Systems of Linear Equations Exploration:

Part One (Tables): Seven-year old Noah had a collection of 20 coins. He saved only dimes and quarters (since they have bigger values than nickels and pennies). The total value of his coin collection was $3.95.

1) Consider some values that will allow you to satisfy the requirement of Noah having 20 coins and write them in the table below.

Dimes	Quarters	Total
		20
		20
		20
		20
		20

a) Note: The total amount of coins is 20 for each combination. Is the monetary value of each of these options the same? Explain your reasoning.

b) This requirement could be represented by the equation $d + q = 20$, where d represents the number of dimes and q represents the number of quarters.

    i) What type of equation is given here?

    ii) If the number of dimes is reduced by one, what effect does that have on the number of quarters?

    iii) If the number of quarters is increased by four, what effect does that have on the number of dimes?

c) A student said 12 dimes and 8 quarters is a solution to this linear equation. Describe what the student means by solution.

d) Consider the graph of the linear equation $d + q = 20$ provided to the right. A point is labeled on the graph. How does this point relate to the answer to part c?
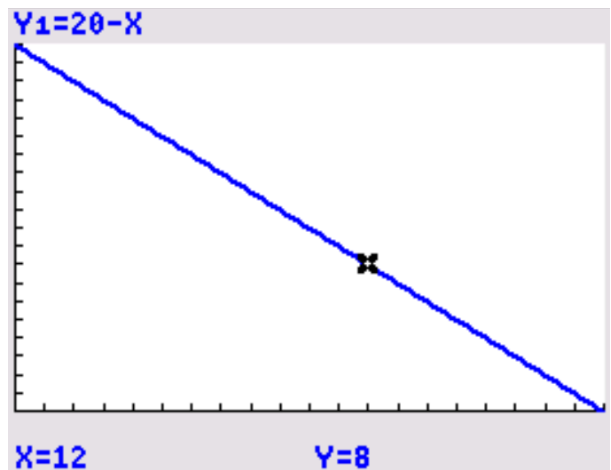
e) Notice that the equation was rewritten as $q = 20 - d$ in the provided graph.

    i) What is the y-intercept of this graph? What does it represent in terms of this scenario?

    ii) What is the slope of this graph? What does it represent in terms of the scenario?

Y1=20-X

X=12   Y=8

2) Consider some values that will allow you to satisfy the requirement of Noah having a value of $3.95 in coins and write them in the table below.

Dimes	Quarters	Total
		$3.95
		$3.95
		$3.95
		$3.95
		$3.95

a) Note: The total amount of monetary value for each combination is $3.95. Is the number of coins of each of these options the same? Explain your reasoning.

b) This requirement could be represented by the equation $0.10d + 0.25q = 3.95$, where d represents the number of dimes and q represents the number of quarters.

    i) What type of equation is given here?

    ii) If the number of dimes is reduced by five, what effect does that have on the number of quarters?

    iii) If the number of quarters is increased by four, what effect does that have on the number of dimes?

c) A student said 27 dimes and 5 quarters is a solution to this linear equation. Describe what the student means by solution.

d) Consider the graph of the linear equation $0.10d + 0.25q = 3.95$ provided to the right. A point is labeled on the graph. How does this point relate to the answer to part c?

Y₁=15.8-.4X
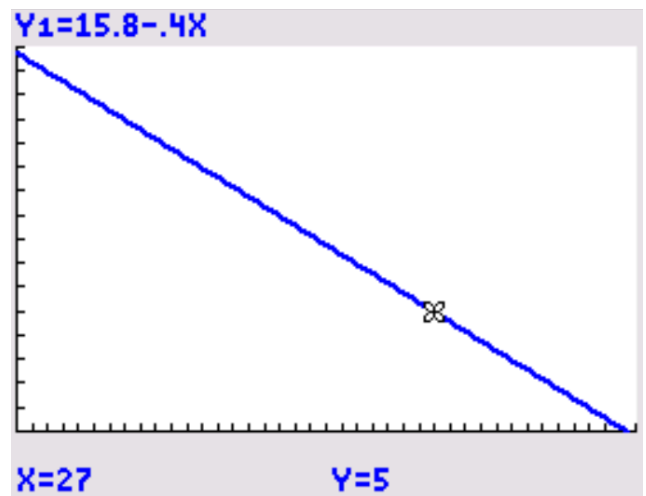
e) Notice that the equation was rewritten as $q = 15.8 - 0.4d$ in the provided graph.

    i) What is the y-intercept of this graph? What does it represent in terms of this scenario?

X=27   Y=5

    ii) What is the slope of this graph? What does it represent in terms of the scenario?

3) Refer back to your tables. As you explored, did you choose the same values (or solutions) for each table? Why or why not?

4) Continue to explore until you find the number of dimes and quarters that would satisfy both requirements at the same time.

| Dimes	Quarters	Total		Dimes	Quarters	Total
		20				$3.95
		20				$3.95
		20				$3.95
		20				$3.95
		20				$3.95

You found the solution to the problem of determining the number of dimes and quarters given in the bag (with the specific requirements).

This answer is called the _____ to the linear system because it satisfies _____ equations in the system.

5) The graph to the right shows both previous graphs together on the same screen with a point labeled.

How would you describe this point?

What does it mean in terms of the scenario?

Intersection
X=7   Y=13
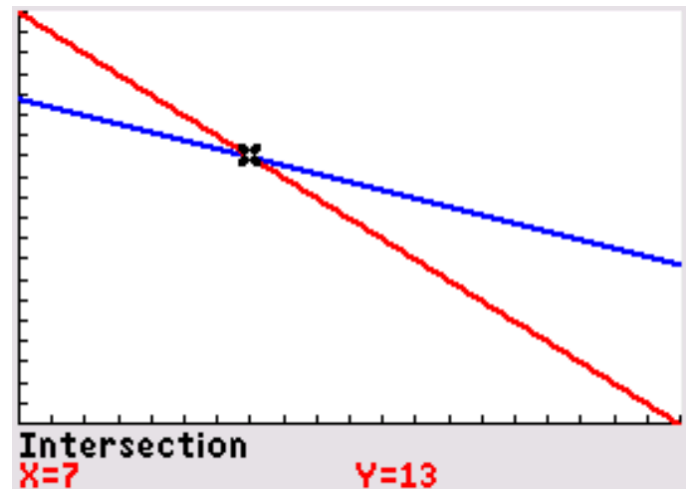
Part Two (Equations): Olivia is creating a paved patio with space for 120 brick pavers that will contain both large square brick pavers and small rectangular brick pavers. Large square brick pavers cost $4.24 each and small rectangular brick pavers cost $2.59 each. Her budget is $390 for the entire patio. How many square brick pavers and how many rectangular brick pavers can she buy and stay with in her budget?

Note: In this problem, there are still two constraints on Olivia's patio. She must have 120 brick pavers and she must spend $390. However, in part two, the goal is to work with equations rather than tables.

1) Given s represents the number of square brick pavers and r represents the number of rectangular brick pavers, write an equation that shows the requirement of having a total of 120 brick pavers in the patio.

2) Given s represents the number of square brick pavers and r represents the number of rectangular brick pavers, write an equation that shows the requirement of having a budget of $390.

3) What type of equations did you write? What would the graph of each equation look like?

4) To make a visual of your answer, you should graph each equation.

   a) First, solve each equation for s.

   b) Next, describe an appropriate window for this graph. Explain how you chose the values.

   c) Type the equations in $Y1$ and $Y2$. Then graph using your chosen window. Sketch your graph and label axes.

d) What do you notice about the graphs?

e) Identify the intersection point from the graph. How do you think that point relates to the scenario and the number of bricks?
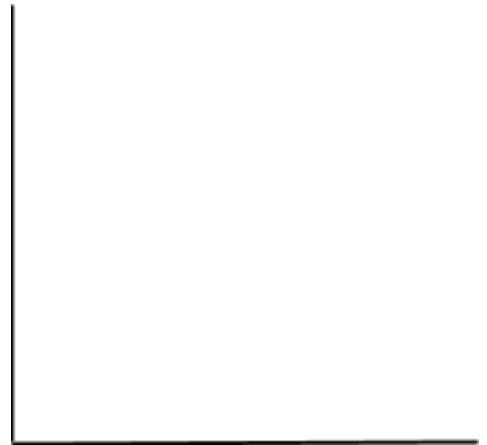
5) Now, let's try that again. To make a visual of your answer, you should graph each equation.

a) First, solve each equation for r.

b) Next, describe an appropriate window for this graph. Explain how you chose the values.

c) Type the equations in $Y1$ and $Y2$. Then graph using your chosen window. Sketch your graph and label axes.

d) What do you notice about the graphs?

e) Does any particular point match your solution found in 4e? Identify the point and describe what it means in terms of the scenario. How does this answer compare with part 4e?

Part Three (Algebra): For a brunch, Liam is bringing mini carrot cake muffins and hard-boiled eggs. Liam would like to bring three times as many carrot cake muffins as hard-boiled eggs. Each mini muffin cost $0.75 and each egg cost $0.22. Liam paid a total cost of $17.29 for his brunch items. How many muffins and eggs did Liam bring to the brunch?

Note: In addition to using tables or graphing systems of equations, there are several algebraic approaches to solving linear systems of equations. One option that works well with the previous steps is substitution.

1) Describe the two constraints that Liam is following for his brunch items.

2) Write two equations with each one representing one of the requirements described in part 1. Use m to represent carrot cake muffins and h to represent hard-boiled eggs.

3) Solve the equations for m. Why is it beneficial to solve both equations for m?

4) Set the equations equal to each other (using substitution) to solve for h.

5) To find m, plug in 7 for h in either equation from part 3.

6) Use the equations from part 3 to check your solution by graphing. Describe an appropriate window.

Part Four (Independent): Solve each system of equations problem by writing two equations that represent the requirements of each scenario. Then solve using a method of your choice.

a) Elijah is restocking his household with flashlights and batteries. He finds an online deal for flashlights for $4.99. Each flashlight needs three (3) AAA batteries, which he found for $0.36 each. His pre-tax total is $24.28. How many flashlights and batteries did Elijah purchase?

b) Amelia teaches a geometry class and is in need of protractors and rulers. She finds protractors for $0.35 and rulers for $0.74 each from a teacher resource store. She purchases a total of 59 protractors and rulers. How many protractors and rulers did Amelia purchase?