Solving Systems of Linear Equations Elimination (Addition)	**Student/Class Goal** Students thinking about continuing their academic studies in a post-secondary institution will need to know and be able to do problems on solving systems of equations.
Outcome (*learning objective*) Students will accurately solve systems of equations using elimination/addition method.	**Time Frame** 1-2 hours
Standard *Use Math to Solve Problems and Communicate*	**NRS EFL** 5-6

Activity Addresses Benchmarks (content)
Primary Benchmarks M.5.19, M.6.19
Supporting Benchmarks M.5.16, M.6.16, M.5.25, M.6.26, M.5.28, M.6.29

Materials
Steps to Solve Systems of Equations by Addition or Elimination Handout
What Do I Eliminate and How? Activity
Using Elimination/Addition to Solve Systems of Equations Activity
Math Scavenger Hunt Teacher Resource
Math Scavenger Hunt Student Answer Sheet
Elimination/Addition Scavenger Hunt Information Sheet/Answers

Learner Prior Knowledge
Students should be fluent in solving linear equations and integer operations. They should have the ability to solve systems of equations by graphing. They will have completed earlier lessons on systems of equations, such as *Solving Systems of Linear Equations Substitutions.* **Teacher Note** Be sure to classify each system as consistent or inconsistent and dependent or independent*.*

Instructional Activities
Step 1 – Discuss the methods they have learned for solving systems of equations (graphing and substitution). Share with the class that today they will learn a third method for solving systems of equations.

Review with the students the basics of solving equations: 1) combining like terms and 2) performing the same operation on both sides of the equation (e.g. subtract 8 from both sides, etc.). As long as the same operation is completed on both sides of the equals sign, terms can be eliminated yet the value of both sides of the equation will remain the same.

Teacher Note This concept is used in the addition or elimination method (different resources call it different things) of solving systems of equations. The properties of equality can be used to adjust the variable so it may be eliminated. Once there is a solution for the first variable, this number can be substituted into one of the original equations, and the equation can be solved for the second variable.

Step 2 - Model the steps used to solve by elimination or addition the sample systems of equations found in the handout, *Steps to Solve Systems of Equations by Addition or Elimination.* Complete the samples on a chalkboard or overhead encouraging student assistance throughout the activity (solution to system in handout: x=6 and y=0).

Distribute handout to the students for review and reference after the examples are completed.

Step 3 - Discuss with students the criteria to look for to determine which variables in a system would be easier to eliminate (variables with the same terms and different signs). Discuss what could be done to create terms to eliminate if necessary - multiply the terms in the equation by a number to create a term to eliminate. Review properties of equality mentioned in teacher note in step 1*.* This can be done in one or both equations. Complete the *What Do I Eliminate and How?* activity.

Teacher Note You can make this a classroom activity. Write the contents of each box and heading on a sentence strip. Add magnets to the back. Arrange on a magnetic board.

Step 4 - Students will solve systems of equations using the addition/elimination method by completing the second activity, *Using Elimination/Addition to Solve Systems of Equations*.

Teacher Note This activity might be completed in pairs to help students feel more comfortable with the process of solving systems with addition/elimination.

Step 5 – For additional practice, solve systems using the elimination method found in math books as needed for independent application of problems.

Step 6 – Set up a Math Scavenger Hunt in the classroom using the directions found in the *Math Scavenger Hunt* Teacher Resource and Answer Sheet. The questions and answers found in the *Elimination/Addition Scavenger Hunt* Information Sheet will provide the questions and solutions to place on each clue card. The answers are also included for your reference.

Assessment/Evidence (*based on outcome*)
Math Scavenger Hunt completed with 100% accuracy.

Teacher Reflection/Lesson Evaluation
This lesson has not yet been field tested.

Next Steps
This is part of a series of lessons on solving systems of linear equations. To continue the study, complete *Solving Systems of Linear Equations Putting It All Together*.

Technology Integration
Systems of Linear Equations: Solving by Addition / Elimination
http://www.purplemath.com/modules/systlin5.htm
Solving Systems of Equations by Addition/Subtraction
http://cstl.syr.edu/fipse/algebra/unit5/equiadd.htm

Steps to Solve Systems of Equations by Addition or Elimination

1. Add or subtract to combine the equations and eliminate one of the variables
2. Solve the resulting equation.
3. Substitute the known value of the first variable (found in step #1) in one of the original equations in the system.
4. Solve this equation for the second variable.
5. Check the solution in both equations of the system.

Sample 1

$$3x + y = 10 \qquad 2x - y = 5$$

$3x + y = 10$ Combine by addition (Step 1)
$\underline{2x - y = 5}$
$5x \quad = 15$ y variable is eliminated (Step 1)

$5x/5 = 15/5$ Divide both sides by 5

$X = 3$ First variable solution (Step 2)
$3(3) + y = 10$ Substitute the variable into the equation (Step 3)

$9 - 9 + y = 10 - 9$ Subtract 9 from both sides
$y = 1$ Second variable solution (Step 4)

Check the solutions (x = 3 and y = 1) in the original equations (Step 5)

$3x + y = 10$	$2x - y = 5$
$3(3) + 1 = 10$	$2(3) - 1 = 5$
$9 + 1 = 10$	$6 - 1 = 5$
$10 = 10$	$5 = 5$

Complete the following system using the steps listed and Sample 1 above:

$$5x - 2y = 30$$
$$X + 2y = 6$$

Solution can be found in step 2 of the lesson.

What Do I Eliminate and How? Activity

Cut out the boxes with systems of equations and phrases located at the bottom of the sheet. Look at each system and decide which variable would be easier to eliminate. Place the system under the correct variable on the chart. If changes need to be made to the system, include those changes under the category "How To."

When completed tape or glue each system and "how to" in the correct column.

ELIMINATE x	ELIMINATE y	HOW TO

MULTIPLY BY (-2)	4x + 2y = 8 5x − 3y = 4	x + 2y = 3 -x + y = -2
MULTIPLY BY 3	x + 4y = 7 2x − 4y = -3	2x + 5y = 6 -x + 2y = 3
MULTIPLY BY 2	-2x + 3y = 7 2x − 5y = -3	2x − 3y = -2 3x + 3y = 4

Using Elimination/Addition to Solve Systems of Equations Activity

Use elimination/addition to solve the systems of equations listed below. Be sure to show the steps you used to solve each system of equations.

$4x + 2y = 8$
$5x - 3y = 4$

$x + 2y = 3$
$-x + y = -2$

$X + 4y = 7$
$2x - 4y = -3$

$2x + 5y = 6$
$-x + 2y = 3$

$-2x + 3y = 7$
$2x - 5y = -3$

$2x - 3y = -2$
$3x + 3y = 4$

Supplies
Paper or card stock (8 ½" by 11")
2 colored markers
Tape

A math scavenger hunt is a fun way to assess the math skills of your students. Most any math topic can be evaluated with this activity, and the students will stay active as they move around the room solving problems and searching for the answers. Students can work in groups or alone as they complete the activity.

To set up a scavenger hunt select 6-8 problems with answers. Before you make the scavenger hunt clue cards, do some planning to make sure each problem and its answer will be on different cards. This has already been done for you in the series of lessons on systems of equations. When you have decided on the problem and answer to place on each card, write a problem at the top (portrait orientation) of the clue card and a solution at the bottom of the card. Write all the answers in one color of marker, and use the second color for the problems. Tape these sheets around the room.

Math Clue Card Example

2 X 4
10

Now it is time for the students to complete the Math Scavenger Hunt. Give each student a Scavenger Hunt Answer Sheet (see below). Students can start their hunt at any location in the room. This way the class will be spread out around the classroom. At their first stop, the students will write the problem on their answer sheet and solve it. Remember the problem will be at the bottom of the sheet. There is space on the answer sheet for the students to show their work. Once they have solved this problem they will find the Scavenger Hunt Clue Card with their answer. The problem at the bottom of this clue card will be the students' next problem to solve. If the students don't find their answer when they look around the room, the students know to redo their work. Students continue with this process until all the problems have been completed, and they return to the card which contains their first problem.

The answers can be corrected quickly because the answers will be in a specific order. Remember each student will start the Scavenger Hunt in a different place in the answer sequence.

Math Scavenger Hunt Student Answer Sheet

Problems	Answers

Use the following systems of equations and solutions to create a Math Scavenger Hunt for the students. The solutions in the left column should be placed on the top of the clue cards, and the system next to it should be written on the bottom of the card. **Note** The solutions do not match the systems they are next to!

$2x + y = 7$ $3x - y = 3$	$(3, 0)$
$x - y = 4$ $x + y = 2$	$(-4, 3)$
$2x + 3y = 8$ $3x + y = 5$	$(-1, 3)$
$2x - 3y = 8$ $2x + 3y = 4$	$(3, 2)$
$5x + y = 15$ $3x + 2y = 9$	$(3, -1)$
$-x + 2y = 10$ $x - 3y = -13$	$(3, -2/3)$
$2x - 3y = 0$ $-2x + 2y = -2$	$(2, 3)$
$y = 3x + 6$ $2y = -3x + 3$	$(1, 2)$

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$2x + y = 7$
$3x - y = 3$

$(3, 0)$

$x - y = 4$
$x + y = 2$

$(-4, 3)$

$2x + 3y = 8$
$3x + y = 5$

$(-1, 3)$

$2x - 3y = 8$
$2x + 3y = 4$

$(3, 2)$

$5x + y = 15$
$3x + 2y = 9$

$(3, -1)$

$-x + 2y = 10$
$x - 3y = -13$

$(3, -2/3)$

$2x - 3y = 0$
$-2x + 2y = -2$

$(2, 3)$

$y = 3x + 6$
$2y = -3x + 3$

$(1, 2)$