	$=$	3	*Substitute x by* 2
$2+(-2)+y$	$=$	$(-2)+3$	*By Addition Property, add (-2) to both sides of the equation*
$\boldsymbol{y}$	$=$	$\mathbf{1}$	*By simplification*

Hence, the ordered pair obtained from Step 2 and Step 3 is (2,1).

Step 4. Check. Using the ordered pair (2,1), substitute the value of x and y to both equation 1 and equation 2.

For equation 1:

$$x+y=3$$
$$2+1=3$$
$$3=3\ \checkmark$$

For equation 2:

$$y=x-1$$
$$1=2-1$$
$$1=1\ \checkmark$$

Both values of x and y satisfy the equations; therefore, the solution to the system is $x=2$ and $y=1$ or the ordered pair $(2,1)$.

Illustrative Example 2: Solve the system $\begin{cases}-5y=-2x+3\\ 3x+y=-4\end{cases}$ by elimination.

Step 1. Write the equations in the standard form $Ax+By=C$.

$-5y=-2x+3 \Rightarrow$	$2x-5y=3$	*Standard form of Equation 1*
	$3x+y=-4$	*Equation 2 is already in standard from*

The system is now $\begin{cases}2x-5y=3\\ 3x+y=-4\end{cases}$

Step 2. Add the equations if the coefficients of the variable to be eliminated are opposites. Subtract the equations if the coefficients are the same.

$2x - 5y$	$=$	3	*Standard form of Equation 1*
$3x + y$	$=$	-4	*Equation 2*

Observe that none of the numerical coefficients of x and y are additive inverses, hence, addition or subtraction cannot be directly performed. This means that multiplication must be done first. Multiply Equation 2 with 5 to eliminate the variable y and solve for x.

$5(3x + y)$	$=$	$5(-4)$	*Multiply each term in equation 2 by 5 so that the coefficients of y in both Equations 1 and 2 become opposites*
$\mathbf{15x + 5y}$	$=$	$\mathbf{-20}$	*Distributive Property*
$2x - 5y$	$=$	3	*Equation 1*
$15x + 5y$	$=$	-20	*Equivalent of Equation 2*
$17x + 0$	$=$	-17	*Eliminate y by adding the 2 equations*
$17x$	$=$	-17	*Additive Identity*
$\frac{1}{17}(17x)$	$=$	$\frac{1}{17}(-17)$	*Multiply both sides by $\frac{1}{17}$ by Multiplication Property of Equality*
$\boxed{x}$	$=$	$\mathbf{-1}$	*By simplification.*

Step 3. Substitute the value of x in either of the equations and solve for the value of y.

$-5y$	$=$	$-2x + 3$	*Given (Equation 1)*
$-5y$	$=$	$-2(-1) + 3$	*Substitute x by −1*
$-5y$	$=$	$2 + 3$	*Simplify*
$-5y$	$=$	5	
$-\frac{1}{5}(-5y)$	$=$	$-\frac{1}{5}(5)$	*Multiply both sides by $-\frac{1}{5}$ by Multiplication Property of Equality*
$\boxed{y}$	$=$	$\mathbf{-1}$	*By simplification.*

Therefore, the ordered pair obtained is $(-1, -1)$.

Step 4. Check. Using the ordered pair obtained in Step 3, substitute the values of x and y in both equations.

For equation 1:

$$-5y = -2x + 3$$
$$-5(-1) = -2(-1) + 3$$

For equation 2:

$$3x + y = -4$$
$$3(-1) + (-1) = -4$$

$$
\begin{aligned}
5 &= 2+3 \qquad\qquad & -3-1 &= -4 \\
5 &= 5 \ \checkmark & -4 &= -4 \ \checkmark
\end{aligned}
$$

Both values of x and y satisfy the equations; therefore, the solution to the system is $x = -1$ and $y = -1$ or the ordered pair $(-1, -1)$.

Note: There are equations that contain fractions or parentheses. These should be simplified or transformed first to the standard form of linear equations $Ax + By = C$ before proceeding to addition or subtraction.

Illustrative Example 3: Solve the system $\begin{array}{l} \frac{6}{7}x + 2 = \frac{1}{7}y \\ \frac{1}{2}y - \frac{3}{5}x = 4 \end{array}$

Step 1. Eliminate the fractions by multiplying each side of the equation by a common denominator, then write the simplified equation in standard form.

$\frac{6}{7}x + 2$	$=$	$\frac{1}{7}y$	*Given (Equation 1)*
$7\left(\frac{6}{7}x + 2\right.$	$=$	$\left.\frac{1}{7}y\right)$	*The LCD is 7. Multiply each term of the equation by 7.*
$6x + 14$	$=$	y	*Distributive Property. Simplification.*
$\mathbf{6x - y}$	$=$	$\mathbf{14}$	*Standard form of Equation 1*

$\frac{1}{2}y - \frac{3}{5}x$	$=$	4	*Equation 2*
$10\left(\frac{1}{2}y - \frac{3}{5}x\right.$	$=$	$\left.4\right)$	*The LCD is 10. Multiply each term by the LCD.*
$5y - 6x$	$=$	40	*Distributive Property. Simplification.*
$\mathbf{-6x + 5y}$	$=$	$\mathbf{40}$	***Standard form of Equation 2***

Hence, the simplified system of linear equations is $\begin{cases} \mathbf{6x - y = -14} \\ \mathbf{-6x + 5y = 40} \end{cases}$

Step 2. Eliminate one variable by addition or subtraction. To do this, add the equations containing variable with opposite numerical coefficients or subtract the equations with variable having the same numerical coefficients. In this example, the numerical coefficients of the x-terms of equation 1 and equation 2 are opposites, 6 and -6, hence, add the two equations.

$\mathbf{6x - y} = \mathbf{-14}$ *Equation 1*

$\mathbf{-6x+5y}$	=	$\mathbf{40}$	*Equation 2*
$4y$	=	26	*Eliminate the variable x by addition.*
$\frac{1}{4}(4y)$	=	$\frac{1}{4}(26)$	*Multiply both sides by $\frac{1}{4}$, by Multiplication Property of Equality*
$\boldsymbol{y}$	=	$\mathbf{\frac{26}{4}}$ ***or*** $\mathbf{\frac{13}{2}}$	*By simplification*

Step 3. Substitute the value of y in either of the equations and solve for the value of x.

$\mathbf{6x-y}$	=	$\mathbf{-14}$	*Given (Equation 1)*
$6x-\frac{13}{2}$	=	-14	*Substitute y by $\frac{13}{2}$*
$2\left(6x-\frac{13}{2}\right)$	=	$2(-14)$	*Multiply both sides by the LCD 2.*
$12x-13$	=	-28	*Distributive Property*
$12x-13+13$	=	$-28+13$	*Add 13 to both sides of the equation by Addition Property of Equality*
$12x$	=	-15	*Additive Inverse*
$\frac{1}{12}(12x)$	=	$\frac{1}{12}(-15)$	*Multiply both sides by $\frac{1}{12}$ by Multiplication Property of Equality*
$\boldsymbol{x}$	=	$\mathbf{\frac{-15}{12}}$ ***or*** $\mathbf{\frac{-5}{4}}$	*By simplification.*

Therefore, the ordered pair obtained is $(-\mathbf{\frac{5}{4}}, \mathbf{\frac{13}{2}})$

Step 4. Check. Using the ordered pair obtained in Step 3, substitute the values of x and y in both equations.

For equation 1: $\frac{6}{7}x+2=\frac{1}{7}y$

$$\frac{6}{7}\left(-\frac{5}{4}\right)+2 = \frac{1}{7}\left(\frac{13}{2}\right)$$
$$-\frac{30}{28}+2 = \frac{13}{14}$$
$$\frac{-30+56}{28} = \frac{13}{14}$$
$$\frac{26}{28} = \frac{13}{14}$$
$$\frac{13}{14} = \frac{13}{14} \checkmark$$

For equation 2: $\frac{1}{2}y-\frac{3}{5}x=4$

$$\frac{1}{2}\left(\frac{13}{2}\right)-\frac{3}{5}\left(\frac{-5}{4}\right) = 4$$
$$\frac{13}{4}+\frac{15}{20} = 4$$
$$\frac{5(13)+15}{20} = 4$$
$$\frac{80}{20} = 4$$
$$4 = 4 \checkmark$$

Both values satisfy the equation; therefore, the solution to the system is $\boldsymbol{x} = -\mathbf{\frac{5}{4}}$ and $\boldsymbol{y} = \mathbf{\frac{13}{2}}$ or may be written as $(-\mathbf{\frac{5}{4}}, \mathbf{\frac{13}{2}})$.

Illustrative example 4: Solve the system $\begin{cases} 4x-2y=8 \\ 2x-y=9 \end{cases}$

Step 1. Write the equations in the standard form $Ax + By = C$.

Since equations 1 & 2 are already expressed in the standard form $Ax + By = C$, then the next step could be done.

Step 2. Eliminate one variable by addition or subtraction. Since none of the variables have coefficients which are the same or opposite, multiply one or both of the equations by a number or numbers which will make the coefficients of one variable the same or opposite in both equations and perform addition or subtraction.

$2x - y$	$= 9$	*Equation 2*
$-2(2x - y$	$= 9)$	*Multiply both sides by* -2
$\mathbf{-4x + 2y}$	$\mathbf{= -18}$	*Distributive Property* *New Equation 2*

$$\begin{array}{rcl} 4x - 2y & = & 8 \\ -4x + 2y & = & -18 \\ \hline 0 & = & -10 \end{array}$$

Equation 1

Equivalent of Equation 2

Elimination by Addition

Notice that $0 = -10$ is a false statement. The fact that statement $0 = -10$ is not true for any values of x and y, then the system has **no solution**.

Illustrative example 5: Solve the system $\begin{cases} x - 4y = 12 \\ 2x - 8y = 24 \end{cases}$

Since both equations are already in the standard form $Ax + By = C$, then you can proceed directly to the next step. To eliminate one variable, multiply one or both equations by a number or numbers which will make the coefficients of either x or y the same or opposite in both equations and perform addition or subtraction.

$x - 4y$	$= 12$	*Equation 1*
$-2(x - 4y$	$= 12)$	*Multiply both sides by* -2
$\mathbf{-2x + 8y}$	$\mathbf{= -24}$	*Distributive Property, New Equation 1*

$$\begin{array}{rcl} -2x + 8y & = & -24 \\ 2x - 8y & = & 24 \\ \hline 0 & = & 0 \end{array}$$

Equivalent of Equation 1

Equation 2

Elimination by Addition

Notice that $0 = 0$ is a true statement. This means that the statement is true for any value of x and y, hence, the system has **infinitely many solutions**.

Recall that in Activity 2: Charlie's Candies, you are asked to solve a problem represented by the system:

$$\begin{cases} x + y = 12 & \textit{Equation } 1 \\ x + 2y = 20 & \textit{Equation } 2 \end{cases}$$

Recall further that in Guide Questions 2 and 3, you are asked to solve the system using substitution and elimination, respectively. Were you able to arrive at the correct answers? If your answer is NO, then try to work again on that problem following the examples presented above. If your answer is YES, then you are now ready to proceed.

Solving Problems Involving Systems of Linear Equations in Two Variables

You have learned the three methods of solving systems of linear equations in two variables: graphing (in Module 15), substitution, and elimination. Hence, you can now use these methods to solve real-life problems that can be translated into systems of linear equations in two variables. You will also use the problem-solving procedures enumerated below.

Steps in problem-solving: (Polya's Approach)

1. **Understand the problem.** Read the problem carefully and decide which quantities are unknown.
2. **Develop a plan (Translate).** Study the stated facts until you understand their meaning. Then translate the related facts into equations in two variables.
3. **Carry out the plan (Solve).** Use one of the methods for solving systems of equations. State the conclusions clearly. Include unit of measure if applicable.

Below are the illustrative examples applying the different methods of solving systems of linear equations in two variables you learned in the previous modules.

Illustrative Example 1: (Age Problem)

The sum of Janna age and Mark's age is 40. Two years ago, Janna was twice as old as Mark. Find Janna's age now.

Step 1: Understand the problem.

Read and understand the problem. Since you are looking for Janna's age, let

$\boldsymbol{x}$ = Janna's age,
$\boldsymbol{y}$ = Mark's age

Step 2: Devise a plan (translate).

Since there are 2 unknowns, you need to form a system with two equations.

For equation 1: The sum of Janna and Mark's age is 40. ⇒ $\boldsymbol{x + y = 40}$

For equation 2: Two years ago, Janna was twice as old as Mark.

Janna (two years ago) = 2 times Mark's age (two years ago)

$x - 2 = 2(y - 2)$ *Simplify. Use distributive Property*

$x - 2 = 2y - 4$ *Combine like terms*

$\boldsymbol{x - 2y = -2}$

Putting the two equations together in a system, you get:

Equation 1 $x + y = 40$
Equation 2 $x - 2y = -2$

Step 3: Carry out the plan (solve).

Use one of the methods for solving systems of equations. For this example, use elimination method. Since the numerical coefficients of the variable x in equation 1 and 2 are the same or equal, then elimination by subtraction can be used.

$x + y = 40$ *Equation 1*

$x - 2y = -2$ *Equation 2*

To find Mark's age,

$$\begin{array}{rcl} - \quad x + y & = & 40 \\ x - 2y & = & -2 \\ \hline 3y & = & 42 \end{array}$$

Eliminate x by subtraction & solve for y

$\frac{1}{3}(3y) = \frac{1}{3}(42)$ *Multiply both sides by $\frac{1}{3}$ by Multiplication Property of Equality*

$\boldsymbol{y = 14}$ *By simplification*

To find Janna's age

$x + y = 40$ *Use equation 1 to find Janna's age*

$x + 14 = 40$ *Substitute the value of y obtained*

$x + 14 - 14 = 40 - 14$ *Add both sides by -14 by Addition Property of Equality*

$\boldsymbol{x = 26}$ *By simplification*

Step 4: Look back (check and interpret).

Check answers directly against the facts of the problems. Substitute the value of x and y to both equations

Sum of Janna's and Mark's age

$$x + y = 40$$
$$26 + 14 = 40$$
$$40 = 40$$

Two years ago, Janna was twice as old as Mark

$$-x + 2y = 2$$
$$-26 + 2(14) = 2$$
$$-26 + 28 = 2$$
$$2 = 2$$

Therefore, Janna's age is 26.

Illustrative Example 2: (Number Problem)

The sum of two numbers is 10. The larger number is 8 more than the smaller number. Find the two numbers.

Step 1: Understand the problem.

Read and understand the problem. Since you are asked to find the two numbers, then let $\boldsymbol{x}$ = larger number and $\boldsymbol{y}$ = smaller number.

Step 2: Devise a plan (translate).

For equation 1: The sum of two numbers is 10 $\Rightarrow$ $x + y = 10$

For equation 2: The larger number is 8 more than the smaller number $\Rightarrow$ $x = y + 8$

Putting the two equations together in a system, you get:

$$\begin{cases} x + y = 10 & \textit{Equation } 1 \\ x = y + 8 & \textit{Equation } 2 \end{cases}$$

Step 3: Carry out the plan (solve).

In this example, notice that in Equation 2, x is expressed in terms of y. Hence, you can substitute x with $y + 8$ in Equation 1:

Use Equation 1 to solve for y:

$x + y = 10 \Rightarrow$	$(y + 8) + y$	$=$	10	Substitute x with $y + 8$ from Equation 2
	$2y + 8$	$=$	10	*Combining like terms*
	$2y + 8 - 8$	$=$	$10 - 8$	*Addition Property of Equality*
	$2y$	$=$	2	*Additive Inverse Property*
	$\frac{1}{2}(2y)$	$=$	$\frac{1}{2}(2)$	*Multiplication Property of Equality*
	$\boldsymbol{y}$	$=$	$\mathbf{1}$	*Multiplicative Inverse Property*

Use Equation 2 to solve for x:

x	$=$	$y+8$	*Equation 2*
x	$=$	$1+8$	*Substitute the value of y*
x	$=$	9	*By simplification*

Hence, the two numbers obtained are x = 9 and y = 1.

Step 4: Look back (check and interpret).

Check whether the obtained values of x and y satisfy both of the equations.

$$x + y = 10 \qquad x = y + 8$$
$$9 + 1 = 10 \qquad 9 = 1 + 8$$
$$10 = 10 \; \checkmark \qquad 9 = 9 \; \checkmark$$

Therefore, the larger number is 9, and the smaller number is 1.

Illustrative Example 3: (Break-even Point Problem)

Mr. Perez is trying to decide between two hotels to be the venue of his daughter's 18th birthday celebration. Both venues are spacious and elegant and can provide LED screen. Hotel ***A*** charges Php12,000.00 for the first five hours venue rental, plus an additional Php500.00 per hour for the extended hours used. Hotel ***B*** charges Php10,500.00 for the first five hours venue rental, plus Php1,000.00 per hour for the extended hour used. At how many hours will the two hotels charge the same amount of money? If you are to recommend to Mr. Perez as to which of the two hotels shall be the venue of his daughter's 18th birthday celebration, which will you recommend? Why?

Step 1: Understand the problem.

Read and understand the problem. Since you are looking for an ordered pair, let

x = number of hours of extended use
y = total cost (rental cost plus the additional charge per hour)

Step 2: Devise a plan (translate).

Since there are 2 unknowns, we need to form a system with two equations

For equation 1 $\quad y = 500x + 12{,}000$

For equation 2 $\quad y = 1{,}000x + 10{,}500$

Step 3: Carry out the plan (solve).

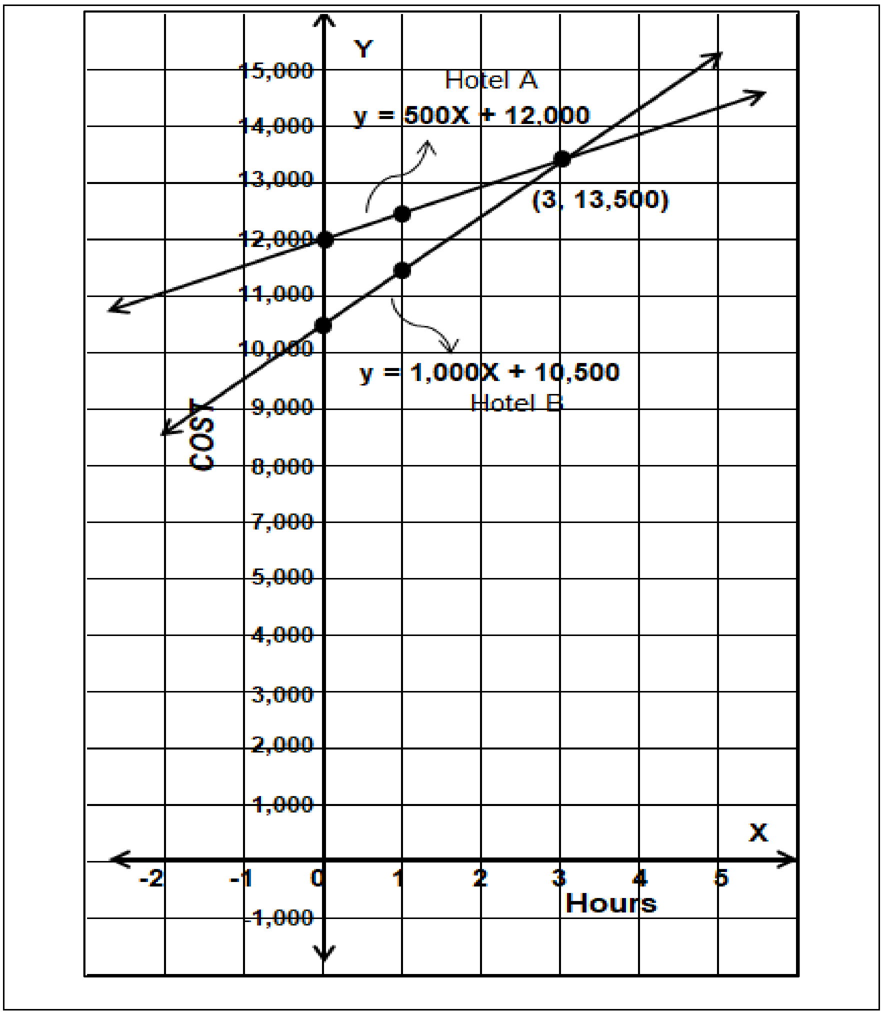
Use one of the methods for solving systems of equations. Since the problem asks us to determine the number of hours where the two hotels charge the same amount of money, we can solve this graphically.

To graph the equations obtained in step 2, simply determine the slopes and y-intercepts of the equations since the two equations obtained in step 2 are already in slope-intercept form.

For eq.1 $y = 500x + 12{,}000$; m = 500; b = 12,000

For eq.2 $y = 1{,}000x + 10{,}500$; m = 1,000; b = 10,500

The point of intersection of the graphs refers to a point where the two hotels charge the same amount of money.



Step 4: Look back (check and interpret).

Check answers directly against the facts of the problems. Substitute the value of x and y to both equations.

$y = 500x + 12{,}000$	$y = 1000x + 10{,}500$
$13{,}500 = 500(3) + 12{,}000$	$13{,}500 = 1000(3) + 10{,}500$
$13{,}500 = 1{,}500 + 12{,}000$	$13{,}500 = 3{,}000 + 10{,}500$
$13{,}500 = 13{,}500$	$13{,}500 = 13{,}500$

Therefore, the number of hours the two hotels charges the same amount is when the extended hours reach 3 hours at Php13,500.00

To answer Question No. 2, let us find the value of y when the extended number of hours is less than 3 hours and when the extended number of hours is more than 3 hours. Suppose we solve for y in both equations when $x = 2$ and when $x = 4$.

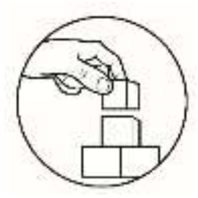
Equation 1: $y = 500x + 12{,}000$ (Hotel A)	Equation 2 : $y = 1000x + 10{,}500$ (Hotel B)
Solve for y, when $x = 2$	Solve for y, when $x = 2$
$y = 500x + 12{,}000$	$y = 1000x + 10{,}500$
$y = 500(2) + 12{,}000$	$y = 1000(2) + 10{,}500$
$y = 1{,}000 + 12{,}000$	$y = 2{,}000 + 10{,}500$
$\mathbf{y = 13{,}000}$	$\mathbf{y = 12{,}500}$

At $x = 2$, the cost of Hotel A is higher than the cost of Hotel B.

Equation 1: $y = 500x + 12{,}000$ (Hotel A)	Equation 2 : $y = 1000x + 10{,}500$ (Hotel B)
Solve for y, when $x = 4$	Solve for y, when $x = 4$
$y = 500x + 12{,}000$	$y = 1000x + 10{,}500$
$y = 500(4) + 12{,}000$	$y = 1000(4) + 10{,}500$
$y = 2{,}000 + 12{,}000$	$y = 4{,}000 + 10{,}500$
$\mathbf{y = 14{,}000}$	$\mathbf{y = 14{,}500}$

At $x = 4$, the cost of Hotel A is lower than the cost of Hotel B.

This means that Hotel B is recommended if the extended number of hours is less than 3 hours, both hotels A & B can be recommended if the extended number of hours is exactly 3 hours, and Hotel A is recommended if the extended number of hours is more than 3 hours.



What's More

Activity 3: Substitute!

Directions: Solve each system of equations by substitution. Check your solutions.

1. $\begin{cases} y = 2x \\ x + y = 6 \end{cases}$ 2. $\begin{cases} 5x + 10y = 3 \\ x = -\frac{1}{2}y \end{cases}$ 3. $\begin{cases} y - x = 3x + 2 \\ 2x + 2y = 14 - y \end{cases}$

Activity 4: Who Will Be Eliminated?

Directions: Identify the terms that can be eliminated. If elimination by addition or subtraction cannot be directly performed, state first the number or numbers that should be multiplied to one or both equations (see example). Then solve each system by elimination. Check your solutions.

Example: $\begin{cases} \mathbf{3x - 4y = -7} \\ \mathbf{2x + y = 10} \end{cases}$	⇒	Multiply first equation 2 by 4, then eliminate $(-4y)$ and $4y$.

1.	$\begin{cases} \mathbf{x + y = -1} \\ \mathbf{x - y = 3} \end{cases}$	⇒	
2.	$\begin{cases} \mathbf{x + y = 5} \\ \mathbf{x + 2y = 8} \end{cases}$	⇒	
3.	$x + y = 1$ $2x - 2y = 4$	⇒	
4.	$4x + 4y = 6$ $5x - 2y = 4$	⇒	

Questions:

1. How did you identify the terms to be eliminated?
2. What have you noticed with the numerical coefficients of the variables of the terms to be eliminated?
3. What operation should be used to eliminate a variable in item 1? in item 2?
4. Can any of the variable be directly eliminated in items 3, and 4? Why or Why not?
5. Is there a need to find equivalent equations in 3, and 4 to eliminate a variable? What are these new equations?

Activity 5: Following Protocols

Directions: Solve the problem below by illustrating the process of finding solution. Write your answer on a separate sheet of paper.

Matt and Ming are selling fruit for a school fundraising activity. Customers can buy small and large pieces of oranges. Matt sells 3 small pieces and 14 large pieces of oranges for a total of P203. Ming sells 11 small pieces of oranges and 11 large pieces of oranges for a total of P220. Find the cost of a small pieces and large pieces of oranges.

Step 1. Understand the problem	Let x _________ Let y _________
Step 2. Devise a plan (translate)	Equation 1:_____________ Equation 2:_____________
Step 3. Carry out the plan (solve).	Solution:
Step 4. Look back (Check and interpret)	Check:

What I Have Learned

Activity 6: You Complete Me!

Directions: Complete each statement below.

In this lesson, I learned the steps in solving a system of linear equations in two variables using substitution method.

First, I ____

After that, I ____

Then, ____

Finally, ____

When I have completed these steps, I have shown that _________________________

____.

Activity 7: Put Me in My Right Place!

Directions: Fill in the blank spaces of the paragraph below with correct word/s or expression/s which you can choose from the box. Word/s or expression/s in the box may be used more than once.

add	eliminate	solution	3	variable	subtract
adding	substitute	(10,3)	10	y	$2y + 4$

I can solve systems of linear equations in two variables by graphing or by algebraic method. In the elimination method, I can either ___ or ______ the equations to eliminate one ______. When the coefficients of one variable are opposite, I can ___ the two equations to eliminate that variable. When the coefficients of one variable are equal, I can ______ the equations to eliminate that variable.

In the system $\begin{cases} x = 2y + 4 \\ x + 3y = 19 \end{cases}$, equation 1 is already solved for x in terms of ____. Therefore, by substitution method, we can ______ the expression _____ for x in the other linear equation to find y and the result would be y = ___. To find the value of x, substitute $y = 3$ in either of the original equations. Hence, the value of x = ___. To check whether the ordered pair $(10, 3)$ satisfies both equations we must substitute it to both equations. Since both equations are true after substituting the obtained values of x and y, this means that coordinate _______ is a _______ to the system.

What I Can Do

Activity 8: Problems Solved!

Directions: Read each problem carefully and solve as required. Then answer the questions that follow. Use a separate sheet of paper.

A. The Number Game

The sum of two numbers is 90. The larger number is 14 more than 3 times the smaller number. Find the numbers.

Questions:

1. What equations can be formed to determine the two numbers?
2. What method of solving systems of linear equation in two variables can best be applied to solve this problem?
3. What are the two numbers?

B. Chocolate Desires

White chocolate costs Php 20.00 per bar, and dark chocolate costs Php 25.00 per bar. If Janine bought 15 bars of chocolate for Php 340, how many bars of dark chocolate did she buy?

Questions:
1. What two equations can be formed to represent the number of chocolate bars?
2. What method of solving systems of linear equations in two variables can best be applied to solve this problem? Why do you think the method you chose is appropriate to solve this type of problem?
3. How many bars of dark chocolate did Janine buy?

C. Bonding, Bonding…

It's vacation time of the year and Luigi's family agreed to go to a famous beach resort in their province. Upon entering the resort, they were asked to pay tickets which cost $Php200.00$ for children (5 to 12 years old) and $Php450.00$ for adults. If the resort were able to sell 250 pieces of beach ticket amounting to $Php76,000.00$, how many children and adults were in the beach?

Questions:

5. What are the two equations that can be used to find the number of children and adults in the beach?
6. How many children and adults were in the beach?

Assessment

Directions: Read the questions carefully and choose the letter of the correct answer. Write your answer on a separate sheet of paper.

1. Which method is best to use when the numerical coefficients of the variables are either $1 \; or \; -1$?
   A. algebraic C. graphical
   B. elimination D. substitution

2. Which method is best to apply to solve the system $\begin{cases} y = 3x - 2 \\ 2x + y = 8 \end{cases}$?
   A. algebraic C. graphical
   B. elimination D. substitution

3. Which of the following equations can best be solved using elimination by addition?

A. $\begin{cases} 2x + y = 10 \\ 2x + y = 8 \end{cases}$

B. $\begin{cases} x + y = 5 \\ x - y = 7 \end{cases}$

C. $\begin{cases} x + y = 10 \\ 2x + y = 8 \end{cases}$

D. $\begin{cases} x - 3y = 5 \\ 3 + x = -2y \end{cases}$

4. The system of linear equation $\begin{cases} y = 2x - 9 \\ x + 3y = 8 \end{cases}$ is solved by substitution. After the initial substitution in the second equation, which of the following is the resulting expanded equation?

A. $x + 3y - 9 = 8$
B. $x + 3(2x) - 9 = 8$
C. $x + 3(2x) - 9 = 8$
D. $x + 3(2x - 9) = 8$

5. The first thing to do when solving systems of linear equation by elimination is rewriting equations into the standard form $Ax + By = C$. Which of the following is the resulting system of equations when $\begin{cases} 3x + 2y + 1 = 5 \\ 3\,(x - 1) = -2y - 4 \end{cases}$ is written in standard form?

A. $\begin{cases} 3x + 2y = 6 \\ 3x + 2y = 7 \end{cases}$

B. $\begin{cases} 3x + 2y = 4 \\ 3x + 2y = 7 \end{cases}$

C. $\begin{cases} 3x + 2y = 4 \\ 3x + 2y = -1 \end{cases}$

D. $\begin{cases} 3x + 2y = 6 \\ 3x - 2y = -3 \end{cases}$

6. The system of linear equation $\begin{cases} 3x + 12y = -12 \\ x - 3y = 10 \end{cases}$ is to be solved using elimination method. What should be the first step to solve this system?

A. Add the two equations.
B. Subtract the equations.
C. Multiply the first equation by -4
D. Multiply the second equation by 4

7. Given $\begin{cases} 2x - 3y = 10 \\ 3x - 2y = -5 \end{cases}$, which of the following is its equivalent system with same x −coefficients?

A. $\begin{cases} 6x - 9y = 10 \\ 6x - 2y = -10 \end{cases}$

B. $\begin{cases} 6x - 3y = 10 \\ 6x - 2y = -5 \end{cases}$

C. $\begin{cases} 6x - 9y = 30 \\ 6x - 4y = -10 \end{cases}$

D. $\begin{cases} 6x - 9y = 30 \\ 6x - 4y = 10 \end{cases}$

8. Given $\begin{cases} 2x - y = 5 \\ x + 2y = -5 \end{cases}$, which of the following is its equivalent system with opposite $y - coefficients$?

A. $\begin{cases} 8x - 4y = 20 \\ 2x + 4y = -10 \end{cases}$

C. $\begin{cases} 8x - 2y = 10 \\ 4x + 2y = -20 \end{cases}$

B. $\begin{cases} -4x - 2y = 20 \\ 8x + 2y = -10 \end{cases}$

D. $\begin{cases} 4x - 4y = 10 \\ -8x + 4y = -20 \end{cases}$

9. In three more years, Miguel's grandfather will be six times as old as Miguel was last year. When Miguel's present age is added to his grandfather's present age, the total is 68. How old is Miguel now?

A. 9
C. 11
B. 10
D. 12

10. The sum of two numbers is 15. If twice the first number is added to thrice the second number their sum would be 35. What are the numbers?

A. 7 and 8
C. 10 and 5
B. 9 and 6
D. 12 and 3

11. A total of 315 Grade 8 students participated in a community outreach program organized by the local government. Some students rode in vans which hold 9 passengers each and some students rode in buses which hold 22 passengers each. How many of each type of vehicle did they use if there were 22 vehicles in total?

A. 9 vans and 13 buses
C. 15 vans and 7 buses
B. 13 vans and 9 buses
D. 7 vans and 15 buses

12. 3 bags and 2 pairs of shoes cost Php1, 500.00 while 5 bags and 8 pairs of shoes cost Php4 950.00. What is the cost of each bag and a pair of shoes?

A. Each bag cost Php250.00 and each pair of shoes cost Php425.00.
B. Each bag cost Php275.00 and each pair of shoes cost Php400.00.
C. Each bag cost Php200.00 and each pair of shoes cost Php475.00.
D. Each bag cost Php150.00 and each pair of shoes cost Php525.00.

13. A farmyard has dogs and chickens. The owner said that his dogs and chickens had a total of 148 legs and 60 heads. How many dogs and chickens were in the farmyard?

A. 22 dogs and 38 chickens
C. 14 dogs and 46 chickens
B. 38 dogs and 22 chicken
D. 46 dogs and 14 chickens

14. After solving the system $\begin{cases} -x + 4y = 6 \\ x + y = -3 \end{cases}$, Arnold says that it has exactly one solution. Which of the following reasons would support his statement?

I. An ordered pair $\left(-\frac{18}{5}, \frac{3}{5}\right)$ satisfies both equations.
II. An ordered pair $\left(\frac{18}{5}, -\frac{3}{5}\right)$ satisfies both equations.
III. The system becomes a true statement after eliminating a variable.
IV. The system becomes a FALSE statement after eliminating a variable.

A. I only
B. I and II
C. II and III
D. IV only

15. John was asked by his Mathematics teacher to solve the system $\begin{cases} x = 2y + 3 \\ 2x + 3y = -3 \end{cases}$. He decided to use substitution method to solve the system. Which of the following statements justify his choice of method?

I. It is always the recommended method for systems with one solution.
II. It is recommended because one of the equations is not in standard form.
III. Substitution should be used since one of the equations is already solved in terms of one variable.

A. I
B. II
C. III
D. I and II

Additional Activities

Activity 9: Let us Explore Further!

Directions: Answer each question as directed. Solve when necessary. Use a separate sheet of paper.

1. Write the equivalent equations without fractions for each equation in the system. Solve the system.

$$\begin{cases} \dfrac{5x-2}{4} + \dfrac{1}{2} = \dfrac{3y+2}{2} \\ \dfrac{7y+3}{3} = \dfrac{x}{2} + \dfrac{7}{3} \end{cases}$$

2. Is it possible to use substitution or elimination to solve a system of linear equations in two variables if one equation represents a vertical line and the other equation represents a horizontal line? Show and explain your answer.

3. Using a Venn Diagram, compare and contrast Graphing, Elimination, and Substitution Methods in solving systems of linear equations in two variables.

Answer Key

What I Know

1. B
2. C
3. B
4. C
5. A
6. B
7. B
8. C
9. B
10. A
11. A
12. D
13. A
14. C
15. D

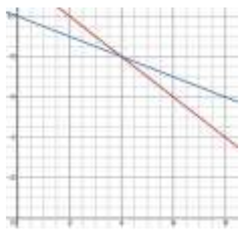
What's In

Activity 1: Transform Me!

Original Equation	Transformed Equation
1. $x + y = 2$	$x = -y + 2$
2. $x - y = \frac{2}{3}$	$x = y + \frac{2}{3}$
3. $3x + 2y = 6$	$x = -\frac{2}{3}y + 2$
4. $\frac{1}{4}x + y = 2$	$y = -\frac{1}{4}x + 2$
5. $4x - 3y = -33$	$y = \frac{4}{3}x + 11$

WHAT'S NEW

Activity 2: Charlie's Candies



1.
1.1 (4, 8)
2. $y = -x + 12$
2.1 (4,8)
2.2 Yes
3. $x = 4$ and $y = 8$
3.1 Yes. (4, 8)
4. Yes.

4 pieces of orange flavored candies & 8 pieces of mint candies

What's More

Activity 3: SUBSTITUTE

1. (2, 4) 2. $\left(-\frac{1}{5}, \frac{2}{5}\right)$ 3. $\left(\frac{4}{7}, \frac{30}{7}\right)$

Activity 4: Who will be eliminated?

1. eliminate $(+y) and (-y)$
Solution: (1, -2)
2. subtract both equations and then eliminate $(x) and (-x)$.
Solution: (2, 3)
3. multiply first equation by 2 and then eliminate $(2y) and (-2y)$
Solution: $\left(\frac{3}{2}, -\frac{1}{2}\right)$
4. multiply second equation by 2 and then eliminate $4y and (-4y)$
Solution: $\left(1, \frac{1}{2}\right)$

Activity 5: Following Protocols

Step 1: let x be small pieces of oranges
Let y be large pieces of oranges

Step 2:
Equation 1: $3x + 14y = 203$
Equation 2: $11x + 11y = 220$

Step 3: Solution:

$$-11(3x + 14y = 203)$$
$$3(11x + 11y = 220)$$

$$-33x - 154y = -2{,}233$$
$$33x + 33y = 660$$
$$\frac{-121y}{-121} = \frac{-1{,}573}{-121}$$
$$y = 13$$

Substitute the value of y to the 1st equation.

$$3x + 14y = 203$$
$$3x + 14(13) = 203$$
$$3x + 182 = 203$$
$$3x = 203 - 182$$
$$3x = 21$$
$$x = 7$$

Step 4: Check and Interpret.

Equation 1: 3x + 14y = 203
3(7) +14(13) = 203
21+182 = 203
203 = 203

Equation 2: 11x + 11y = 220
11(7) + 11(7) = 220
77 + 143 = 220
220 = 220

Therefore, small pieces of oranges costs P7.00 and the large pieces of oranges costs P13.00

WHAT HAVE I LEARNED

Activity 6: You Complete Me!

Answers may vary.

Activity 7: Put Me in My Right Place!

I can solve systems of linear equations in two variables by graphing or by algebraic method. In the elimination method, I can either add or subtract the equations to eliminate one variable. When the coefficients of one variable are opposite, I can add the two equations to eliminate that variable. When the coefficients of one variable are equal, I can subtract the equations to eliminate that variable.

In the system $\begin{cases} x = 2y + 4 \\ x + 3y = 19 \end{cases}$, equation 1 is already solved for x in terms of y. Therefore by substitution method, we can substitute the expression $2y + 4$ for x in the other linear equation to find y and the result would be y = 3. To find the value of x, substitute $y = 3$ in either of the original equations. Hence, the value of x = 10. To check whether the ordered pair (10, 3) satisfies both equations we must substitute it to both equations. Since both equations are true after substituting the obtained values of x and y, this means that coordinate (10,3) is a solution to the system.

What I Can Do

Activity 8: Problems Solved!

A. The Number Game

1. $x + y = 90$ *and* $x = 3y + 14$
2. Substitution method
3. 71 and 19

B. Chocolate Desires

1. $x + y = 15$ and
   $20x + 25y = 340$
2. Answers may vary.
3. 8 bars of dark chocolate

C. Bonding, Bonding

1. $x + y = 250$ *and* $200x + 450y = 76{,}000$
2. 146 children and 104 adults

Assessment

1. B	6. D	11. B
2. D	7. C	12. D
3. B	8. A	13. C
4. D	9. C	14. A
5. C	10. C	15. C

Additional Activities:

Activity 9: Let's Explore Further!

1. $\begin{cases} 5x - 6y = 4 \\ 3x - 14y = -8 \end{cases}$; (2,1)

2. No. Horizontal lines have a slope of 0 and is represented by formula y=b so it always takes the same value, the same goes with vertical lines, x only takes one value thus, the equation is $x = a$. Looking at these formulas, solving using substitution or eliminations method is unapplicable.

3.

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