Mathematics Instructional Cycle Guide

Systems of Equations
(CCSS.Math.Content.HSA.REI.C.6)

Created by Colm Duffin, 2014 Connecticut Dream Team Teacher

CT CORE STANDARDS

This Instructional Cycle Guide relates to the following *Standards for Mathematical Content* in the *CT Core Standards for Mathematics*:

Model and solve a real world problem using a system of equations.
CCSS.Math.Content.HSA.REI.C.6
Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

This Instructional Cycle Guide also relates to the following *Standards for Mathematical Practice* in the *CT Core Standards for Mathematics*:

CCSS.Math.Practice.MP1	**Make sense of problems and persevere in solving them.**
CCSS.Math.Practice.MP4	**Model with mathematics.**
CCSS.Math.Practice.MP7	**Look for and make use of structure.**

WHAT IS INCLUDED IN THIS DOCUMENT?

- A Mathematical Checkpoint to elicit evidence of student understanding and identify student understandings and misunderstandings **(PAGE 2)**
- A student response guide with examples of student work to support the analysis and interpretation of student work on the Mathematical Checkpoint **(PAGE 3)**
- A follow-up lesson plan designed to use the evidence from the student work and address the student understandings and misunderstandings revealed **(PAGE 7)**
- Supporting lesson materials **(PAGE 9)**
- Precursory research and review of standard **CCSS.Math.Content.HSA.REI.C.6** and assessment items that illustrate the standard **(PAGE 20)**

HOW TO USE THIS DOCUMENT

1) Before the lesson, administer the **(Amanda's Party)** ***Mathematical Checkpoint*** individually to students to elicit evidence of student understanding.
2) Analyze and interpret the student work using the ***Student Response Guide***
3) Use the next steps or ***follow-up lesson plan*** to support planning and implementation of instruction to address student understandings and misunderstandings revealed by the Mathematical Checkpoint
4) Make instructional decisions based on the checks for understanding embedded in the follow-up lesson plan

MATERIALS REQUIRED

- **None**

TIME NEEDED

CHECKPOINT (Amanda's Party) administration: **20 minutes**
Follow-Up Lesson Plan: **1 class period (45 minutes)**

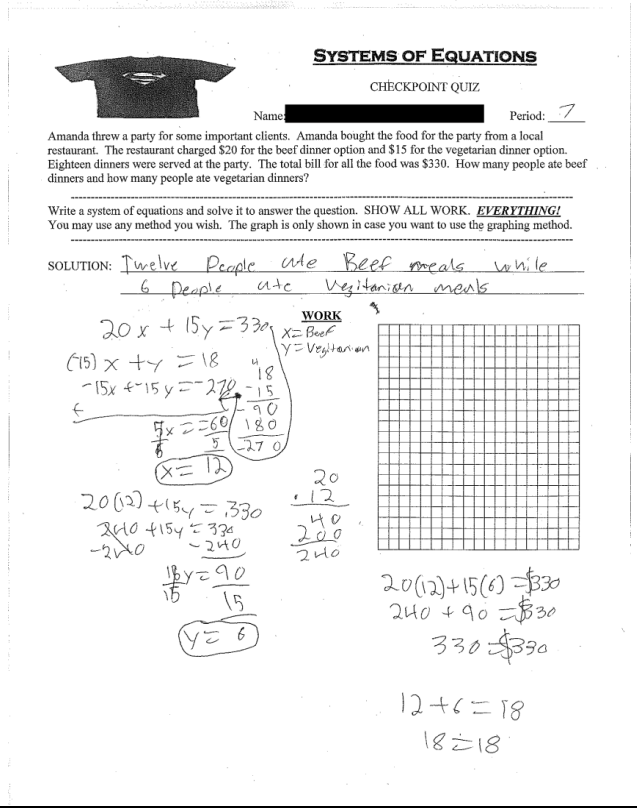
Timings are only approximate. Exact timings will depend on the length of the instructional block and needs of the students in the class.

Step 1: Elicit evidence of student understanding		
Mathematical Checkpoint		
Question(s)	**Purpose**	
Amanda threw a party for some important clients. Amanda bought the food for the party from a local restaurant. The restaurant charged $20 for the beef dinner option and $15 for the vegetarian dinner option. Eighteen dinners were served at the party. The total bill for all the food was $330. How many people ate beef dinners and how many people ate vegetarian dinners? Write and solve a system of equations to answer the question.	**CT Core Standard:**	CCSS.Math.Content.HSA.REI.C.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
	Target question addressed by this checkpoint:	Can students correctly model and solve a real world problem using a system of equations? Can student correctly check the solution to a system of equations? Can students interpret the mathematical solution to a system of equations in the context of the given problem?

Step 2: Analyze and Interpret Student Work

Student Response Guide

Got It



SYSTEMS OF EQUATIONS

CHECKPOINT QUIZ

Name: [redacted] Period: 7

Amanda threw a party for some important clients. Amanda bought the food for the party from a local restaurant. The restaurant charged $20 for the beef dinner option and $15 for the vegetarian dinner option. Eighteen dinners were served at the party. The total bill for all the food was $330. How many people ate beef dinners and how many people ate vegetarian dinners?

Write a system of equations and solve it to answer the question. SHOW ALL WORK. ***EVERYTHING!*** You may use any method you wish. The graph is only shown in case you want to use the graphing method.

SOLUTION: Twelve People ate Beef meals while 6 People ate Vegitarian meals

WORK

$20x + 15y = 330$

X= Beef
Y= Vegitarian

$(15)\ x + y = 18$

$-15x + -15y = -270$

$5x = -60$

$x = 12$

$20(12) + 15y = 330$

$240 + 15y = 330$

$-240 \quad -240$

$15y = 90$

$y = 6$

$20 \cdot 12 = 240$

$20(12) + 15(6) = \$330$

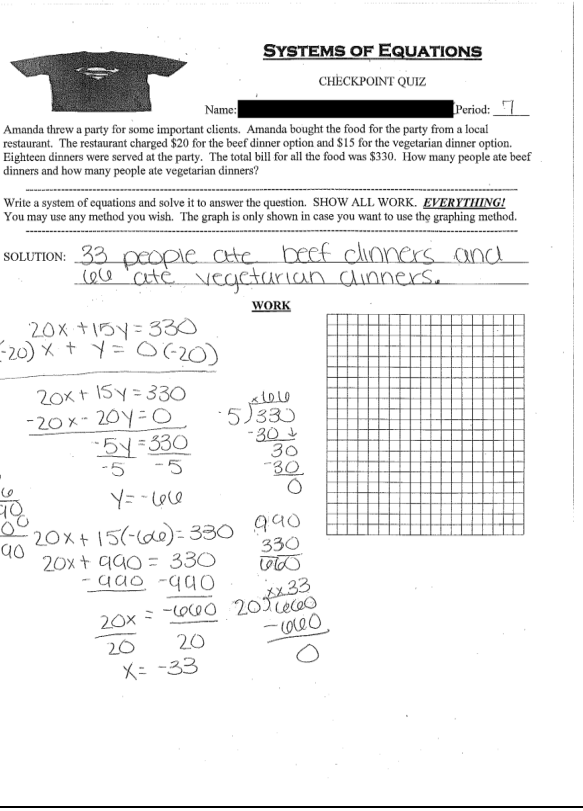
$240 + 90 = \$330$

$330 = \$330$

$12 + 6 = 18$

$18 = 18$

Developing



SYSTEMS OF EQUATIONS

CHECKPOINT QUIZ

Name: [redacted] Period: 7

Amanda threw a party for some important clients. Amanda bought the food for the party from a local restaurant. The restaurant charged $20 for the beef dinner option and $15 for the vegetarian dinner option. Eighteen dinners were served at the party. The total bill for all the food was $330. How many people ate beef dinners and how many people ate vegetarian dinners?

Write a system of equations and solve it to answer the question. SHOW ALL WORK. ***EVERYTHING!*** You may use any method you wish. The graph is only shown in case you want to use the graphing method.

SOLUTION: 33 people ate beef dinners and 66 ate vegetarian dinners.

WORK

$20x + 15y = 330$

$(-20)\ x + y = 0\ (-20)$

$20x + 15y = 330$

$-20x - 20y = 0$

$-5y = 330$

$-5 \quad -5$

$y = -66$

$20x + 15(-66) = 330$

$20x + 990 = 330$

$-990 \quad -990$

$\frac{20x}{20} = \frac{-660}{20}$

$x = -33$

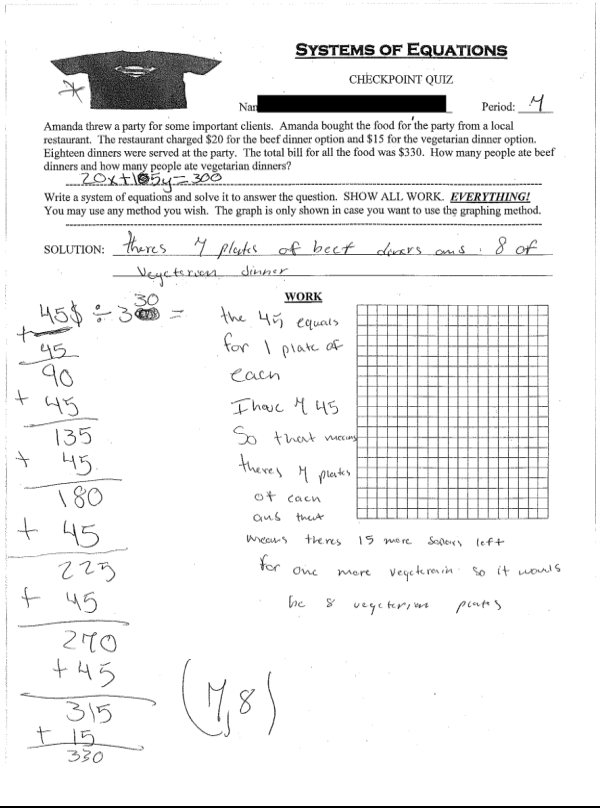
$5 \overline{)330}$ -30 30 -30 0

$15 \times 66 = 90$, $90 \times 11 = 990$

990 330 660

$20 \overline{)660}$ -660 0

Getting Started



SYSTEMS OF EQUATIONS

CHECKPOINT QUIZ

Name: [redacted] Period: 4

Amanda threw a party for some important clients. Amanda bought the food for the party from a local restaurant. The restaurant charged $20 for the beef dinner option and $15 for the vegetarian dinner option. Eighteen dinners were served at the party. The total bill for all the food was $330. How many people ate beef dinners and how many people ate vegetarian dinners?

$20x + 15y = 330$

Write a system of equations and solve it to answer the question. SHOW ALL WORK. ***EVERYTHING!*** You may use any method you wish. The graph is only shown in case you want to use the graphing method.

SOLUTION: theres 4 plates of beef dinners and 8 of Vegeterian dinner

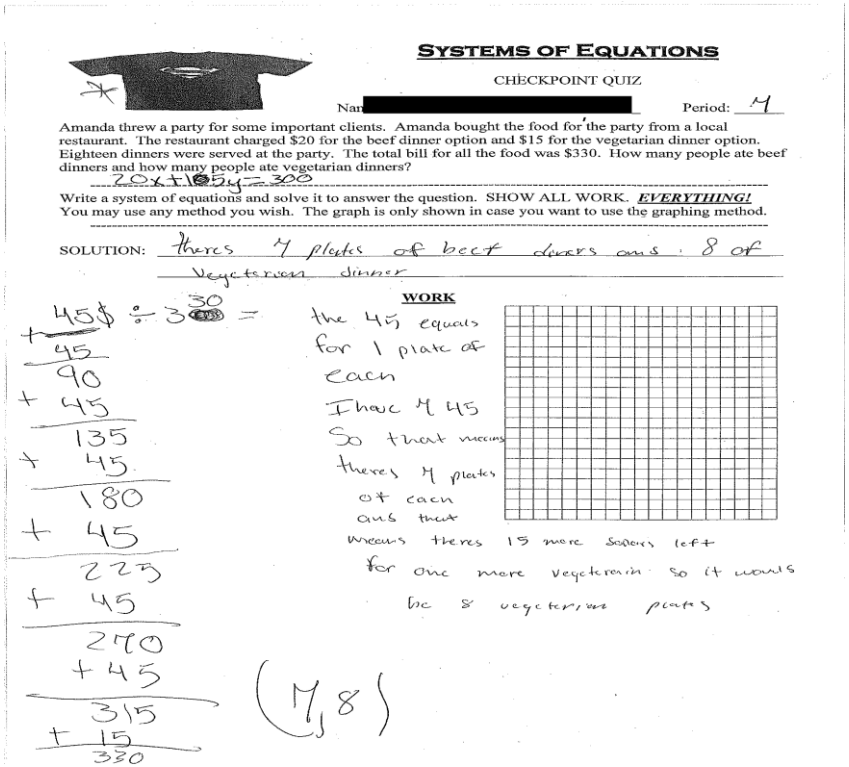
WORK

$45 \div 30 =$

45
90
+ 45
135
+ 45
180
+ 45
225
+ 45
270
+ 45
315
+ 15
330

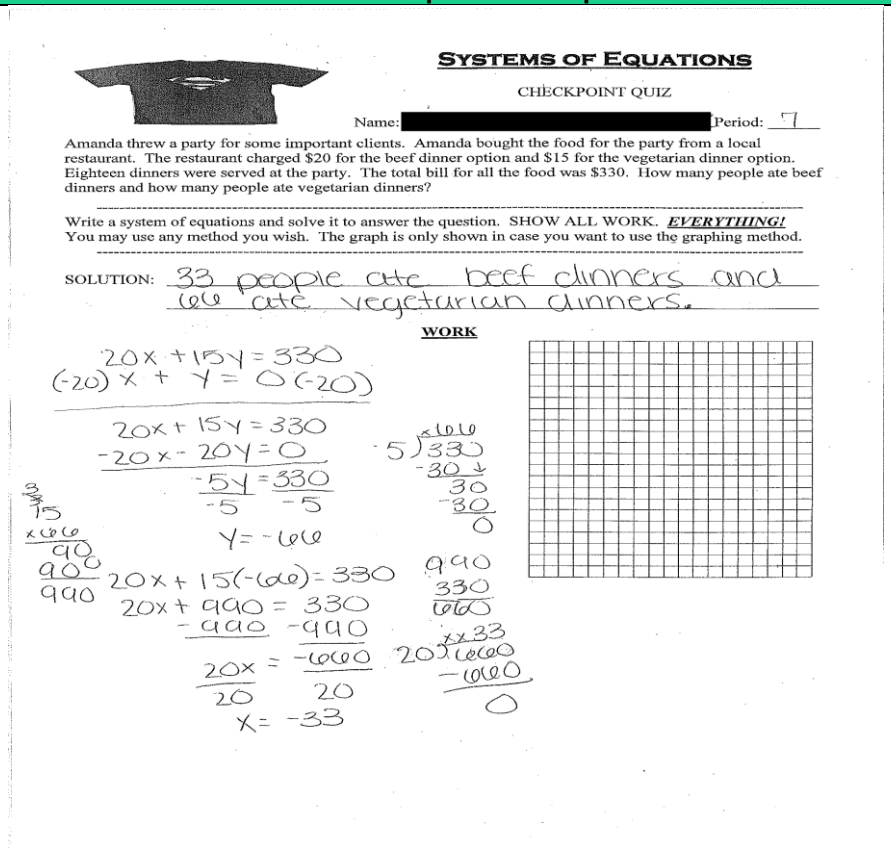
the 45 equals for 1 plate of each I have 4 45 So that means theres 4 plates of each and that means theres 15 more soldiers left for one more vegeterain so it would be 8 vegeterians plates

(4, 8)

Getting Started	
Student Response Example	**Indicators**
	• Student does not show the ability to write a system of equations to model a real world problem. • Student does not show understanding of how to solve a system of equations • Student does not show ability to check solution to a system of equations.
In the Moment Questions/Prompts	**Closing the Loop (Interventions/Extensions)**
P: Tell me how you approached this problem. Where did you start? Q: What are the unknowns in this problem? How can we write an equation to match the given information? Q: How did you arrive at your solution? Q: Can you explain how you checked your solution? Does your solution work with the information given. Q: What difficulties did you have as you were solving this system?	http://learnzillion.com/lessons/2577-solve-a-system-of-linear-equations-using-elimination Provide student with more practice on skill-based problems using the elimination method.

Developing

Student Response Example



SYSTEMS OF EQUATIONS

CHECKPOINT QUIZ

Name: [redacted] Period: 7

Amanda threw a party for some important clients. Amanda bought the food for the party from a local restaurant. The restaurant charged $20 for the beef dinner option and $15 for the vegetarian dinner option. Eighteen dinners were served at the party. The total bill for all the food was $330. How many people ate beef dinners and how many people ate vegetarian dinners?

Write a system of equations and solve it to answer the question. SHOW ALL WORK. ***EVERYTHING!*** You may use any method you wish. The graph is only shown in case you want to use the graphing method.

SOLUTION: 33 people ate beef dinners and 660 ate vegetarian dinners.

WORK

$20x + 15y = 330$

$(-20)\ x + y = 0\ (-20)$

$20x + 15y = 330$

$-20x - 20y = 0$

$-5y = 330$

$-5 \quad -5$

$y = -660$

$20x + 15(-660) = 330$

$20x + 990 = 330$

$-990 \quad -990$

$\frac{20x}{20} = \frac{-6600}{20}$

$x = -33$

$5)330$, -30, 30, -30, 0

990, 330, 660, $\times 33$, $20)6600$, -6000, 0

15, $\times 660$, 90, 900, 990

Indicators

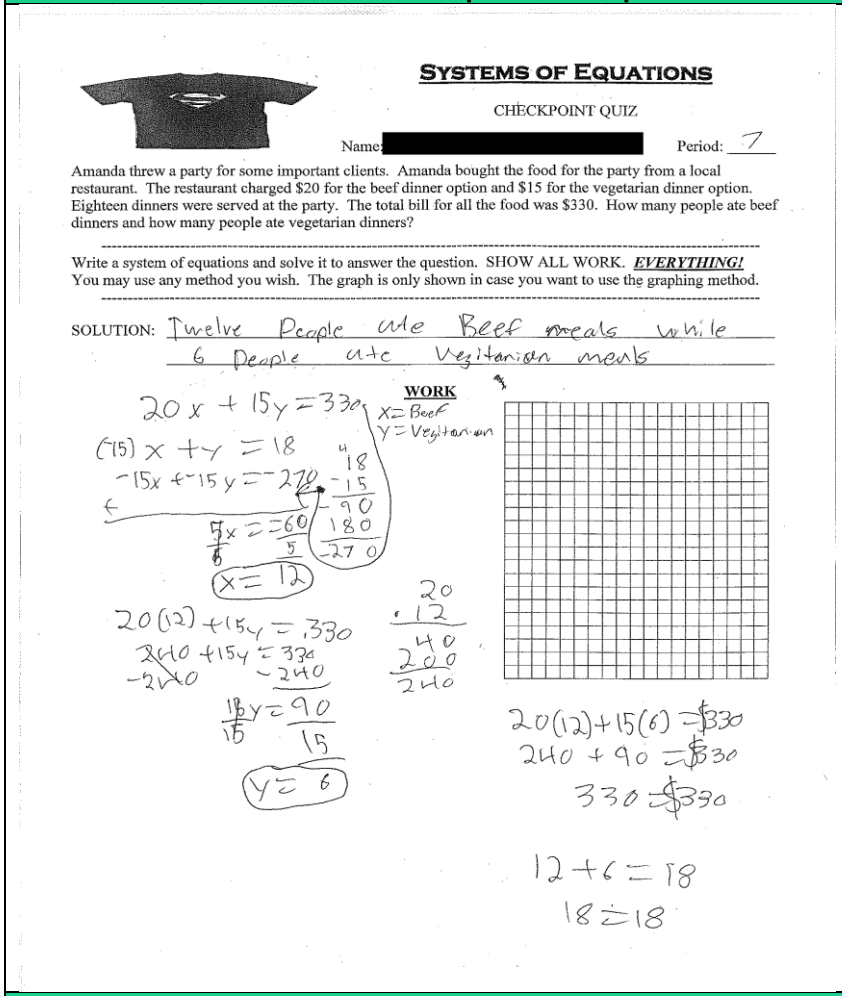
- Student shows procedural understanding of how to solve a system of equations by elimination.
- Student shows some ability to write a system of equations to model a real world problem.
- Student does not show ability to check reasonableness of solution.
- Student does not show ability to check solution to a system of equations.

In the Moment Questions/Prompts

P: Please explain how you setup your equations for this system.
Q: How many dinners were served total? Where is this shown in your system?
Q: Does it make sense to get negative answers here? What do your variables represent?
Q: How do you know if your solution is correct?

Closing the Loop (Interventions/Extensions)

Provide student with a system of equations and multiple possible solutions for student to check.
Provide student with contextual problems and have them select correct system of equations from multiple systems, explaining reasoning.

Got it	
Student Response Example	**Indicators**
	• Student shows the ability to write a system of equations to model a real world problem. • Students show the ability to select an effective method for solving a system of equations. • Student shows procedural knowledge of how to solve a system of equations using the elimination method. • Student shows the ability to check the solution to a system of equations in all equations. • Student shows the ability to interpret the solution to a system of equations in the given context of the real world problem.
In the Moment Questions/Prompts	**Closing the Loop (Interventions/Extensions)**
P: Explain how you approached the problem Q: Why did you select the elimination method to solve this system? Q: Could you have used another method to solve this system?	Provide student with systems where solutions contain fractions or decimals. Provide student with systems where solution indicates maximum values, not exact, have student interpret solution in context. Provide student systems where exact solution does not exist, or exact mathematical solution does not make sense in context of problem.

Steps 3 and 4: Act on Evidence from Student Work and Adjust Instruction	
Lesson Objective:	Students will solve a system of equations and interpret solution in the context of a given real world situation.
Content Standard(s):	CCSS.Math.Content.HSA.REI.C.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.
Targeted Practice Standard :	CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them.

Mathematical Goals	Success Criteria
Students will be able to solve a system of equations, and interpret their solution in the context of the problem. *Students will compare and contrast different methods for solving a system of equations.*	- *Students will be able to correctly solve a system of equations.* - Students will be able to check the solution to a system of equations - Students will be able to interpret the solution to a system of equations in the context of a given word problem.

Launch (Probe and Build Background Knowledge)

Purpose: ***Assess and activate background knowledge of the different methods of solving systems of equations.***

Students will be provided warmup question to reactivate prior subject knowledge required for lesson content. Warmup questions focus on finding, checking, and interpreting solutions to systems of equations.

- *1. Define: What is a solution to a system of equations?*
- 2. How can you check a solution to a system of equations?
- 3. Jack says that the point (3, 4) is a solution to the following system: $y = 3x - 5$ $x + y = 11$
  Is Jack correct? Explain why or why not.
- 4. Maria says that the point (-2, 3) is a solution to the following system: $y = 3x + 9$ $x + y = 1$
  Is Jack correct? Explain why or why not.
- 5. Describe the different methods to solve systems of equations.
  Describe what aspect of each method you find challenging.

Launch Notes: All students should complete questions #1 - #3. Students unable to complete questions #1 -#3 will need additional assistance during the lesson. Students completing questions #1 - #3 before class is ready to continue can answer questions #4 and $5.

Instructional Task

Purpose: *Students will be solving a system of equations and interpreting the solution in the context of a given problem. Students will be using all methods to solve and comparing how difficult each method is in general, and in terms of the given problem.*

Engage (Setting Up the Task)

Students will be given a problem about class field trips. Students will be initially divided into homogeneous groups based on results from the prior day's checkpoint exit ticket. There are four group levels:

- ***GRAPHING GROUP***
  Students demonstrating difficulty with elimination and substitution methods and difficulty writing equations to match given information for a system of equations.
  Students will be given equations and asked to solve using graphing method.

- ***Substitution Group***
  Students demonstrating difficulty with elimination method and difficulty writing equations to match given information for a system of equations.
  Students will be given equations and asked to solve using substitution method.

- ***Elimination Group A***
  Students demonstrating difficulty with writing equations to match given information for a system of equations.
  Students will be given equations and asked to solve using elimination method.

- ***Elimination Group B***
  Students who should need minimal assistance to write and solve a system of equations using elimination method.
  Students are only given the problem description.

- ***ALL GROUPS***
  All students have the same goal and the same directions. After solving the systems, students are regrouped. In their new groups, students will discuss their solutions with new group members who solved the system with alternate methods and evaluate the method they were assigned to use.
  Additional Differentiation – There is a challenging extension problem for students if any groups finish this section early.

Checking for Understanding

Student Conversations	Do students see the benefits/drawbacks to each method?
&	Do students understand that each method should result in the same solution?
Exit Tickets	Can students determine which method is easy or harder based on the problem?
	Can students solve and check solution using any method?

Common Misunderstanding

Students may believe that one method is always best to use, regardless of the given problem.
Students may believe that different methods will yield different solutions.
Students may have difficulty writing the equations for the system or solving the system.
Students may not check their solution, or may forget to interpret solution in given context.

Closure

After both grouping activities, student groups will share out to the entire class. Groups will discuss difficulties with each method, and pick which method their group believed was best to solve each system. Groups will be asked to explain their choice. Students will also complete an exit ticket.

Extension Task

Students or groups that finish early or who are ready for a challenge will be asked to create their own systems. In the first grouping, students are challenged to try and create a system that will not have any solution. In the second grouping, students are challenged to create a system that will have many solutions.

Systems of Equations

Name: _____ ***First Group: Graphing A*** Second Group: _____

The Problem

Jack is organizing a fundraiser for a class field trip. He is going to sell t-shirts and sweatshirts. Jack has $660 to buy all the clothes that are going to be sold. He can buy t-shirts for $6 and sweatshirts for $10. Jack needs to buy twice as many t-shirts as sweatshirts. How many t-shirts and sweatshirts can Jack purchase for the fundraiser?

HINT

This problem can be modeled with the following equations:

$6x + 10y = 660$ $2y = x$ x represents the number of t-shirts, y represents the number of sweatshirts

Your Job

Write a system of equations to model this problem.

Solve this system by graphing.

Interpret your solutions and answer the question based on your solution.

Systems of Equations

Name: _____ ***First Group: Substitution A*** Second Group: _____

The Problem

Jack is organizing a fundraiser for a class field trip. He is going to sell t-shirts and sweatshirts. Jack has $660 to buy all the clothes that are going to be sold. He can buy t-shirts for $6 and sweatshirts for $10. Jack needs to buy twice as many t-shirts as sweatshirts. How many t-shirts and sweatshirts can Jack purchase for the fundraiser?

HINT

This problem can be modeled with the following equations:

$6x + 10y = 660$ $2y = x$ x represents the number of t-shirts, y represents the number of sweatshirts

Your Job

Solve this system by substitution.

Interpret your solutions and answer the question based on your solution.

Systems of Equations

Name: _____ ***First Group: Elimination A*** Second Group: _____

The Problem

Jack is organizing a fundraiser for a class field trip. He is going to sell t-shirts and sweatshirts. Jack has $660 to buy all the clothes that are going to be sold. He can buy t-shirts for $6 and sweatshirts for $10. Jack needs to buy twice as many t-shirts as sweatshirts. How many t-shirts and sweatshirts can Jack purchase for the fundraiser?

HINT

This problem can be modeled with the following equations:

$6x + 10y = 660$ $2y = x$ x represents the number of t-shirts, y represents the number of sweatshirts

Your Job

Solve this system by elimination.

Interpret your solutions and answer the question based on your solution.

Systems of Equations

Name: _____ ***First Group: Elimination B*** Second Group: _____

The Problem

Jack is organizing a fundraiser for a class field trip. He is going to sell t-shirts and sweatshirts. Jack has $660 to buy all the clothes that are going to be sold. He can buy t-shirts for $6 and sweatshirts for $10. Jack needs to buy twice as many t-shirts as sweatshirts. How many t-shirts and sweatshirts can Jack purchase for the fundraiser?

Your Job

Write a system of equations to model this problem.

Solve this system by elimination.

Interpret your solutions and answer the question based on your solution.

Systems of Equations

Activity Directions - ***First Grouping*** Name: _____ Period: _____

Read the problem handout you received. You must work with your group to solve the problem. You will be working together, but ***everyone in your group needs to record the work***.

Your group will be split up later and you will each be explaining your work to other students.

A. Each member of your group should solve the problem. If you get stuck, ask your group members for help. If nobody in your group can answer your question, then ask your teacher for help.
B. After solving, check your solutions. Once all group members have solved, check each others solutions. Do you all agree?
C. Once you all agree on the solution to the problem, answer the follow-up questions below.

Follow-up Questions

1. What problems did you have solving the problem? What was difficult about solving the problem?

   _____
   _____

2. Do you think this method is the easiest way to solve this system? Is there an easier method?
   Explain.

   _____
   _____

3. If you solved this system using a different method, would you have gotten the same solution?
   Explain why or why not.

   _____
   _____

4. RANK the three methods (graphing, substitution, elimination) in terms of how hard they would be to use to ***solve this specific problem***.

   HARDEST = _____

   MIDDLE = _____

   EASIEST = _____

5. RANK the three methods (graphing, substitution, elimination) in the order you prefer to use them.

   FAVORITE = _____

   MIDDLE = _____

   LEAST FAVORITE = _____

Extension: Write your own system of equations problem, similar to the one above.
BONUS: Can you write your problem so that it will ***not*** *have any solutions?*

Systems of Equations

Activity Directions – ***Second Grouping*** Name: _____ Period: _____

The Solutions

1. Did everyone in your new group get the same solution? Is this surprising? Will this happen for every problem? Discuss with your group before writing your answer here.

_____

_____

The Methods

Each person in your group should briefly summarize *to the other members of the group* how they solved the system with their method. Each person should be able to answer the following questions based on those summaries.

GRAPHING

2. What is difficult about this method? What is important to remember in this method?

_____

_____

3. Did you solve the system and agree on the solution in your previous group? If you did solve the system, how did you know you were done? How did you know you had found the solution?

_____

_____

If you did not solve the system, where did you get stuck? Ask your other group members for help and finish solving the system now.

4. How did you verify that your solution was correct?

_____

5. What is the hardest part of this method?

_____

SUBSTITUTION

6. What is difficult about this method? What is important to remember in this method?

_____

_____

7. How did you know you were done? How did you know you had found the solution?

_____

8. How did you verify that your solution was correct?

_____

9. What is the hardest part of this method?

_____

ELIMINATION

10. What is difficult about this method? What is important to remember in this method?

_____

_____

11. How did you know you were done? How did you know you had found the solution?

_____

12. How did you verify that your solution was correct?

_____

13. What is the hardest part of this method?

_____

THIS PROBLEM

14. Which method is the easiest to use for this type of problem. Explain why.

_____

_____

15. Which method is the hardest to use for this type of problem. Explain why.

_____

_____

16. Does the solution to a system change if you use a different method to solve? Explain.

_____

_____

Extension: Write your own system of equations problem, similar to the one you solved.
BONUS: Can you write your problem so that it will *have **many** solutions?*

Systems of Equations

Exit Ticket

Name: _____

Period: _____

TRUE or FALSE:

It is easiest to always use the same method to solve any system of equations:

_____

TRUE or FALSE:

You always get the same solution to a system of equations regardless of which method you use:

_____

TRUE or FALSE:

A solution to a system of equation MUST work in all equations in the system:

_____

TRUE or FALSE:

To be sure a solution is correct, you only need to check it in one equation:

_____

Which method do you find easiest to use?

_____

How hard was the problem today? Answer from 1 – 10.

_____

1 = Super easy ***5 = It got it, but it took time*** ***10 = crazy hard and confusing***

Systems of Equations

Exit Ticket

Name: _____

Period: _____

TRUE or FALSE:

It is easiest to always use the same method to solve any system of equations:

_____

TRUE or FALSE:

You always get the same solution to a system of equations regardless of which method you use:

_____

TRUE or FALSE:

A solution to a system of equation MUST work in all equations in the system:

_____

TRUE or FALSE:

To be sure a solution is correct, you only need to check it in one equation:

_____

Which method do you find easiest to use?

_____

How hard was the problem today? Answer from 1 – 10.

_____

1 = Super easy ***5 = It got it, but it took time*** ***10 = crazy hard and confusing***

Systems of Equations – ANSWER KEY

The Problem

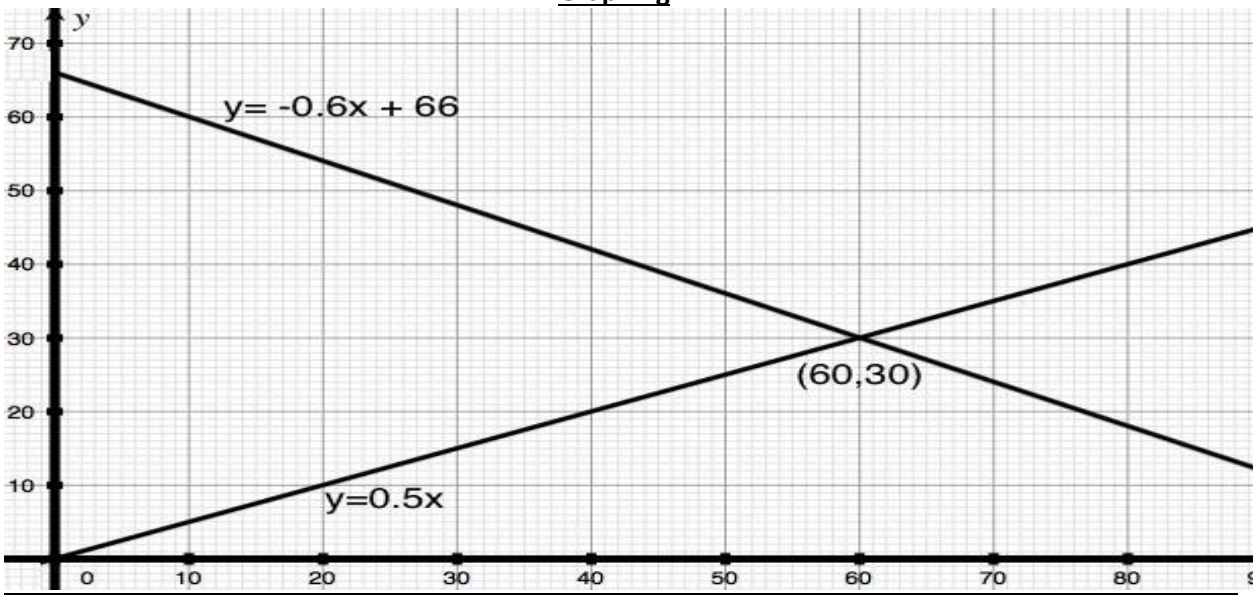
Jack is organizing a fundraiser for a class field trip. He is going to sell t-shirts and sweatshirts. Jack has $660 to buy all the clothes that are going to be sold. He can buy t-shirts for $6 and sweatshirts for $10. Jack needs to buy twice as many t-shirts as sweatshirts. How many t-shirts and sweatshirts can Jack purchase for the fundraiser?

VARIABLES Let x = number of t-shirts sold. Let y = number of sweatshirts sold.

EQUATIONS		
Written from problem:	6x + 10y = 660	x = 2y
Adjusted for Graphing:	$y = -\frac{3}{5}x + 66$	$y = \frac{1}{2}x$
Adjusted for Elimination:	6x + 10y = 660	6x – 12y = 0

WORK

Graphing



Substitution

SOLVING	*CHECK*
6(2y) + 10y = 660	6x + 10y = 660
12y + 10y = 660	6(60) + 10(30) = 660
22y = 660	360 + 300 = 660
y = 30	660 = 660
x = 2y	x = 2y
x = 2(30)	60 = 2(30)
x = 60	60 = 60

Elimination

SOLVING	*CHECK*
6x + 10y = 660	6x + 10y = 660
6x – 12y = 0	6(60) + 10(30) = 660
0x + 22y = 660	360 + 300 = 660
22y = 660	660 = 660
y = 30	
x = 2y	x = 2y
x = 2(30)	60 = 2(30)
x = 60	60 = 60

SOLUTION: (60, 30)

INTERPRETATION: **Jack can buy 60 t-shirts and 30 sweatshirts for the fundraiser.**

Systems of Equations – Answer Key

Activity Directions - ***First* Grouping** Name: _____ Period: _____

Read the problem handout you received. You must work with your group to solve the problem. You will be working together, but ***everyone in your group needs to record the work***.

Your group will be split up later and you will each be explaining your work to other students.

A. Each member of your group should solve the problem. If you get stuck, ask your group members for help. If nobody in your group can answer your question, then ask your teacher for help.
B. After solving, check your solutions. Once all group members have solved, check each other's solutions. Do you all agree?
C. Once you all agree on the solution to the problem, answer the follow-up questions below.

Follow up Questions

1. What problems did you have solving the problem? What was difficult about solving the problem?

ANSWERS WILL VARY

2. Do you think this method is the easiest way to solve this system? Is there an easier method?
Explain.

ANSWERS WILL VARY

3. If you solved this system using a different method, would you have gotten the same solution?
Explain why or why not.

YES. THE SOLUTION IS NOT DEPENDENT ON METHOD USED TO SOLVE.

4. RANK the three methods (graphing, substitution, elimination) in terms of how hard they would be to use to ***solve this specific problem***.

ANSWERS WILL VARY

5. RANK the three methods (graphing, substitution, elimination) in the order you prefer to use them.

ANSWERS WILL VARY

Systems of Equations – ANSWER KEY

Activity Directions – ***Second Grouping*** Name: _____ Period: _____

The Solutions

1. Did everyone in your new group get the same solution? Is this surprising? Will this happen for every problem? Discuss with your group before writing your answer here.

   EVERY GROUP MEMBER SHOULD HAVE SAME SOLUTION REGARDLESS OF METHOD USED.

The Methods

Each person in your group should briefly summarize *to the other members of the group* how they solved the system with their method. Each person should be able to answer the following questions based on those summaries.

GRAPHING

2. What is difficult about this method? What is important to remember in this method?

   ANSWERS WILL VARY

3. Did you solve the system and agree on the solution in your previous group? If you did solve the system, how did you know you were done? How did you know you had found the solution?

   THE SOLUTION IS A VALUE FOR EACH VARIABLE. IN A GRAPH, SOLUTION IS THE POINT WHERE THE LINES INTERSECT.

   If you did not solve the system, where did you get stuck? Ask your other group members for help and finish solving the system now.

   ANSWERS WILL VARY

4. How did you verify that your solution was correct?

   THE SOLUTION CAN BE CHECKED BY SUBSTITUTING THE VALUES INTO VARIABLES IN THE ORIGINAL EQUATIONS. SOLUTIONS CAN ALSO BE CHECKED AGAINST THE LANGUAGE OF THE ORIGINAL PROBLEM.

5. What is the hardest part of this method?

   ANSWERS WILL VARY

SUBSTITUTION

6. What is difficult about this method? What is important to remember in this method?

   ANSWERS WILL VARY

7. How did you know you were done? How did you know you had found the solution?

THE SOLUTION IS A VALUE FOR EACH VARIABLE. YOU HAVE SOLVED THE SYSTEM WHEN YOU HAVE FOUND THE VALUE FOR EACH VARIABLE.

8. How did you verify that your solution was correct?

THE SOLUTION CAN BE CHECKED BY SUBSTITUTING THE VALUES INTO VARIABLES IN THE ORIGINAL EQUATIONS. SOLUTIONS CAN ALSO BE CHECKED AGAINST THE LANGUAGE OF THE ORIGINAL PROBLEM.

9. What is the hardest part of this method?

ANSWERS WILL VARY

ELIMINATION

10. What is difficult about this method? What is important to remember in this method?

ANSWERS WILL VARY

11. How did you know you were done? How did you know you had found the solution?

ANSWERS WILL VARY

12. How did you verify that your solution was correct?

THE SOLUTION CAN BE CHECKED BY SUBSTITUTING THE VALUES INTO VARIABLES IN THE ORIGINAL EQUATIONS. SOLUTIONS CAN ALSO BE CHECKED AGAINST THE LANGUAGE OF THE ORIGINAL PROBLEM.

13. What is the hardest part of this method?

ANSWERS WILL VARY

THIS PROBLEM

14. Which method is the easiest to use for this type of problem. Explain why.

ANSWERS WILL VARY

15. Which method is the hardest to use for this type of problem. Explain why.

ANSWERS WILL VARY

16. Does the solution to a system change if you use a different method to solve? Explain.

NO. THE SOLUTION IS NOT DEPENDENT ON METHOD USED TO SOLVE.

Systems of Equations – ANSWER KEY

Exit Ticket

Name: _____

Period: _____

TRUE or FALSE:

It is easiest to always use the same method to solve any system of equations: ***FALSE***

TRUE or FALSE:

You always get the same solution to a system of equations regardless of which method you use: ***TRUE***

TRUE or FALSE:

A solution to a system of equation MUST work in all equations in the system: ***TRUE***

TRUE or FALSE:

To be sure a solution is correct, you only need to check it in one equation: ***FALSE***

THE SOLUTION SHOULD BE CHECKED IN EVERY EQUATION IN THE SYSTEM

Which method do you find easiest to use? ***ANSWERS WILL VARY***

How hard was the problem today? Answer from 1 – 10. ***ANSWERS WILL VARY***

1 = Super easy ***5 = It got it, but it took time*** ***10 = crazy hard and confusing***

<table>
<tr><th colspan="3">Research and review of standard</th></tr>
<tr><th>Content Standard(s):</th><th colspan="2">Standard(s) for Mathematical Practice:</th></tr>
<tr><td>CCSS.Math.Content.HSA.REI.C.6
Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.</td><td colspan="2">CCSS.Math.Practice.MP1
Make sense of problems and persevere in solving them.
CCSS.Math.Practice.MP4
Model with mathematics.
CCSS.Math.Practice.MP7
Look for and make use of structure.</td></tr>
<tr><th>Smarter Balanced Claim</th><th colspan="2">Smarter Balanced Item</th></tr>
<tr><td>Primary Claim: 2 - Problem Solving
Students can solve a range of well-posed problems in
pure and applied mathematics, making productive use
of knowledge and problem-solving strategies.

Secondary Claim: 1 - Concepts and Procedures
Students can explain and apply mathematical concepts
and interpret and carry out mathematical procedures
with precision and</td><td colspan="2">A restaurant serves a vegetarian and a chicken lunch special each day. Each vegetarian special is the same price. Each chicken special is the same price. However, the price of the vegetarian special is different from the price of the chicken special.

• On Thursday, the restaurant collected $467 selling 21 vegetarian specials and 40 chicken specials.

• On Friday, the restaurant collected $484 selling 28 vegetarian specials and 36 chicken specials.

What is the cost of each lunch special?</td></tr>
<tr><td>CPR Pre-Requisites
(Conceptual Understanding, Procedural Skills, and Representations)

Look at the Progressions documents, Learning Trajectories, LZ lesson library, unpacked standards documents from states, NCTM Essential Understandings Series, NCTM articles, and other professional resources. You'll find links to great resources on your PLC Platform.</td><td colspan="2">Conceptual Understanding and Knowledge
• Understand how to model a real world problem with equations or inequalities.
• Understand that the solution(s) to a system of equations must satisfy all the equations and/or inequalities in that system.
• Understand that in a graph, the solution to a system of two equations is shown in the intersection of the two lines.
• Understand that, when using tables, the solution to a system of two equations is shown in a row of values common to both tables for each equation.
• Understand that a system of equations in two variables can have zero, one, or infinite solutions.

Procedural Skills
• Solving a system of equations by graphing.
• Solving a system of equations by substitution.
• Solving a system of equations by elimination.
• Students must be able to identify parallel lines.
• Solve an equation in one variable.
• Check the solution to a system of equations.

Representational
• Write equations to model word problems, using variables to represent the unknown value(s).
• Transform equations to solve equations in terms of a variable or change the form of an equation.</td></tr>
</table>

	• Create tables and/or graphs to represent equations expressed verbally or symbolically. **Social knowledge** • Know that the solution to a system of equations needs values for all of the unknowns. • Know how to interpret the solution to a system of equations in the given context of the real world problem. • Know how to interpret infinite solutions to a system in the context of a given real world problem. Know how to interpret a system of equations with no solution in the context of a given real world problem.

Standards Progression		
Pre-Requisite Standards	**Co-Requisite Standards**	**Future Standards**
CCSS.Math.Content.6.EE.C.9 Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. CCSS.Math.Content.7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. CCSS.Math.Content.8.EE.C.8.c Solve real-world and mathematical problems leading to two linear equations in two variables.	CCSS.Math.Content.HSA.CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. CCSS.Math.Content.HSA.CED.A.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. CCSS.Math.Content.HSA.CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. CSS.Math.Content.HSA.REI.B.3 Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. CCSS.Math.Content.HSA.REI.C.5 Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.	CCSS.Math.Content.HSA.CED.A.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context CCSS.Math.Content.HSA.REI.C.7 Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically.

	CCSS.Math.Content.HSA.REI.D.10 Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line).	

Common Misconceptions/Roadblocks

What characteristics of this problem may confuse students?

- Writing the system of equations to correctly model the situation.
- Interpreting the solution of the system in the given context.
- Selecting an appropriate method for solving the system.

What are the common misconceptions and undeveloped understandings students often have about the content addressed by this item and the standard it addresses?

- Students do not know how to interpret decimal and fractional solutions to systems and may assume that an error was made if the solution is a decimal or fraction.
- Students incorrectly interpret the coefficients of standard form equations, believing those values represent slope or the number of items.
- Students do not correctly combine like terms when using the elimination method.
- Students fail to check the solution to the system of equations, or only check the solution in one equation.
- Students rely on one method for solving a system and do not select the most effective method based on the information given.
- Students do not realize the constraints placed on the domain and range values by the real world context of the problem and fail to recognize solutions that do not make sense given the context of the problem.

What overgeneralizations may students make from previous learning leading them to make false connections or conclusions?

- Always using slope intercept form regardless of the given information or task.
- Answers are always integers and solutions with fractions, decimals, or irrational numbers must be incorrect.
- The solution will have one value, incompletely solving the system.