CITYTUTOR DC

Eighth Grade Math Lesson Materials

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CITYTUTOR DC

G8 Unit 4:

Rational Number Arithmetic

G8 U4 Lesson 1

Solve linear equations by performing balanced moves on both sides.

G8 U4 Lesson 1 - Today we will solve linear equations by performing balanced moves on both sides.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will solve linear equations by performing balanced moves on both sides. We've already been doing some of this in our last unit. You did some of this in previous grades. But today we need to review the main concept of why we do it the way we do. Because in the next lessons, it gets really sophisticated. So, let's make sure we pay close attention to not just getting the right answer but also understanding why our process works so that we have a strong foundation for the rest of this unit.

Let's Review (Slide 3): It is helpful to notice that we think of the equal sign in two different ways. I'll show you what this means with the equations below. This says, "Simplify each equation to find the value of the question mark." How do you simplify this first equation? Possible Student Answers, Key Points:

- You just do the math.
- You do 1 plus 4 is 5 plus 7 is 12 minus 3 is 9.
- You add then subtract.

For an equation like this, where all the operations are on one side and the question mark is on the other, we can just crunch the number. 1 plus 4 is 5. 5 plus 7 is 12. 12 minus 3 is 9. So, 1 + 4 + 7 - 3 equals 9. When we see the equal sign here, we almost think of it as a direction to "DO THE MATH!" In elementary school, this is the main way we think about the equal sign because there is so much pure number crunching. There's nothing wrong with it. But it is only one perspective. There is another perspective.

$1 + 4 + 7 - 3 = ?$

$1+4+7-3=9$

How might you think about simplifying this next equation? Possible Student Answers, Key Points:

- You add 2 + 7 and get 9.
- You have to think about how to make 9 since 2 plus 7 is 9.
- The answer is 8 because 1 plus 8 is 9, and 2 + 7 is 9.

For an equation like this, it is not as simple as "DO THE MATH!" For an equation like this, we SHIFT OUR PERSPECTIVE and think about the equal sign as a balance. It says, "This side is the same as this side." So, I might still number crunch but I keep the two sides separate, and I am thinking how to keep them the same or equal to each other. I could rewrite the equation as 1 plus question mark equals 9. And now it is obvious that the question mark is 8 because 1 plus 8 is also 9.

$1 + ? = 2 + 7$

$1+?=9$

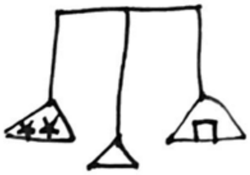
$1+8=9$

So, how did we shift our perspective of the equal sign in the two different equations? In one equation, we thought of the equal sign as something telling us to "DO THE MATH!" and in the other equation , we thought of the equal sign as something telling us, "This side is the same as this side." Both of these ways of thinking of the equal sign are correct. Sometimes one way is more helpful than the other. And for solving equations, it is the second perspective that is going to be helpful.

Let's Talk (Slide 4): Thinking of the equal sign as a balance helps us understand how to solve equations. So, this is the "this side is the same as this side" perspective. The question says, "If the scale below is balanced, how many stars must be hidden in one of the two equal boxes?" It would be really helpful if I had a balance with just one box, right? If it looked like this, I would know exactly how many stars were hidden in the box because the left side would equal the right side.

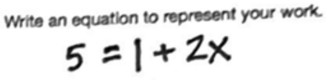
So, let's think about how we could get this scale to have just one box. But - and this is the key - we need it to stay balanced the whole time, right? That's how we know one side equals the other. I want to get one box by itself so I am going to start by taking away the star on the right. But if I cross out one star on this side then I have to cross out one star on the other side to keep it balanced. Whatever I do to one side I have to do to the other side so that it stays equal.

Now I have 4 stars is the same as 2 boxes. I want just one box. So I will split this right side of the graph into two parts. But if I split the right side into two parts then I need to split the left side into two parts to keep it balanced. Then I can see that there would be 2 stars in each box.



My scale in the bottom would be 2 stars equals the mystery box.

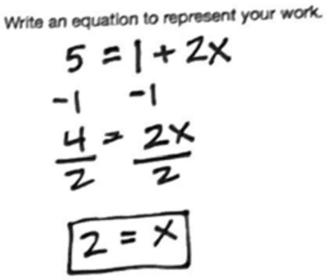
Now we aren't going to spend 8th grade drawing scales. This just shows us the idea of what happens when we solve equations because solving for a variable is like finding the amount in the mystery box. This says, "Write an equation to represent your work." This will help us see how what we did with the balance teaches us what to do with numbers. On the left side, I had 5 stars so I'm just going to write 5. And that equals whatever is on the other side. On the other side, I have 1 star so I'll write 1 plus I have these two mystery boxes. The mystery boxes are the unknown and I have two of them so I'm going to write that as 2x. X stands for an unknown amount and there are two unknown amounts so 2x.



Write an equation to represent your work.

$$5 = 1 + 2x$$

Now, when we tried to find the amount of stars in one box, that was like solving for x. And just like we'd like to get one box by itself on the balance, we want to get x by itself on one side of the equation. The first thing we did was take a star from both sides. I will write that as minus 1 on this side and minus 1 on this side. That left us with 4 stars balanced with 2 boxes, which in this case is 5 minus 1 makes 4 on the left and 1 minus 1 is zero so 2x is alone on the right. Then we split what was left by 2 so we'd just have 1 box. In our equation, that is the same as dividing by two on both sides. Again, whatever I do to one side, I do to the other to keep the equation balanced. That leaves us with 4 divided by 2, which is 2, on the left. On the right, 2 divided by 2 is 1 so we just have x. 2 equals x.

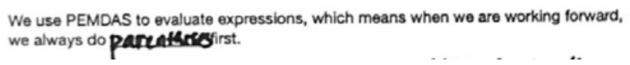


Write an equation to represent your work.

$$5 = 1 + 2x$$
$$-1 \quad -1$$
$$\frac{4}{2} = \frac{2x}{2}$$
$$\boxed{2 = x}$$

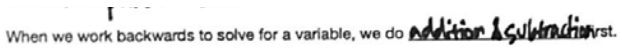
Let's take a moment to notice what we did here. The doing the same to both sides is obvious. The other thing we ended up doing is WORKING BACKWARDS from the operations that written in the expression. In the original expression, it was x times 2 plus 1. And then we worked backwards: minus 1 divided by 2. I kind of think of it like a zipper. The equation is all zipped up and then we pull the zipper down. *Make a motion like zipping a hoodie up then down.* Zip and unzip. The equation is zipped and we unzip, working backwards. And of course, as we unzip we do it to both sides to keep the equation balanced. This is the main idea of our work today.

Let's Think (Slide 5): Here is the big key idea of the day, "To solve for a variable, we must work backwards from the order of operations while keeping the equation balanced." There are a few ideas that will help us. This is something we already know. *Read the first sentence.* "We used PEMDAS to evaluate expressions, which means when we are working forward, we always do…" PARENTHESES first.



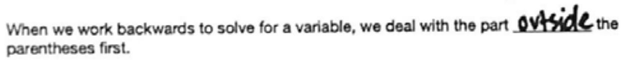
We use PEMDAS to evaluate expressions, which means when we are working forward, we always do parentheses first.

PEMDAS is the acronym for order of operations. P stands for parentheses. E stands for exponents. M stands for multiplication. D stands for division. Multiplication and division go together.*Circle the MD in PEMDAS.* A stands for addition. S stands for subtraction. Addition and subtraction go together. *Circle the AS in PEMDAS.* Now we just talked about zipping and unzipping. We just said that to solve for a variable, we're going to have to work backwards. "When we work backwards to solve for a variable, we do…" ADDITION AND SUBTRACTION first.



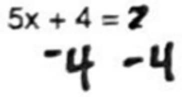
When we work backwards to solve for a variable, we do addition & subtraction first.

This also means "When we work backwards to solve for a variable, we deal with the part OUTSIDE the parentheses first." I'll do two examples and then we'll practice together.

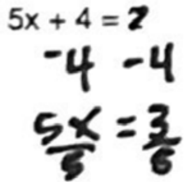


When we work backwards to solve for a variable, we deal with the part outside the parentheses first.

I have 5 times x plus 4 equals 7. I am going to start by working backwards from the addition and subtraction. So here is plus 4 and to cancel that out. I work backwards and do minus 4. I have to do that on both sides. The most important thing about this unit is that I actually show my work and keep it really carefully lined up and organized so that we can understand all the steps we did.



$$5x + 4 = 7$$
$$-4 \quad -4$$



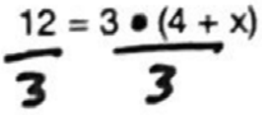
$$5x + 4 = 7$$
$$-4 \quad -4$$
$$\frac{5x}{5} = \frac{3}{5}$$

That gives me 5x = 3.

I want x by itself, and right now it is getting multiplied by 5. So I am going to cancel that out. I need to do the opposite operation like I am working backwards, I divide by 5 and I do that on both sides.

$$\boxed{x = \frac{3}{5}}$$

3 divided by 5 doesn't really make a nice even number so I am just going to leave that as a fraction. I will write x equals 3 fifths. I put a rectangle around it so I can follow the work on my paper.



$$\frac{12}{3} = \frac{3 \bullet (4 + x)}{3}$$

Let's do the next one. Now, if we were evaluating this expression on the right, we would do the stuff in the parentheses first and then multiply it by 3. But we are trying to work backwards. So I will first divide by 3. That will cancel that 3 out and leave me with a simpler expression. I do that to both sides.

$$\frac{12}{3} = \frac{3 \bullet (4 + x)}{3}$$

That gives me 4 equals 4 + x.

$$4 = 4 + x$$

$$-4 \quad -4$$

$$\boxed{0 = x}$$

Now I subtract 4 from both sides and I am left with zero equals x.

Let’s Try It (Slide 6): Let’s solve more equations together. I will walk you through step by step.

WARM WELCOME

Today we will solve linear equations by performing balanced moves on both sides.

Let's Review:

It is helpful to notice that we think of the equal sign in two different ways.

Simplify each equation to find the value of the question mark.

1 + 4 + 7 - 3 = ?

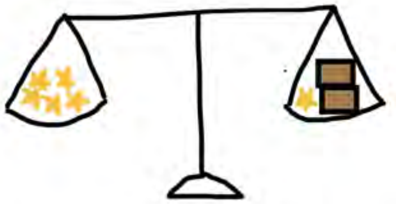
1 + ? = 2 + 7

How did we shift our perspective of the equal sign in the two different equations?

Let's Talk:

Thinking of the equal sign as a balance helps us understand how to solve equations.

If the scale below is balanced, how many stars must be hidden in one of the two equal boxes?



Write an equation to represent your work.

Let's Think:

To solve for a variable, we must work backwards from the order of operations while keeping the equation balanced.

We use PEMDAS to evaluate expressions, which means when we are working forward, we always do ___________ first.

When we work backwards to solve for a variable, we do _____________________ first.

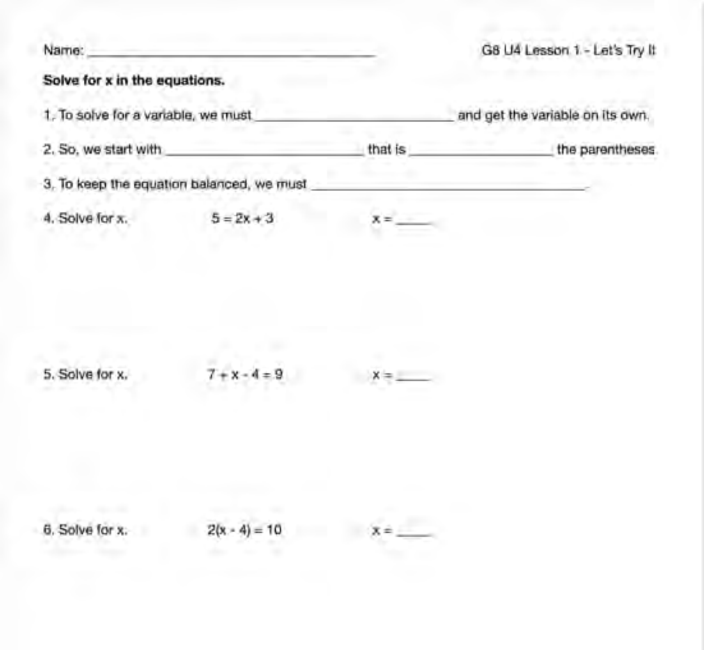
When we work backwards to solve for a variable, we deal with the part _________ the parentheses first.

$5x + 4 = 2$

$12 = 3 \boxdot (4 + x)$

Let's Try It:

Let's solve some more equations together!



Name: ______________________________ G8 U4 Lesson 1 - Let's Try It

Solve for x in the equations.

1. To solve for a variable, we must ____________________ and get the variable on its own.

2. So, we start with ____________________ that is _______________ the parentheses.

3. To keep the equation balanced, we must ____________________________.

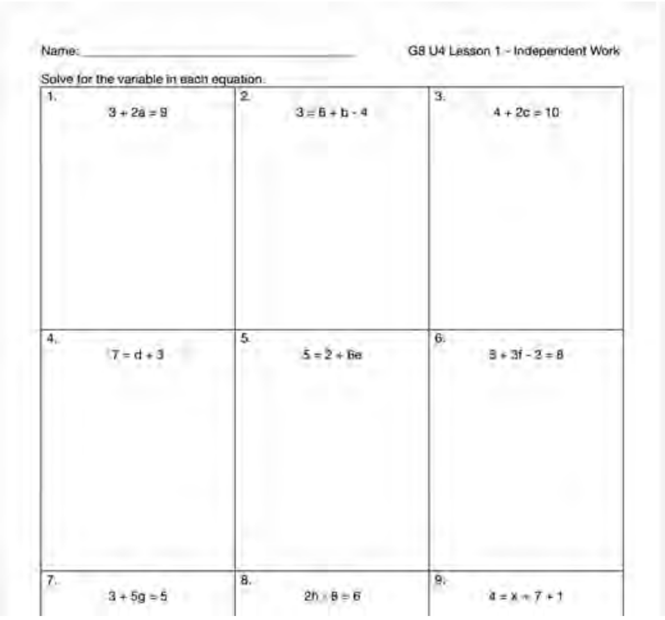
4. Solve for x. $5 = 2x + 3$ $x =$ ____

5. Solve for x. $7 + x - 4 = 9$ $x =$ ____

6. Solve for x. $2(x - 4) = 10$ $x =$ ____

On your Own:

Now it’s time for you to do it on your own!



Name:______________________________ G8 U4 Lesson 1 - Independent Work

Solve for the variable in each equation.

1. 3 + 2a = 9	2. 3 = 6 + b - 4	3. 4 + 2c = 10
4. 7 = d + 3	5. 5 = 2 + 6e	6. 5 + 3f - 2 = 8
7. 3 + 5g = 5	8. 2h - 8 = 6	9. 4 = x - 7 + 1

Name: ____

Solve for x in the equations.

1. To solve for a variable, we must ____________________________ and get the variable on its own.

2. So, we start with ____________________________ that is ____________________ the parentheses.

3. To keep the equation balanced, we must ______________________________________.

4. Solve for x. $5 = 2x + 3$ $x =$ _____

5. Solve for x. $7 + x - 4 = 9$ $x =$ _____

6. Solve for x. $2(x - 4) = 10$ $x =$ _____

7. Solve for x. $3 + x \div 8 = 1$ $x =$ _____

Name: ____ G8 U4 Lesson 1 - Independent Work

Solve for the variable in each equation.

1. $3 + 2a = 9$
2. $3 = 6 + b - 4$
3. $4 + 2c = 10$
4. $7 = d + 3$
5. $5 = 2 + 6e$
6. $5 + 3f - 2 = 8$
7. $3 + 5g = 5$
8. $2h - 8 = 6$
9. $4 = x \div 7 + 1$

Solve for the variable in each equation.

10. $7 = 2j - 3$

11. $6 = 1 + 4k - 7$

12. $4(m - 2) = 4$

13. $9 + 4n = 10$

14. $(6 + x) \div 7 = 11$

15. $6 + x \div 7 = 11$

16. $3 + 2g = 5$

17. $3 + 2h - 8 = 10$

18. $x \div 7 + 1 = 4$

Name: ANSWER KEY G8 U4 Lesson 1 - Let's Try It

Solve for x in the equations.

1. To solve for a variable, we must work backwards and get the variable on its own.

2. So, we start with addition and subtraction that is outside the parentheses.

3. To keep the equation balanced, we must do the same to both sides.

4. Solve for x. $5 = 2x + 3$ x = 1

$-3 \quad -3$

$\frac{2}{2} = \frac{2x}{2}$

$1 = x$

5. Solve for x. $7 + x - 4 = 9$ x = 6

$+4 \quad +4$

$7 + x = 13$

$-7 \quad -7$

$x = 6$

6. Solve for x. $\frac{2(x - 4)}{2} = \frac{10}{2}$ x = 9

$x - 4 = 5$

$+4 \quad +4$

$x = 9$

7. Solve for x. $3 + x \div 8 = 1$ x = $-\frac{1}{4}$

$-3 \quad -3$

$\frac{x \div 8}{8} = \frac{-2}{8}$

$x = -\frac{2 \div 2}{8 \div 2} -\frac{1}{4}$

Name: ANSWER KEY

G8 U4 Lesson 1 - Independent Work

Solve for the variable in each equation.

1.

$3 + 2a = 9$

$-3 \quad -3$

$\frac{2a}{2} = \frac{6}{2}$

$\boxed{a = 3}$

2.

$3 = 6 + b - 4$

$+4 \quad +4$

$7 = 6 + b$

$-6 \quad -6$

$\boxed{1 = b}$

3.

$4 + 2c = 10$

$-4 \quad -4$

$\frac{2c}{2} = \frac{6}{2}$

$\boxed{c = 3}$

4.

$7 = d + 3$

$-3 \quad -3$

$\boxed{4 = d}$

5.

$5 = 2 + 6e$

$-2 \quad -2$

$\frac{3}{6} = \frac{6e}{6}$

$\frac{3 \div 2}{6 \div 2} = e$

$\boxed{\frac{1}{2} = e}$

6.

$5 + 3f - 2 = 8$

$-5 \quad -5$

$3f - 2 = 3$

$+2 \quad +2$

$\frac{3f}{3} = \frac{5}{3}$

$1\frac{2}{3}$

$3\overline{)5}$

-3

2

$\boxed{f = 1\frac{2}{3}}$

7.

$3 + 5g = 5$

$-3 \quad -3$

$\frac{5g}{5} = \frac{2}{5}$

$\boxed{g = \frac{2}{5}}$

8.

$2h - 8 = 6$

$+8 \quad +8$

$\frac{2h}{2} = \frac{14}{2}$

$\boxed{h = 7}$

9.

$4 = x \div 7 + 1$

$-1 \quad -1$

$3 = x \div 7$

$\times 7 \quad \times 7$

$\boxed{21 = x}$

Solve for the variable in each equation.

10.

$7 = 2j - 3$

$+3 \quad +3$

$\frac{10}{2} = \frac{2j}{2}$

$\boxed{5 = j}$

11.

$6 = 1 + 4k - 7$

$+7 \quad +7$

$13 = 1 + 4k$

$-1 \quad -1$

$\frac{12}{4} = \frac{4k}{4}$

$\boxed{3 = k}$

12.

$\frac{4(m - 2)}{4} = \frac{4}{4}$

$m - 2 = 1$

$+2 \quad +2$

$\boxed{m = 3}$

13.

$9 + 4n = 10$

$-9 \quad -9$

$\frac{4n}{4} = \frac{1}{4}$

$\boxed{n = \frac{1}{4}}$

14.

$(6 + x) \div 7 = 11$

$\times 7 \quad \times 7$

$6 + x = 77$

$-6 \quad -6$

$\boxed{x = 71}$

15.

$6 + x \div 7 = 11$

$-6 \quad -6$

$x \div 7 = 5$

$\times 7 \quad \times 7$

$\boxed{x = 35}$

16.

$3 + 2g = 5$

$-3 \quad -3$

$\frac{2g}{2} = \frac{2}{2}$

$\boxed{g = 1}$

17.

$3 + 2h - 8 = 10$

$+8 \quad +8$

$3 + 2h = 18$

$-3 \quad -3$

$\frac{2h}{2} = \frac{15}{2}$

$$\begin{array}{r} 0\,7\frac{1}{2} \\ 2\overline{)15} \\ -14 \\ 1 \end{array}$$

$\boxed{h = 7\frac{1}{2}}$

18.

$x \div 7 + 1 = 4$

$-1 \quad -1$

$x \div 7 = 3$

$\times 7 \quad \times 7$

$\boxed{x = 21}$

G8 U4 Lesson 2

Solve linear equations by thinking about the subtraction symbol in two different ways.

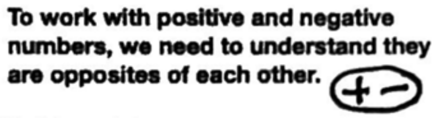
CITYTUTOR DC

G8 U4 Lesson 2 - Today we will solve linear equations by thinking about the subtraction symbol in two different ways.

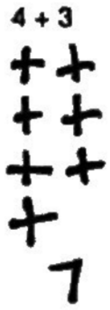
Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will solve linear equations by thinking about the subtraction symbol in two different ways. The reason we'll need to do this is because sometimes the minus sign is used for subtraction but sometimes it is used to show that a number is negative. We need to practice moving between those two ideas as we work with equations. Let's go!

Let's Review (Slide 3): To work with positive and negative numbers, we need to understand that they are opposites of each other. I think of positive numbers like going up the stairs and negative numbers like going down the stairs. If I go up a step and then down a step, it cancels out and I am back where I started. So if I have 1 positive and 1 negative, they cancel out and I have nothing, zero. I am going to write that here just to record the idea. And I'll draw a little picture underneath. I want a plus sign for the positive one and a minus sign for the negative one. And I'll circle this pair to show they cancel out. There's nothing left outside this circle.


To work with positive and negative numbers, we need to understand they are opposites of each other.

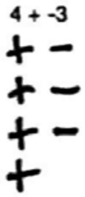
This says, "use the idea of opposites to add the integers below." You may have learned how to do this in a previous grade. But one thing that sometimes happens is that our teacher teaches us so many rules that the rules start to get mixed up in our head and we forget which is which. But if we can bring ourselves back to an idea of what is happening it will help us remember the rule. An easy way to do that is to draw a picture. As soon as you start to draw even a little bit, you will see what is happening.



Let's start with a super easy problem. You all know the answer. But just to get our drawing strategy going, let me draw it out. We have a positive 4 so I'll draw 4 plus signs. We have a positive 3 so I'll draw 3 plus signs. There's not any negative to cancel the positive. It's just a bunch of positives. It's like we went up some stairs and then we went up some more stairs. We just end up going up a lot of stairs. Anyway, we count these up and we get seven positives, which is just seven. You all knew 4 plus 3 was 7. But this picture is showing us how positives and negatives work, and we get our first rule - a positive plus a positive is positive. You don't even need to think about it as a rule because it makes so much sense. That's not such a big deal because you already knew that one. But let's see if we can get the other problems to make sense too.

It is negative 4 plus negative 3. For negative 4, I will draw 4 negatives. For negative 3, I will draw 3 negatives. That's not any positive to cancel the negative. It's just a bunch of negative. It's like we went down some stairs and then we went down some more stairs. We just end up going down a lot of stairs. So we count these up and we get seven negatives. Again, this picture is showing us a rule you might have heard before - a negative plus a negative is a negative. Or your teacher might have said, "When the signs are the same, you add." But without understanding why, it is easy to forget. So we draw a quick picture and it makes more sense to us.

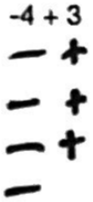
Now we know if we have -435 + -3,256, we can just add those up too. We don't need to draw the picture because we saw how it worked with small numbers.



Let’s look at the next one. I have a positive 4 so I draw 4 positives. I have a negative 3 so I draw 3 negatives. *Be sure to draw these so that the amounts are lined up side by side.*

Here, I do have things that cancel. A positive and a negative together cancel eachother out. Another positive and negative cancel eachother out. Another positive and negative cancel eachother out. When I look at what is left after the cancellations, there is just one positive there, which we write at 1. And that makes sense because I had a bigger positive number than negative number. I had more positives than negatives so of course I will end up with overall positive after they cancel out.

Again, a quick picture helps us understand that canceling is happening. A lot of times teachers will say, “When signs are different, we subtract.” That’s technically true. But I like to use the word “cancel” because this is an addition problem and thinking of just randomly changing the operation is confusing. But we know positives and negatives cancel each other out so we’ll have to cancel. Then I have 4 thirds plus negative 1 half, this is too complicated to draw a picture. But we know these are going to cancel eachother out a little bit and we’ll have positives leftover.

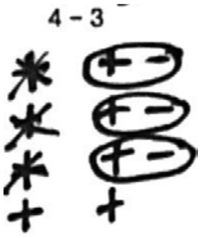


Last one! We’re going to see the same idea as the last problem because we have positives and negatives, which will cancel eachother out. I draw 4 negatives and 3 positives.

These cancel and these cancel and these cancel. I have one negative left. My answer is negative 1.

We have the same big idea as always - a quick sketch me how the numbers will interact and I either count them all up or cancel some out. In all of these cases, the minus sign means “negative.” So now let’s think about what happens when we see the minus sign meaning “subtract.”

Let’s Talk (Slide 4): When we subtract integers, we will need to shift between two different ways of thinking about the minus sign. We still know that positive and negative together cancel eachother out. That’s not going to change. Let’s see how that is going to work with these problems. It says, “use the idea of opposites to subtract the integers below.” We have 4 - 3. So first of all, you know 4 - 3. It’s 1. Easy. You knew that in Kindergarten. And in Kindergarten, you were probably taught that in order to draw subtraction you cross things out. Like this.



I know it is going to feel lame to continue thinking about this problem but stick with me because it will teach us something about subtracting integers for harder problems. And this is where we are going to learn the most important idea for today. We can draw 4 and cross 3 out. But another way to get rid of 3 would be to ADD 3 NEGATIVES. Look at this picture. I draw 4 positives. If I add 3 negatives. Then I cancel this one and this one and this one. And I'm left with 1 just like before.

Now, why would we do this? We wouldn't. But it shows us one important idea: subtracting is the same as adding the opposite. Say it after me, "Subtracting is the same as adding the opposite." That is called a SHIFT IN PERSPECTIVE. It means we can look at the minus sign and think, "Oh, subtraction! That means crossing out." Or we can look at that same minus sign and think, "Oh, a minus sign! I will write it as adding the opposite." Let me rewrite the problem just so we start to see these as equivalent. Another way to write 4 minus 3 is to write 4 plus negative 3.

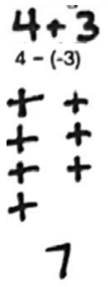
4+-3
4 - 3

We will see this same idea on the next problem. I start with negative four. So let me draw 4 negatives. Now I need to take away 3 negatives. I can cross them out and I have one negative leftover.

I could also draw it another way. I start with 4 negatives. Now I want to subtract or get rid of 3 negatives. I get rid of negatives by adding the opposite. So I will add 3 positives. This cancels. This cancels. This cancels. I am left with negative 1. That's the exact same answer we got before. So, once again, we can think of the minus sign as "takeaway" or "cross out." But we can also think of it as a negative and we just add the opposite to find the answer.

-4+3
-4 - (-3)

That's a shift in perspective, a shift in how we think about things. That would be negative 4 plus 3. And this problem actually looks simpler than the original, doesn't it?



Now here's where we're going to see shifting our perspective becoming actually important. We start with 4. I will draw 4 positive. Then it wants us to subtract negative 3. That would mean crossing out 3 negatives. But there aren't any negatives to cross out! I am suddenly pretty stuck if I only think of this one perspective that the minus sign means subtract. Instead I'm going to think of it as adding the opposite. If I add 3 positive, that is the same as if I were crossing out 3 negatives. They aren't there but positives cancel negatives, right? So I will add 3 positives. I see 4 positives and 3 positives. Nothing gets circled. My answer is 7.

I can see all these minuses and get really panicky. Or I can see this minus and SHIFT MY PERSPECTIVE. I will change it to 4 plus the opposite, 3. You might have heard this before called "KEEP CHANGE FLIP." That is a trick that people sometimes say. But that gets really confusing - when do you do it? Why do you do it? It is better to actually understand that adding the opposite cancels something out so it is the same as subtraction.

$-4 + -3$

$-4 - 3$

− −
− −
− −
−

-7

Let's do one more! We start with 4 negatives so I will draw those. Now if I look at this minus sign as subtraction, I need to cross out 3 positives. I don't have any positives. I can't cross them out. Instead, I have to SHIFT MY PERSPECTIVE. I will think of the minus sign as canceling and I will add the opposite to cancel them. I will add 3 negatives. I can see this is 7 negatives.

This problem turned into negative 4 plus negative 3. And then it's easy to see, "Oh, I have negatives and more negatives. My answer is going to be a lot of negatives." The big idea here is that subtracting is the same as adding the opposite.

Let's Think (Slide 5): **"**We will need to shift how we think of the minus sign as we solve equations." This says, "Solve for the variable in the equations. Think about when you might have to think about the minus sign as negative instead of subtraction." Now, hopefully you remember from previous grades that we solve equations by working backwards and doing the same thing to both sides to keep the equation balanced. Now, this first one is really tricky because we were just looking at minus a negative on the last slide and we said it was easier to switch it to adding the opposite. But remember, we're working backwards to get to f anyway so I can just add negative 2 and I'll be working backwards. I have to do that on both sides.

$-3 = 5f - (-2)$

$+-2 \quad +-2$

$-3 = 5f - (-2)$

$+-2 \quad +-2$

$-5 = 5f$

Now I can think to myself, negative 3 and negative 2 is a lot of negatives put together. I get negative five equals 5f.

I work backwards on the 5f by dividing by 5 on both sides. Negative 5 divided by 5 is negative 1, which equals f. Now, I'll mention that we haven't spent any time talking about multiplying and dividing positive and negatives today. That's because we can use our old idea of multiplication and division as groups to understand the rules there. If I have positive and negatives getting multiplied then I either have negative groups or groups of negatives. And either way my answer will be negative. If I have a negative times a negatives that's like negative groups of negatives and now we're talking about the opposite of negatives, which is positives. The point is that in this case, I thought of the minus sign as subtraction and I just worked backwards from subtraction.

$-3 = 5f - (-2)$

$+-2 \quad +-2$

$\frac{-5}{5} = \frac{5f}{5}$

$\boxed{-1=f}$

$-2 = a + 8$

$-8 \quad -8$

$\boxed{-10 = a}$

Let's look at the next one. At first, there isn't even a minus sign to worry about. I want to get a by itself so I will subtract 8 from both sides.

Alert! Alert! I have negative 2 minus 8! NOW we're in a tricky spot! I can't cross out 8 when there isn't even 8 there! I have to think of this as adding negative 8. Some people won't even rewrite this. They will just do a quick invisible shift in their mind where they turn minus 8 into negative 8. And that is totally acceptable. If the shift doesn't happen for you as quickly yet, it's no big deal. Put a little plus sign and think of this as adding negative 8 instead. Now we can think 2 negatives and 8 negatives is a lot of negatives altogether. That's 10 negatives or negative 10 equals a.

In this case, we thought of the minus sign as negative.

Let's do one more. We have 4 equals negative 7 plus x. We want x by itself so we have to get rid of

$$\begin{array}{l} 4 = -7 + x \\ +7 \quad +7 \end{array}$$

this negative 7. You can do a whole lot of thinking about how we get rid of negatives. But if we think of the minus sign as subtraction then it's obvious that to get rid of it, we add 7. And I'm going to do that to both sides.

$$\begin{array}{l} 4 = -7 + x \\ +7 \quad +7 \\ \boxed{11 = x} \end{array}$$

Then I get 11 equals x. In this case, again, someone might have this quick invisible moment in their head where they change the negative sign to the idea of subtracting. Great. Let's spell it out just because it's still kind of new for us.

We thought of the minus sign as subtraction. The big idea here is that you will have to stop and think. You might try to think of the minus sign as subtraction and feel stuck so then you can try thinking of it as a negative. You will have to do a little bit of trial and error to solve these equations.

$$\begin{array}{l} -9 = 6 - 3x \\ -6 \quad -6 \end{array}$$

Let's Think (Slide 6): Let's do two more examples that are a little trickier. Here we have negative 9 equals 6 minus 3x. I will start by getting rid of this 6 by subtracting 6 on both sides.

$$\begin{array}{l} -9 = 6 - 3x \\ -6 \quad -6 \\ -15 = -3x \end{array}$$

When I write it over on the left, I think of it as negative 6 so that becomes negatives and more negatives. I get lots of negatives. It's negative 15. That equals minus 3x.

$$\begin{array}{l} -9 = 6 - 3x \\ -6 \quad -6 \\ \frac{-15}{-3} = \frac{-3x}{-3} \\ \boxed{5 = x} \end{array}$$

Now this is really interesting. When I first looked at the problem, it seemed like 3x was being subtracted. But now it looks more like negative 3 times x. No problem! I shift my perspective. To work backward, I will divide each side by negative 3.

Negative 15 divided by negative 3 is positive 5 because it's like I have the negative groups of negative. In other words, the opposite of negative is positive. 5 equals x.

$$\begin{array}{l} -9 = 6 - 3x \\ -6 \quad -6 \\ \frac{-15}{-3} = \frac{-3x}{-3} \\ \boxed{5 = x} \end{array}$$

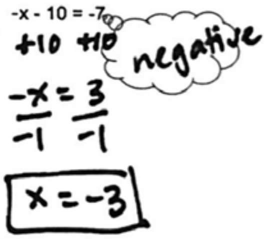
I thought of the minus sign as a negative.

$$\begin{array}{l} -x - 10 = -7 \\ +10 \quad +10 \\ -x = 3 \end{array}$$

One more! I will start by adding 10 to both sides to work backwards from the subtracting happening here. The positive 10 cancels the negative 7 so I get negative x equals positive 3.

$$\begin{array}{l} -x - 10 = -7 \\ +10 \quad +10 \\ -x = 3 \end{array}$$

So far, I saw the minus sign as subtraction. But the next step is a super big deal! When I see a negative x and I need the x by itself, it is easiest if I think of it as negative 1 times x. That is a really important shift in perspective.



Then I divide by negative 1 on both sides. That cancels out on the left and I get x equals something. 3 divided by negative 1 is negative 3 because I have different signs. X equals negative 3.

Let's Try It (Slide 7): Let's solve equations with minus signs together. I will walk you through each step.

WARM WELCOME

Today we will solve linear equations by thinking about the subtraction symbol in two different ways.

Let's Review:

To work with positive and negative numbers, we need to understand they are opposites of each other.

Use the idea of opposites to add the integers below.

4 + 3

-4 + -3

4 + -3

-4 + 3

Let's Talk:

When we subtract integers, we will need to shift between two different ways of thinking about minus sign.

Use the idea of opposites to subtract the integers below.

4 − 3

-4 − (-3)

4 − (-3)

-4 − 3

Let's Think:

We will need to shift how we think of the minus sign as we solve equations.

Solve for the variable in the equations. Think about when you might have to think about the minus sign as negative instead of subtraction.

-3 = 5f − (-2)

-2 = a + 8

4 = -7 + x

Let's Think:

We will need to shift how we think of the minus sign as we solve equations.

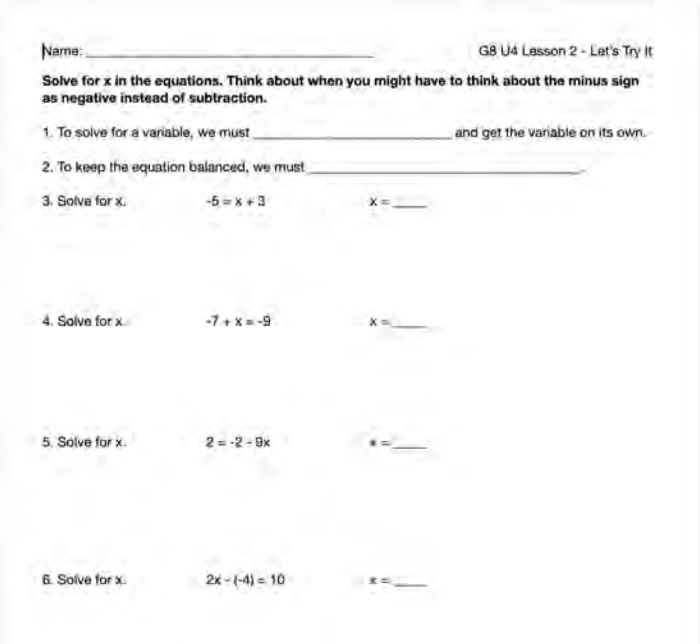
Solve for the variable in the equations. Think about when you might have to think about the minus sign as negative instead of subtraction.

-9 = 6 - 3x

-x - 10 = -7

Let's Try It:

Let's solve equations with minus signs together!



Name: ______________________ G8 U4 Lesson 2 - Let's Try It

Solve for x in the equations. Think about when you might have to think about the minus sign as negative instead of subtraction.

1. To solve for a variable, we must ______________ and get the variable on its own.

2. To keep the equation balanced, we must ______________.

3. Solve for x. -5 = x + 3 x = ____

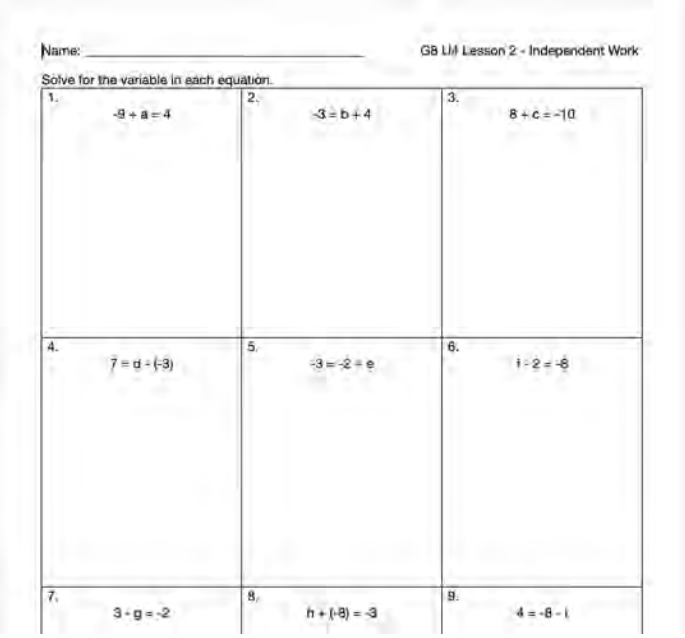
4. Solve for x. -7 + x = -9 x = ____

5. Solve for x. 2 = -2 - 9x x = ____

6. Solve for x. 2x - (-4) = 10 x = ____

On your Own:

Now it's time for you to do it on your own!



Name: ______________________ G8 U4 Lesson 2 - Independent Work

Solve for the variable in each equation.

1. -9 + a = 4	2. -3 = b + 4	3. 8 + c = -10
4. 7 = d - (-3)	5. -3 = -2 - e	6. i - 2 = -8
7. 3 - g = -2	8. h + (-8) = -3	9. 4 = -8 - i

Solve for x in the equations. Think about when you might have to think about the minus sign as negative instead of subtraction.

1. To solve for a variable, we must ____________________________ and get the variable on its own.

2. To keep the equation balanced, we must ______________________________________.

3. Solve for x. $-5 = x + 3$ $x =$ _____

4. Solve for x. $-7 + x = -9$ $x =$ _____

5. Solve for x. $2 = -2 - 9x$ $x =$ _____

6. Solve for x. $2x - (-4) = 10$ $x =$ _____

7. Solve for x. $-6 = 5 - x$ $x =$ _____

Name: ____

G8 U4 Lesson 2 - Independent Work

Solve for the variable in each equation.

1. $-9 + a = 4$

2. $-3 = b + 4$

3. $8 + c = -10$

4. $7 = d - (-3)$

5. $-3 = -2 + e$

6. $f - 2 = -8$

7. $3 - g = -2$

8. $h + (-8) = -3$

9. $4 = -8 - i$

Solve for the variable in each equation.

10. $-7 = 2j - (-3)$

11. $-6 = -1 + 6k$

12. $-m - 2 = -4$

13. $-9 - 4n = 3$

14. $-6 = -2b + 4$

15. $8 - c = 10$

16. $3 + 2g = -5$

17. $-h + (-8) = -10$

18. $1 = 7 - i$

Name: ANSWER KEY

G8 U4 Lesson 2 - Let's Try It

Solve for x in the equations. Think about when you might have to think about the minus sign as negative instead of subtraction.

1. To solve for a variable, we must work backwards and get the variable on its own.

2. To keep the equation balanced, we must do the same to both sides.

3. Solve for x. $-5 = x + 3$ x = -8

$-3 \quad -3$

$-8 = x$

4. Solve for x. $-7 + x = -9$ x = -2

$+7 \quad +7$

$x = -2$

5. Solve for x. $2 = -2 - 9x$ x = $-\frac{4}{9}$

$+2 \quad +2$

$\frac{4}{-9} = \frac{-9x}{-9}$

6. Solve for x. $2x - (-4) = 10$ x = 3

$2x + 4 = 10$

$-4 \quad -4$

$\frac{2x}{2} = \frac{6}{2}$

$x = 3$

7. Solve for x. $-6 = 5 - x$ x = 11

$-5 \quad -5$

$\frac{-11}{-1} = \frac{-x}{-1}$

$11 = x$

Name: ANSWER KEY

G8 U4 Lesson 2 - Independent Work

Solve for the variable in each equation.

1.

$-9 + a = 4$

$+9 \quad +9$

$\boxed{a = 13}$

2.

$-3 = b + 4$

$-4 \quad -4$

$\boxed{-7 = b}$

3.

$8 + c = -10$

$-8 \quad -8$

$\boxed{c = -18}$

4.

$7 = d - (-3)$

$7 = d + 3$

$-3 \quad -3$

$\boxed{4 = d}$

5.

$-3 = -2 + e$

$+2 \quad +2$

$\boxed{-1 = e}$

6.

$f - 2 = -8$

$+2 \quad +2$

$\boxed{f = -6}$

7.

$3 - g = -2$

$-3 \quad -3$

$\frac{-g}{-1} = \frac{-5}{-1}$

$\boxed{g = 5}$

8.

$h + (-8) = -3$

$+8 \quad +8$

$\boxed{h = 5}$

9.

$4 = -8 - i$

$+8 \quad +8$

$\frac{12}{-1} = \frac{-i}{-1}$

$\boxed{-12 = i}$

Solve for the variable in each equation.

10.

$-7 = 2j - (-3)$

$-7 = 2j + 3$

$-3 \quad -3$

$\frac{-10}{2} = \frac{2j}{2}$

$\boxed{-5 = j}$

11.

$-6 = -1 + 6k$

$+1 \quad +1$

$-\frac{5}{6} = \frac{6k}{6}$

$\boxed{-\frac{5}{6} = k}$

12.

$-m - 2 = -4$

$+2 \quad +2$

$\frac{-m}{-1} = \frac{-2}{-1}$

$\boxed{m = 2}$

13.

$-9 - 4n = 3$

$+9 \quad +9$

$\frac{-4n}{-4} = \frac{12}{-4}$

$\boxed{n = -3}$

14.

$-6 = -2b + 4$

$-4 \quad -4$

$\frac{-10}{-2} = \frac{-2b}{-2}$

$\boxed{5 = b}$

15.

$8 - c = 10$

$-8 \quad -8$

$\frac{-c}{-1} = \frac{2}{-1}$

$\boxed{c = -2}$

16.

$3 + 2g = -5$

$-3 \quad -3$

$\frac{2g}{2} = \frac{-8}{2}$

$\boxed{g = -4}$

17.

$-h + (-8) = -10$

$+8 \quad +8$

$\frac{-h}{-1} = \frac{-2}{-1}$

$\boxed{h = 2}$

18.

$1 = 7 - i$

$-7 \quad -7$

$\frac{-6}{-1} = \frac{-i}{-1}$

$\boxed{6 = i}$

G8 U4 Lesson 3
Solve linear equations with the distributive property.

CITYTUTOR DC

G8 U4 Lesson 3 - Today we will solve linear equations with the distributive property.

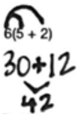
Warm Welcome (Slide 1): Tutor choice

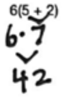
Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will solve linear equations with the distributive property. This is the next level of complexity in what we've already been doing. You are ready for it! Let's go!

Let's Review (Slide 3): This says, "The distributive property is an important part of solving equations." Raise your hand if you ever remember hearing about the distributive property in an earlier grade. What do you remember? Possible Student Answers, Key Points:

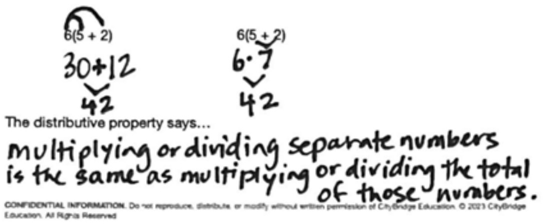
- It means that you can multiply or divide a whole amount by something and you'll get the same answer as if you multiply or divide it in pieces instead.
- It means you take that 6 and multiply it by 5. Then you multiply it by 2 and you get 30 plus 12.

You might hear a whole lot of correct and incorrect responses. The purpose of the question is just to get a sense of what kids know. Do not confirm or correct student answers. Here's what I would say. I would say the distributive property says that we can distribute a multiplier or divisor to each piece of a whole and then we would multiply or divide each piece. Or we can put all the pieces together into a whole amount and then multiply or divide them. And we will get the same answer either way. Let me show you with this example. If I have the stuff in this parentheses times 6. I will multiply each part of my parentheses. Let me draw arrows just to show you what I'm thinking. I will do 6 times 5 and 6 times 2. 6 times 5 is 30. That gets added to 6 times 2, which is 12. 30 plus 12 is 42.





Now let's do the same problem a different way. This time, I will follow order of operations and do the parentheses first. 5 plus 2 is 7 so now I have 6 x 7. 6 x 7 is 42. I get the same answer.

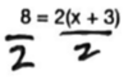


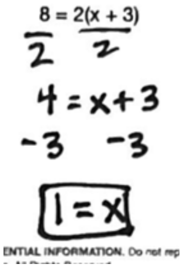
The distributive property says…

multiplying or dividing separate numbers is the same as multiplying or dividing the total of those numbers.

So, the distributive property says… multiplying or dividing separate numbers is the same as multiplying or dividing the total of those numbers. This is going to be very important because we are going to need to solve equations that have the distributive property. That's what today's lesson is about.

Let's Talk (Slide 4): There are two ways to solve an equation when we have the distributive property. We can cancel out the part outside the parentheses with the opposite operation. Or we can distribute the factor and then solve. The first one usually has fewer steps. Let me show you what I mean. I see that I have 8 equals 2 times this amount in parentheses, x plus 3. I will need to work backwards and divide by 2 on each side.





Then I get 4 equals x plus 3. I want to get x by itself so I will subtract 3 on both sides. I get 1 equals x. When we do the problem like this, we are thinking about which steps we would solve and then working backwards from those steps. Like normally we would do whatever is in the parentheses and then multiply it. But we're going to work backwards from that so we'll get rid of the multiplication first.

$$
\begin{aligned}
8 &= 2(x+3)\\
8 &= 2x+6
\end{aligned}
$$

The other way to do it is to distribute the factor. That means multiply the factor times everything in the parentheses. Then we'll get a simpler equation. I will draw arrows to show everything that has to get multiplied.So I will do 8 equals 2 times x, which is 2x. Then I do 2 x 3, which is 6. Now I have 8 equals 2x plus 6.

$$
\begin{aligned}
8 &= 2(x+3)\\
8 &= 2x+6\\
-6 &\quad\; -6\\
\frac{2}{2} &= \frac{2x}{2}\\
&\boxed{1=x}
\end{aligned}
$$

I can subtract 6 from each side, which leaves me with 2 equals 2x. Now I divide by 2 on each side. I get 1 equals x. The same answer! Yay! That means we're doing it right!What I can't do is just attach this 2 to the x and rewrite the expression as if the parentheses were never there. The parentheses are there because everything inside these parentheses has to get multiplied by 2. I can't write 8 = 2x =3. *Write the equation and then cross it out.* I either have to cancel out that multiplier like we did in the first problem or distribute that multiplier like we did in the second problem.

Let's Think (Slide 5): There is one additional thing that makes this a bit trickier. This says, "If we are subtracting a factor, we must shift our perspective and think of it as a negative number as we multiply and divide." Let's solve for the variables and I'll show you what I mean. The first problem is straightforward. I want to start by canceling the addition and subtraction outside the parentheses so I will subtract 8 from both sides. That leaves me with 9 times 2x minus 10 equals 54.

$$
\begin{aligned}
8 + 9(2x-10) &= 62\\
-8 \qquad\quad &\quad -8\\
9(2x-10) &= 54
\end{aligned}
$$

$$
\begin{aligned}
8 + 9(2x-10) &= 62\\
-8 \qquad\quad &\quad -8\\
\frac{9(2x-10)}{9} &= \frac{54}{9}\\
2x-10 &= 6\\
+10 &\quad +10\\
\frac{2x}{2} &= \frac{16}{2}\\
&\boxed{x=8}
\end{aligned}
$$

Now I will divide by 9 on each side. That gives me 2x plus 10 equals 6.

We keep working backwards. I will add 10 to both sides. That gives me 2x equals 16.

I divide by 2 on each side and get x equals 8.

The next problem is exactly the same except that not it is 8 MINUS 9 instead of 8 plus 9. It starts the same way. I subtract 8 from both sides.

$$
\begin{aligned}
8 - 9(2x-10) &= 62\\
-8 \qquad &\quad -8\\
-9(2x-10) &= 54
\end{aligned}
$$

The key thing is that as the eight is canceled out, I still have this minus sign before the 9. It doesn't disappear because everything after it is supposed to be subtracted or taken away. So, I will leave it in front of the 9 and now it's like NEGATIVE nine times what it's in the parentheses. I have negative nine times 2x - 10 equals 54.

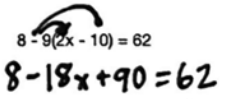
$$
\begin{aligned}
8 - 9(2x-10) &= 62\\
-8 \qquad &\quad -8\\
\frac{-9(2x-10)}{-9} &= \frac{54}{-9}\\
2x-10 &= -6\\
+10 &\quad +10\\
\frac{2x}{2} &= \frac{4}{2}\\
&\boxed{x=2}
\end{aligned}
$$

I keep going but now when I divide, I divide by NEGATIVE 9 on both sides. That gives me 2x minus 10 equals NEGATIVE 6. Because I have different signs, a positive divided by a negative.

I want to add 10 to both sides. That leaves me with 2x on the left. On the right, I have negative 6 plus positive 10. They cancel and I'm only left with positive 4.

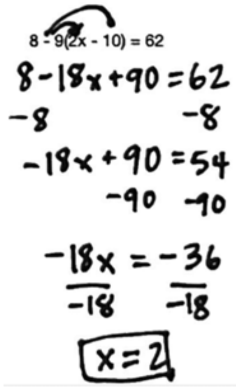
I divide by 2 on each side. I get x equals 2. So you see, I get a different answer with that minus sign there. I can't just let it disappear.

Let’s do this one more time to see what happens if I wanted to distribute first. I can’t think of it as distributing 9 because it is 8 minus 9. And to distribute it, I would need to think of it as 8 plus negative 9. And in fact, I would think of this minus 10 as plus negative 10 too. Then I would distribute NEGATIVE 9. It would be NEGATIVE 9 times 2x and NEGATIVE 9 times negative 10. I would get 8 plus negative 18x plus 90 equals 62.



$8 - 9(2x - 10) = 62$

$8 - 18x + 90 = 62$



$8 - 9(2x - 10) = 62$

$8 - 18x + 90 = 62$

$-8 \qquad -8$

$-18x + 90 = 54$

$-90 \quad -90$

$-18x = -36$

$\overline{-18} \quad \overline{-18}$

$\boxed{x=2}$

Let’s keep solving. I will subtract 8 from both sides. I get negative 18x plus 90 equals 54. Then I subtract 90 from each side. That’s kind of hard. I might have to do 90 minus 54 on the side of my paper to see what is left when these cancel eachother out. I can do it in my head, and it leaves negative 36. So we have negative 18x equals negative 36. I divide by negative 18 on both sides, and I get x equals 2.

I want you to see that it is very tricky to distribute something that is being subtracted. It is easier to cancel it out with an opposite operation. But if you have to then you can. And you need to look out for whether it is necessary to change it to adding a negative like we did in our last lesson.

Let’s Try It (Slide 6): Let’s solve equations with the distributive property together. I will walk you through each step.

WARM WELCOME

Today we will solve linear equations with the distributive property.

Let's Review:

The distributive property is an important part of solving equations.

Evaluate the expression below two ways.

$6(5 + 2)$ $6(5 + 2)$

The distributive property says…

Let's Talk:

There are two ways to solve an equation when we have the distributive property.

We can cancel out the part outside the parentheses with the opposite operation. Or we can distribute the factor and then solve.

$8 = 2(x + 3)$ $8 = 2(x + 3)$

Let's Think:

If we are subtracting a factor, we must shift our perspective and think of it as a negative number as we multiply and divide.

Solve for the variables.

$8 + 9(2x - 10) = 62$ $8 - 9(2x - 10) = 62$ $8 - 9(2x - 10) = 62$

Let's Try It:

Let's solve some equations together!

Name: ______________________ G8 U4 Lesson 3 - Let's Try It

Solve for x in the equations.

1. When working backward from a problem with parentheses, we must do the part ____________ the parentheses first.

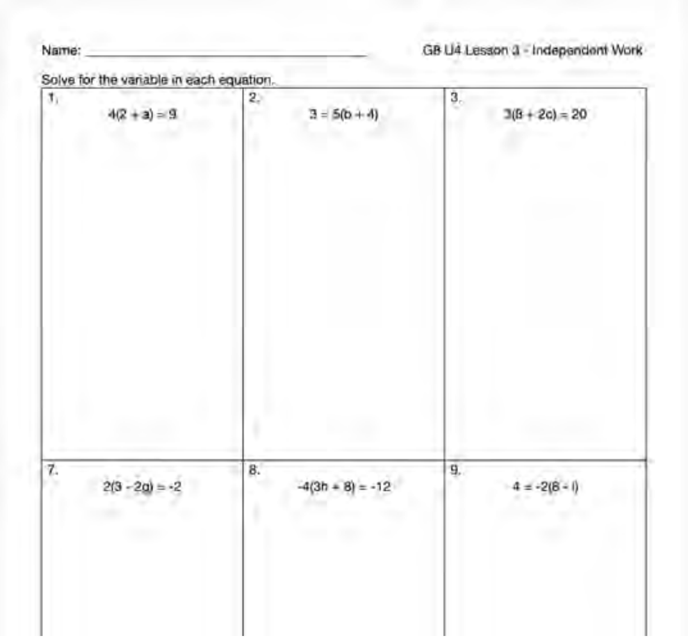
2. Solve for x without distributing. $5 = 2(x + 3)$ x = ____

3. Distribute then solve for x. $5 = 2(x + 3)$ x = ____

4. Solve for x without distributing. $2 = 6 - 2(4 - 3x)$ x = ____

On your Own:

Now it’s time for you to do it on your own!



Name: ______________________________

G8 U4 Lesson 3 - Independent Work

Solve for the variable in each equation.

1. $4(2 + a) = 9$
2. $3 = 5(b + 4)$
3. $3(8 + 2c) = 20$
7. $2(3 - 2g) = -2$
8. $-4(3h + 8) = -12$
9. $4 = -2(8 - i)$

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Solve for x in the equations.

1. When working backward from a problem with parentheses, we must do the part _______________ the parentheses first.

2. Solve for x without distributing. $5 = 2(x + 3)$ x = _____

3. Distribute then solve for x. $5 = 2(x + 3)$ x = _____

4. Solve for x without distributing. $2 = 6 - 2(4 - 3x)$ x = _____

5. Distribute then solve for x. $2 = 6 - 2(4 - 3x)$ x = _____

Name: ____

Solve for the variable in each equation.

1. $4(2 + a) = 9$

2. $3 = 5(b + 4)$

3. $3(8 + 2c) = 20$

7. $2(3 - 2g) = -2$

8. $-4(3h + 8) = -12$

9. $4 = -2(8 - i)$

Solve for the variable in each equation.

10. $6 = 4(3j - 3) + 12$

11. $5 = 2(-1 + 6k) - 1$

12. $3 + 6(2m + 3) = 57$

16. $-2(3 + 2g) = -5$

17. $3(-h - 8) + 5 = -10$

18. $-6 = 9 - 3(7i + 3)$

Name: ANSWER KEY

G8 U4 Lesson 3 - Let's Try It

Solve for x in the equations.

1. When working backward from a problem with parentheses, we must do the part Outside the parentheses first.

2. Solve for x without distributing. $5 = 2(x + 3)$ $x = -\frac{1}{2}$

$\frac{5}{2} = \frac{2(x+3)}{2}$

$2\overset{2\frac{1}{2}}{\overline{)5}}$
-4
1

$2\frac{1}{2} = x + 3$

$-3 \quad -3$

$\boxed{-\frac{1}{2} = x}$

3. Distribute then solve for x. $5 = 2(x + 3)$ $x = -\frac{1}{2}$

$5 = 2x + 6$

$-6 \quad -6$

$\frac{-1}{2} = \frac{2x}{2}$

$\boxed{-\frac{1}{2} = x}$

4. Solve for x without distributing. $2 = 6 - 2(4 - 3x)$ $x = \frac{2}{3}$

$-6 \quad -6$

$\frac{-4}{-2} = \frac{-2(4-3x)}{-2}$

$2 = 4 - 3x$

$-4 \quad -4$

$\frac{-2}{-3} = \frac{-3x}{-3}$ $\quad \frac{2}{3} = x$

5. Distribute then solve for x. $2 = 6 - 2(4 - 3x)$ $x = \frac{2}{3}$

$2 = 6 - 8 + 6x$

$+8 \quad +8$

$10 = 6 + 6x$

$-6 \quad -6$

$\frac{4}{6} = \frac{6x}{6}$ $\quad \frac{4 \div 2}{6 \div 2} = x$ $\quad \frac{2}{3} = x$

Name: ANSWER KEY

G8 U4 Lesson 3 - Independent Work

Solve for the variable in each equation.

1.

$4(2 + a) = 9$

$8+4a=9$

$-8 \qquad -8$

$\frac{4a}{4}=\frac{1}{4}$

$\boxed{a=\frac{1}{4}}$

2.

$3 = 5(b + 4)$

$3=5b+20$

$-20 \qquad -20$

$\frac{-17}{5}=\frac{5b}{5}$

$\boxed{-3\frac{2}{5}=b}$

$\begin{array}{r} 03 \\ 5\overline{)17} \\ -15 \\ \hline 2 \end{array}$

3.

$3(8 + 2c) = 20$

$24+6c=20$

$-24 \qquad -24$

$\frac{6c}{6}=\frac{-4}{6}$

$c=-\frac{4\div 2}{6\div 2}$

$\boxed{c=-\frac{2}{3}}$

7.

$\frac{2(3 - 2g)}{2} = \frac{-2}{2}$

$3-2g=-1$

$-3 \qquad -3$

$\frac{-2g}{-2}=\frac{-4}{-2}$

$\boxed{g=2}$

8.

$\frac{-4(3h + 8)}{-4} = \frac{-12}{-4}$

$3h+8=3$

$-8 \qquad -8$

$\frac{3h}{3}=\frac{-5}{3}$

$\begin{array}{r} 1\frac{2}{3} \\ 3\overline{)5} \\ -3 \\ \hline 2 \end{array}$

$\boxed{h=-1\frac{2}{3}}$

9.

$\frac{4}{-2} = \frac{-2(8 - i)}{-2}$

$-2=8-i$

$-8 \qquad -8$

$\frac{-10}{-1}=\frac{-i}{-1}$

$\boxed{10=i}$

Solve for the variable in each equation.

10.

$6 = 4(3j - 3) + 12$

$-12 \qquad -12$

$-6 = 4(3j - 3)$

$-6 = 12j - 12$

$+12 \qquad +12$

$\frac{6}{12} = \frac{12j}{12}$

$\frac{6 \div 6}{12 \div 6} = j$

$\boxed{\frac{1}{2} = j}$

11.

$5 = 2(-1 + 6k) - 1$

$+1 \qquad +1$

$6 = -2 + 12k$

$+2 \qquad +2$

$\frac{8}{12} = \frac{12k}{12}$

$\frac{8 \div 4}{12 \div 4} = k$

$\boxed{\frac{2}{3} = k}$

12.

$3 + 6(2m + 3) = 57$

$-3 \qquad -3$

$\frac{6(2m+3)}{6} = \frac{54}{6}$

$2m + 3 = 9$

$-3 \qquad -3$

$\frac{2m}{2} = \frac{6}{2}$

$\boxed{m = 3}$

16.

$-2(3 + 2g) = -5$

$-6 + -4g = -5$

$+6 \qquad +6$

$\frac{-4g}{-4} = \frac{1}{-4}$

$\boxed{g = -\frac{1}{4}}$

17.

$3(-h - 8) + 5 = -10$

$-5 \qquad -5$

$\frac{3(-h-8)}{3} = \frac{-15}{3}$

$-h - 8 = -5$

$+8 \qquad +8$

$\frac{-h}{-1} = \frac{3}{-1}$

$\boxed{h = -3}$

18.

$-6 = 9 - 3(7i + 3)$

$-9 \qquad -9$

$\frac{-15}{-3} = \frac{-3(7i + 3)}{-3}$

$5 = 7i + 3$

$-3 \qquad -3$

$\frac{2}{7} = \frac{7i}{7}$

$\boxed{\frac{2}{7} = i}$

G8 U4 Lesson 4
Solve linear equations with variables on both sides.

G8 U4 Lesson 4 - Today we will solve linear equations with variables on both sides.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will solve linear equations with variables on both sides. It is all of the ideas we've already been working with one extra twist. You are going to do great!

Let's Review (Slide 3): We know that we need to keep any equation we are solving balanced by doing the same operation to both sides. This says, "Solve for x." What steps might I do first? Possible Student Answers, Key Points:

- Distribute the 7.
- Add 5 to both sides.

=There are actually two different ways I could start. As our equations get more sophisticated, that is going to happen more and more often. Sometimes I think about what numbers I would get with each step in my head before I write anything down. Then I can think what would be friendlier. For example, in this problem, I could do the distribution. I'm thinking in my head that would give me 14x plus 21 minus 5. I could work backwards from that but it's a lot of numbers. The other idea would be to add 5 to both sides. I'm thinking in my head that gets rid of the 5 on the left and makes things a little simpler. So let's do that. I am going to add 5 to both sides.

$$7(2x + 3) - 5 = 16$$
$$+5 \quad +5$$

$$7(2x + 3) - 5 = 16$$
$$+5 \quad +5$$
$$\frac{7(2x+3)}{7} = \frac{21}{7}$$

Now I have 7 times 2x + 3 equals 21. There are two different ways I could do the next step too! I'm kind of always doing some pre-thinking in my head about what would make my life easier. What steps might I do next? Possible Student Answers, Key Points:

- Distribute the 7.
- Divide by 7 on both sides.

Once again, I think about what numbers I would get with each step in my head before I write anything down. Then I can think what would be friendlier. For example, a lot of time it's easier to distribute the factor outside the parentheses. Then I won't have parentheses anymore. That's nice. Or I could divide by 7 on both sides. Sometimes that gives me some really tricky numbers. Sometimes that gives me fractions. But in this case, it's actually a nice friendly number so I'll do that and save myself some steps. I divide by 7 on both sides.

$$7(2x + 3) - 5 = 16$$
$$+5 \quad +5$$
$$\frac{7(2x+3)}{7} = \frac{21}{7}$$
$$2x + 3 = 3$$
$$-3 \quad -3$$

I get 2x + 3 equals 3. What step should I do next? Possible Student Answers, Key Points:

- Subtract 3 on both sides.

Now in this case, I don't have two options that I can choose between. The order of operations, which is PEMDAS, tells us that multiplication and division come before addition and subtraction. To work backwards from that, I have to work on the addition and subtraction first. I am going to subtract 3 from both sides.

$$2x = 0$$

Now this might seem a little scary because I am going to get 2x equals ZERO. But it is totally okay to get zero as an answer. But that doesn't means we can just drop one whole side of the equation. We write down zero and keep going.

$$7(2x + 3) - 5 = 16$$

$$\quad +5 \quad +5$$

$$\frac{7(2x+3)}{7} = \frac{21}{7}$$

$$2x + 3 = 3$$

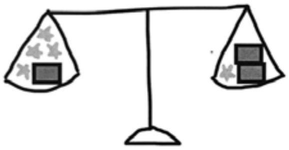
$$\quad -3 \quad -3$$

$$\frac{2x}{2} = \frac{0}{2} \qquad \boxed{x=0}$$

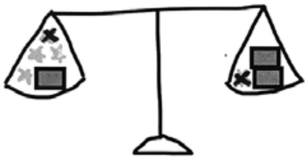
Now I can divide by 2 on each side.

That gives me x on this side and 2 divided by zero is still zero. So x equals zero. Just because zero means nothing doesn't mean you didn't get an answer. Zero can be an answer, and that's what we got here. Great work!

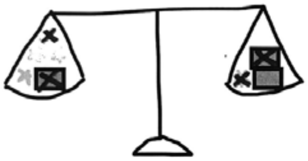
Let's Talk (Slide 4): For the big idea of today's lesson, we are back to a model we used a few lessons ago. This says, "The balance can help us think about what to do when there is a variable on both sides of the equal sign." So you can see in our picture that now our balance has boxes on both sides. That is totally fine. We still do the same thing to both sides so that it stays balanced. This says, "If the scale below is balanced, how many stars must be hidden in one of the equal boxes?" So we know that we are trying to figure out what the scale would look like if there were only 1 box on one side. Then we would know what it is balanced with. I am going to draw that underneath just so we can think about where we're trying to end up.



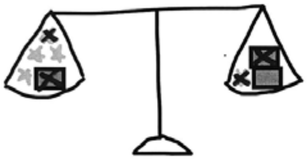
Now, one big idea that is going to keep coming up is that before I just dive in and start writing down numbers, I am going to think in my head, "What could make this simpler?" or "What could make this friendlier?" In this case, I am going to cross out a star on each side because then the right side will only have boxes and that's a bit easier to think about.



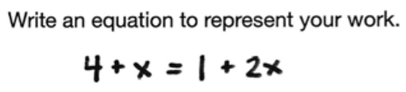
Now I want to get just one box on one side and right now I have boxes on both sides. That is not very simple or friendly. So I am going to take off this box on the left. And if I do that, I have to take off a box on the right to keep it balanced.



Look what we have! There are 3 stars on the left and 1 box on the right. So now I know 3 stars equals 1 box.



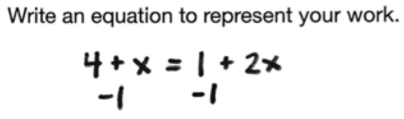
Next this says to write an equation to represent your work. Remember the stars we know and the boxes are the unknowns like a question mark or a variable. On the left side we have 4 stars so I'll write 4 plus x, which stands for the unknown amount in the box. That equals what we have on the right side. The right side has 1 star so I'll write 1 plus 2x for the 2 boxes, which is 2 unknowns.



Write an equation to represent your work.

$$4 + x = 1 + 2x$$

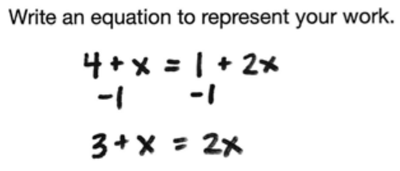
The first thing we did was take away a star from each side. That's the same as doing minus one on the left and minus one on the right. We can see that we are working backwards from the addition that is written on the right.



Write an equation to represent your work.

$$\begin{aligned} 4 + x &= 1 + 2x \\ -1 \quad & \quad -1 \end{aligned}$$

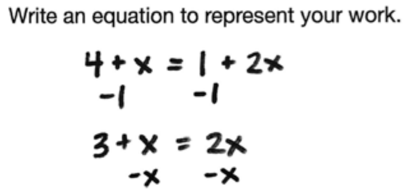
That gives us 3 + x equals 2x.



Write an equation to represent your work.

$$\begin{aligned} 4 + x &= 1 + 2x \\ -1 \quad & \quad -1 \\ 3 + x &= 2x \end{aligned}$$

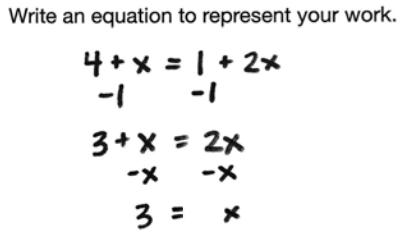
Next we wanted to get one x by itself. Sometimes people call that "isolating the variable." So we crossed out a box on each side. That's the same as subtracting x on the side and subtracting x on this side.



Write an equation to represent your work.

$$\begin{aligned} 4 + x &= 1 + 2x \\ -1 \quad & \quad -1 \\ 3 + x &= 2x \\ -x \quad & \quad -x \end{aligned}$$

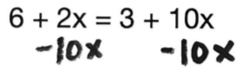
Then we just have 3 on the left. That equals x on the right. That's because we're thinking of it like 2 boxes minus 1 box or like 2 exes minus 1 ex. That leaves 1 ex but we just write x. And that's our answer. The big idea here is that even if we have variables on both sides, it works the same way as equations we've done before. We still are working backwards. We still are doing the same thing to both sides to keep the equation balanced. The only new thing is that we want to isolate the variable so we might need to add or subtract a variable from one side so that all the variables are on the other side.



Write an equation to represent your work.

$$\begin{aligned} 4 + x &= 1 + 2x \\ -1 \quad & \quad -1 \\ 3 + x &= 2x \\ -x \quad & \quad -x \\ 3 &= x \end{aligned}$$

Let's Think (Slide 5): Just like we can add or subtract numbers, we can add or subtract a variable and its coefficient. Coefficient is just the word for the number before a variable. So for this 2x, for example, 2 is the coefficient. *Point to the 2x.* For this 10x, 10 is the coefficient. *Point to the 10x.* On the last slide, we had 2 boxes and 1 box and that's just like 2 exes and 1 ex. Those are variables with coefficients. Now, here is one really important tip: "It is generally easier to subtract the number with the smaller coefficient so you don't get negative numbers if you don't have to." That means in this example, it is going to be easier to subtract 2x than 10x. This is where that thing we talked about earlier, where we do a little bit of thinking in our mind before we start number crunching, can really come in handy. Let me show you what I mean. We have the same equation written twice here and I am going to solve it two different ways. Maybe first I see this plus 10x and I decide to subtract 10x from both sides.



$$\begin{aligned} 6 + 2x &= 3 + 10x \\ -10x \quad & \quad -10x \end{aligned}$$

$$\begin{array}{l} 6+2x=3+10x \\ -10x \qquad -10x \\ 6-8x=3 \end{array}$$

Then on the left side, I get 6 and we have to think about this 2x, which is positive, and the minus 10x, which is like a negative. You can already see how subtracting the variable with the bigger coefficient is making things a little tricky. I have to think about how positive cancels negative so I get negative 8x. And on the right side, it equals 3.

$$\begin{array}{l} 6+2x=3+10x \\ -10x \qquad -10x \\ 6-8x=3 \\ -6 \qquad -6 \\ -8x=-3 \end{array}$$

Now in order to keep going, I will subtract 6 from both sides.

The left side 6 and minus 6 cancel eachother out. So it's just negative 8x. On the right side, I have positive 3 and minus 6 or I can think of it as negative 6. Positive 3 and negative 6 cancel eachother out. We are left with negative 3.

$$\begin{array}{l} 6+2x=3+10x \\ -10x \qquad -10x \\ 6-8x=3 \\ -6 \qquad -6 \\ \frac{-8x}{-8}=\frac{-3}{-8} \\ \boxed{x=\frac{3}{8}} \end{array}$$

Now I divide by negative 8 on both sides.

I get x equals something. I have to think a negative divided by a negative is positive because they have the same sign as each other. So x equals 3 eighths.

$$\begin{array}{l} 6+2x=3+10x \\ -2x \qquad -2x \end{array}$$

Now, I want you to notice how much easier it is if I subtract the number with the smaller coefficient instead. This is the same problem. But I am going to subtract 2x from both sides.

$$\begin{array}{l} 6+2x=3+10x \\ -2x \qquad -2x \\ 6 \quad =3+8x \end{array}$$

Then I get 6 equals 3 plus 8x. It is really to figure out 10x minus 2x is 8x. No negatives are involved.

$$\begin{array}{l} 6+2x=3+10x \\ -2x \qquad -2x \\ 6 \quad =3+8x \\ -3 \qquad -3 \\ 3=8x \end{array}$$

Next I will subtract 3 from each side.

This is easy too because it's just 6 minus 3. I get 3 equals 8x.

$$\begin{array}{l} 6+2x=3+10x \\ -2x \qquad -2x \\ 6 \quad =3+8x \\ -3 \qquad -3 \\ \frac{3}{8}=\frac{8x}{8} \\ \boxed{\frac{3}{8}=x} \end{array}$$

I divide by 8 on both sides.

And I get 3 eighths equals x. It is the same answer as before but I didn't have to think about negative numbers at all. So, it is going to be a good idea to think and do some number crunching in my mind before I start writing. And then I will try to do the numbers that will make things simpler and easier.

Let's Think (Slide 6): I want us to explore one more tricky spot. This says, "Sometimes we might begin with one strategy and realize there is a simpler strategy. Sometimes we might get zero." We've already talked about how we might do some thinking in our head before we just jump to a first step. The other thing to realize is that it's okay to get zero. Just as long as we don't totally drop it, we can keep working and making sure the equation stays balanced. Here is a good example. When I look at this problem, I might think that it would be easiest if I divided each side by 3. That would cancel out the 3 on the right side. But then I would end up with a fraction on the left side of my equation. It would be like 1 divided by 3, and that isn't a really friendly number to work with. So that is invisible thinking that I am doing before I just start writing things now. And now I might decide to distribute the 3 instead. I would do the 3 times the 2x and the 3 times the 6.

$$x = 3(2x - 6)$$

$$\begin{aligned} x &= 3(2x - 6) \\ x &= 6x - 18 \end{aligned}$$

My new equation is x equals 6x minus 18.

$$\begin{aligned} x &= 3(2x - 6) \\ x &= 6x - 18 \\ -x &\quad -x \end{aligned}$$

Now let's say I remember that I want to subtract the variable with the smaller coefficient so I do minus x on both sides.

$$\begin{aligned} x &= 3(2x - 6) \\ x &= 6x - 18 \\ 0 &= 5x - 18 \\ +18 &\quad +18 \end{aligned}$$

When I rewrite this, I will get x minus x, which is zero. Even though zero is nothing, I can't just leave this side empty. I write down the zero because there is still more math to do and I will have to add, subtract, multiply or divide that zero. I get zero equals 5x minus 18. I want to get x alone so I will add 18 to both sides.

$$\begin{aligned} x &= 3(2x - 6) \\ x &= 6x - 18 \\ -x &\quad -x \\ 0 &= 5x - 18 \\ +18 &\quad +18 \end{aligned}$$

Now we can see why it was so important to keep that zero. I have zero plus 18 which is 18. That equals 5x.

$$\frac{18}{5} = \frac{5x}{5}$$

I divide by 5 on both sides.

$$\begin{array}{r} 03\tfrac{3}{5} \\ 5\overline{)18} \\ -15 \\ \hline 3 \end{array}$$

And I am going to have to go off to the side of my paper and do that division. 5 goes into 18 three times. I subtract 15 and have 3 leftover, which becomes 3 fifths.

$$\begin{aligned} x &= 3(2x - 6) \\ x &= 6x - 18 \\ -x &\quad -x \\ 0 &= 5x - 18 \\ +18 &\quad +18 \\ \frac{18}{5} &= \frac{5x}{5} \\ &\boxed{3\tfrac{3}{5} = x} \end{aligned}$$

I get 3 and 3 fifths equals x. That is my answer. So again, we have to do some pre-thinking. Sometimes we might begin with one strategy and realize there is a simpler strategy. And sometimes we might get zero. That's fine. We write that zero down and keep doing the math.

Let's Try It (Slide 7): Let's solve some equations with variables on both sides together. I will walk you through each step.

WARM WELCOME

Today we will solve linear equations with variables on both sides.

Let's Review:

We know that we need to keep any equation we are solving balanced by doing the same operation to both sides.

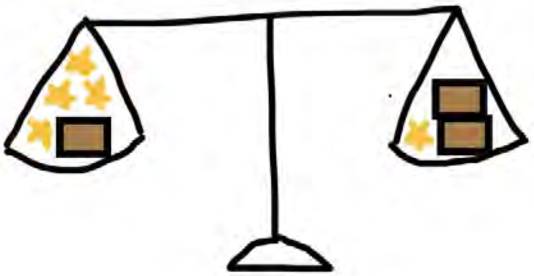
Solve for x.

$7(2x + 3) - 5 = 16$

Let's Talk:

The balance can help us think about what to do when there is a variable on both sides of the equal sign.

If the scale below is balanced, how many stars must be hidden in one of the equal boxes?



Write an equation to represent your work.

Let's Think:

Just like we can add or subtract numbers, we can add or subtract a variable and its coefficient.

It is generally easier to subtract the number with the smaller coefficient so you don't get negative numbers if you don't have to.

$6 + 2x = 3 + 10x$	$6 + 2x = 3 + 10x$

Let's Think:

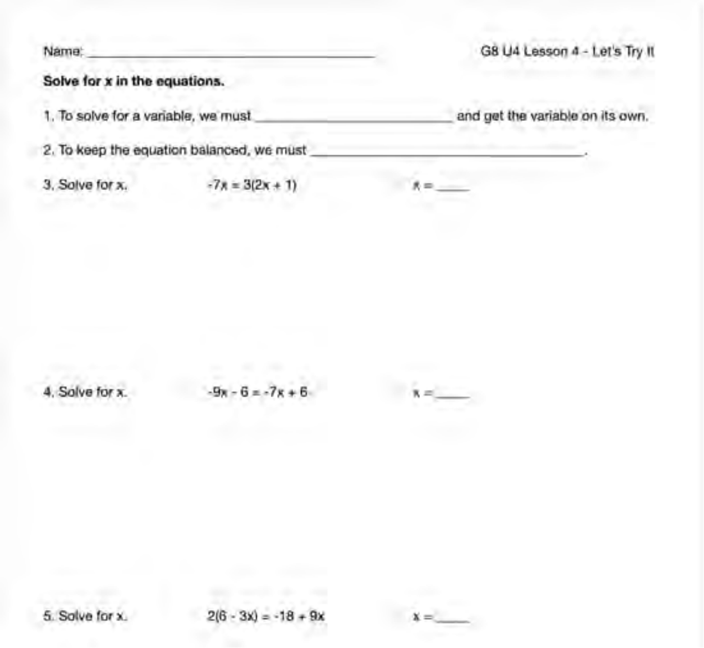
Sometimes we might begin with one strategy and realize there is a simpler strategy. Sometimes we might get zero.

Solve for x.

$x = 3(2x - 6)$

Let's Try It:

Let's solve some equations together!



Name: ____________________ G8 U4 Lesson 4 - Let's Try It

Solve for x in the equations.

1. To solve for a variable, we must ____________ and get the variable on its own.

2. To keep the equation balanced, we must ____________.

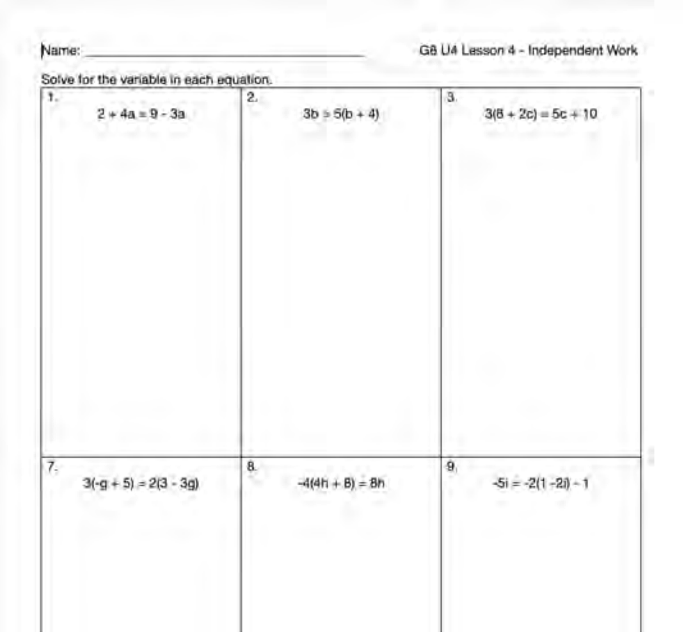
3. Solve for x. $-7x = 3(2x + 1)$ $x =$ ____

4. Solve for x. $-9x - 6 = -7x + 6$ $x =$ ____

5. Solve for x. $2(6 - 3x) = -18 + 9x$ $x =$ ____

On your Own:

Now it's time for you to do it on your own!



Name: ____________________ G8 U4 Lesson 4 - Independent Work

Solve for the variable in each equation.

1. $2 + 4a = 9 - 3a$	2. $3b = 5(b + 4)$	3. $3(6 + 2c) = 5c + 10$
7. $3(-g + 5) = 2(3 - 3g)$	8. $-4(4h + 8) = 8h$	9. $-5i = -2(1 - 2i) - 1$

Name: ____

Solve for x in the equations.

1. To solve for a variable, we must ____________________________ and get the variable on its own.

2. To keep the equation balanced, we must _______________________________________.

3. Solve for x. $-7x = 3(2x + 1)$ $x =$ _____

4. Solve for x. $-9x - 6 = -7x + 6$ $x =$ _____

5. Solve for x. $2(6 - 3x) = -18 + 9x$ $x =$ _____

Name: ____

Solve for the variable in each equation.

1. $2 + 4a = 9 - 3a$

2. $3b = 5(b + 4)$

3. $3(8 + 2c) = 5c + 10$

7. $3(-g + 5) = 2(3 - 3g)$

8. $-4(4h + 8) = 8h$

9. $-5i = -2(1 -2i) - 1$

Solve for the variable in each equation.

10. $4j + 3 = 20 - 3j - 3$

11. $3k + 13 = 2(-1 - 6k)$

12. $6(2m + 3) = 17 - m$

16. $-20 + 7g = -5 + g - 15$

17. $3(h - 8) + 5 = 2h$

18. $-3a = 10 + 2a$

Name: ANSWER KEY

Solve for x in the equations.

1. To solve for a variable, we must work backwards and get the variable on its own.

2. To keep the equation balanced, we must do the same to both sides.

3. Solve for x. $-7x = 3(2x + 1)$ x = $-\frac{3}{13}$

$-7x = 6x + 3$

$-6x \quad -6x$

$\frac{-13x}{-13} = \frac{3}{-13}$

$x = -\frac{3}{13}$

4. Solve for x. $-9x - 6 = -7x + 6$ x = -6

$+9x \quad +9x$

$-6 = 2x + 6$

$-6 \quad -6$

$\frac{-12}{2} = \frac{2x}{2}$

$-6 = x$

5. Solve for x. $2(6 - 3x) = -18 + 9x$ x = 2

$12 - 6x = -18 + 9x$

$+6x \quad +6x$

$12 = -18 + 15x$

$+18 \quad +18$

$\frac{30}{15} = \frac{15x}{15}$

$2 = x$

Name: ANSWER KEY

G8 U4 Lesson 4 - Independent Work

Solve for the variable in each equation.

1.

$2 + 4a = 9 - 3a$

$+3a \quad +3a$

$2 + 7a = 9$

$-2 \quad -2$

$\frac{7a}{7} = \frac{7}{7}$

$\boxed{a = 1}$

2.

$3b = 5(b + 4)$

$3b = 5b + 20$

$-3b \quad -3b$

$0 = 2b + 20$

$-20 \quad -20$

$\frac{-20}{2} = \frac{2b}{2}$

$\boxed{-10 = b}$

3.

$3(8 + 2c) = 5c + 10$

$24 + 6c = 5c + 10$

$-5c \quad -5c$

$24 + c = 10$

$-24 \quad -24$

$\boxed{c = -14}$

7.

$3(-g + 5) = 2(3 - 3g)$

$-3g + 15 = 6 - 6g$

$+3g \quad +3g$

$15 = 6 - 3g$

$-6 \quad -6$

$\frac{9}{-3} = \frac{-3g}{-3}$

$\boxed{-3 = g}$

8.

$-4(4h + 8) = 8h$

$-16h - 32 = 8h$

$+16h \quad +16h$

$\frac{-32}{24} = \frac{24h}{24}$

$\boxed{-1\frac{1}{3} = h}$

$$\begin{array}{r} 01 \\ 24\overline{)032} \\ -24 \\ \hline 8 \end{array}$$

$1\frac{8 \div 8}{24 \div 8} = 1\frac{1}{3}$

9.

$-5i = -2(1 -2i) - 1$

$-5i = -2 + 4i - 1$

$-4i \quad -4i$

$-9i = -2 - 1$

$\frac{-9i}{-9} = \frac{-3}{-9}$

$i = \frac{3 \div 3}{9 \div 3}$

$\boxed{i = \frac{1}{3}}$

Solve for the variable in each equation.

10.

$4j + 3 = 20 - 3j - 3$

$+3j \quad +3j$

$7j + 3 = 20 - 3$

$7j + 3 = 17$

$-3 \quad -3$

$\frac{7j}{7} = \frac{14}{7}$

$\boxed{j = 2}$

11.

$3k + 13 = 2(-1 - 6k)$

$3k + 13 = -2 - 12k$

$+12k \quad +12k$

$15k + 13 = -2$

$-13 \quad -13$

$\frac{15k}{15} = \frac{-15}{15}$

$\boxed{k = -1}$

12.

$6(2m + 3) = 17 - m$

$12m + 18 = 17 - m$

$+m \quad +m$

$13m + 18 = 17$

$-18 \quad -18$

$\frac{13m}{13} = \frac{-1}{13}$

$\boxed{m = -\frac{1}{13}}$

16.

$-20 + 7g = -5 + g - 15$

$-g \quad -g$

$-20 + 6g = -5 - 15$

$-20 + 6g = -20$

$+20 \quad +20$

$\frac{6g}{6} = \frac{0}{6}$

$\boxed{g = 0}$

17.

$3(h - 8) + 5 = 2h$

$3h - 24 + 5 = 2h$

$-2h \quad -2h$

$h - 24 + 5 = 0$

$+24 \quad +24$

$h + 5 = 24$

$-5 \quad -5$

$\boxed{h = 19}$

18.

$-3a = 10 + 2a$

$-2a \quad -2a$

$\frac{-5a}{-5} = \frac{10}{-5}$

$\boxed{a = -2}$

G8 U4 Lesson 5
Solve linear equations by combining like terms.

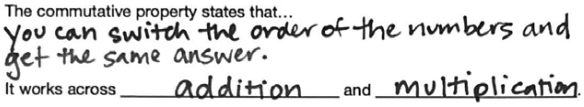
G8 U4 Lesson 5 - Today we will solve linear equations by combining like terms.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will solve linear equations by combining like terms. This is the final lesson in this series on solving equations, and then in our next lesson we get to move onto applications on this important skill. Let's go!

Let's Review (Slide 3): Today we are starting by asking, "What is the commutative property?" That is going to really help us simplify the equations we have to solve. So, what do you remember from earlier grades. What is the commutative property? Possible Student Answers, Key Points:

- The commutative property is the turnaround rule.
- The commutative property means you can switch the order of the numbers and get the same answer.
- The commutative property means you can do 3 x 4 or 4 x 3.



The commutative property states that…
you can switch the order of the numbers and get the same answer.
It works across addition and multiplication.

The commutative property states that… you can switch the order of the numbers and get the same answer. But here's the key thing to remember - it only work across ADDITION and MULTIPLICATION. 5 takeaway 1 is not the same as 1 takeaway 5. You can't switch the order of subtraction or division.

Let's use the commutative property to rearrange the expressions. 5 x 10 is easy. It can be rewritten as 10 x 5. We would get the same answer either way. If I could 5 ten times. *Put up your fingers as you skip count by 5.* That is 5 - 10 - 15 - 20 - 25 - 30 - 35- 40 - 45 - 50 - 55 - 60 - 65 - 70 - 75 - 80 - 85 - 90 - 95 - 100! Or I could count 10 five times. *Put up your fingers as you skip count by 10.* That is 10 - 20 - 30 - 40 - 50! We get the same answer even if we switch the order.

5×10

10×5

$3 + 2$

$2 + 3$

3 + 2 is easy! We get the same answer if we do 2 + 3. I can count up from 3 and get 3 - 4 - 5! Or I can count up from 2 and get 2 - 3 - 4 - 5!

This last one might look scary but really it's easy too. As long as I stick to using the commutative property across addition, I can just move all of these separate addends around in a different order. So I could do 5 + 1 + 2 + 1x + 6x. It's still the same numbers just getting added in a different order. This is the expression that is really interesting because it helps us see that this expression can be simplified. 5 plus 1 plus 2 is 8 and 1x plus 6x is 7x. So when I use the commutative property, it helps me see that this expression is the same as 8 + 7x. Let's do this again on the next slide so we're clear on how the commutative property is so helpful here.

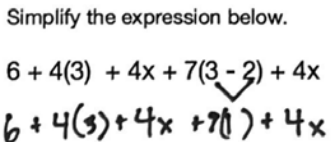
$5 + 1x + 1 + 6x + 2$

$$\underbrace{5+1+2}_{8} + \underbrace{1x+6x}_{7x}$$

Let's Talk (Slide 4): You probably already know how to simplify an expression from previous grades. How would you go about simplifying this expression? *The purpose of this question is just to hear what students think. It is not to arrive at a right answer. So you can collect responses and just say, "Interesting!" after each one.* Possible Student Answers, Key Points:

- I would do what is in the parentheses first.
- I would use PEMDAS.
- I would do 4 times 3.

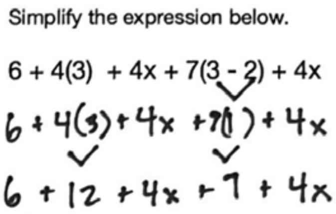
- I would do 7 times 2 and 7 times 3.
- I would put 4x and 4x together.


Simplify the expression below.

6 + 4(3) + 4x + 7(3 - 2) + 4x

6 + 4(3) + 4x + 7(1) + 4x

There's actually many different right ways to simplify the expression. But in the past, you probably focused a lot on PEMDAS. You might start with the parentheses, and do 3 minus 2 is 1. Then rewrite the expression as 6 + 4(3) + 4x + 7(1) + 4x.

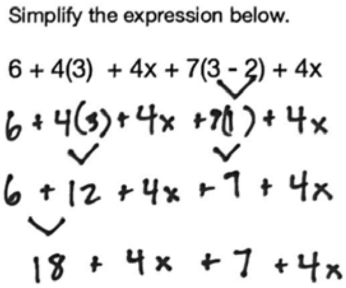

Simplify the expression below.

6 + 4(3) + 4x + 7(3 - 2) + 4x

6 + 4(3) + 4x + 7(1) + 4x

6 + 12 + 4x + 7 + 4x

Then you would do the multiplication and division. So that would be 4 times 3 and 7 times 1 in this case. You would end up with 6 + 12 + 4x + 7 + 4x. You can't do the multiplication and division for the variables because you don't know what they are.


Simplify the expression below.

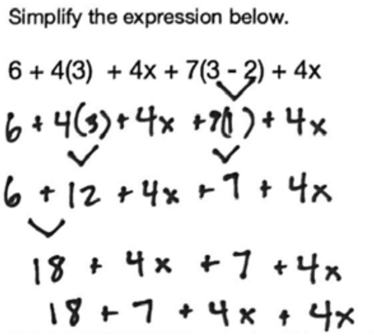
6 + 4(3) + 4x + 7(3 - 2) + 4x

6 + 4(3) + 4x + 7(1) + 4x

6 + 12 + 4x + 7 + 4x

18 + 4x + 7 + 4x

So next up is the addition and subtraction, and you would probably want to start working from left to right. You would do 6 plus 12 is 18 plus 4x. You still have this 7 and then another 4x. It feels tricky to do that without knowing what the variables are.


Simplify the expression below.

6 + 4(3) + 4x + 7(3 - 2) + 4x

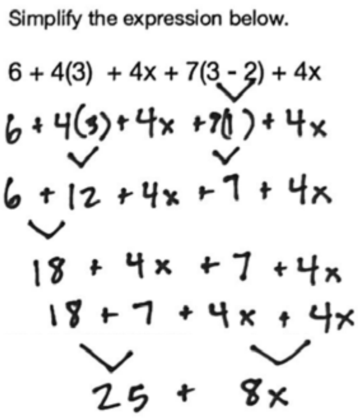
6 + 4(3) + 4x + 7(1) + 4x

6 + 12 + 4x + 7 + 4x

18 + 4x + 7 + 4x

18 + 7 + 4x + 4x

This is where the commutative property can be really helpful. I can change the order of the addends and rewrite this as 18 plus 7 plus 4x plus 4x.


Simplify the expression below.

6 + 4(3) + 4x + 7(3 - 2) + 4x

6 + 4(3) + 4x + 7(1) + 4x

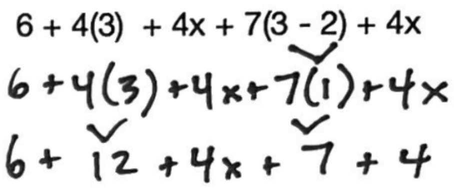
6 + 12 + 4x + 7 + 4x

18 + 4x + 7 + 4x

18 + 7 + 4x + 4x

25 + 8x

And now I could go back to adding. 18 plus 7 is 25 and 4x plus 4x is 8x. My new expression is 25 + 8x. This is the most important big idea of today's lesson. We ended up putting all the plain numbers together - the 6 and the 12 and the 7. And we ended up putting all the same variables together. This is called "combining like terms." We are combining or putting together the parts of the equations that are "like" or similar. Numbers with numbers and variables with variables.

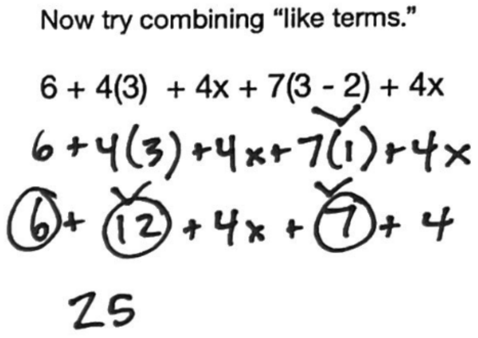


$6 + 4(3) + 4x + 7(3 - 2) + 4x$

$6 + 4(3) + 4x + 7(1) + 4x$

$6 + 12 + 4x + 7 + 4$

From now on, if you understand the commutative property, you can go ahead and do that without rewriting the whole expression. In the part of PEMDAS when it is time to add and subtract, you can circle all the "like terms" and put them together. Let me show you what I mean. First, I am going to do the parentheses, just like before. I get 6 + 4(3) + 4x + 7(1) + 4x. Then I do the multiplication and division and get 6 + 12 + 4x + 7 + 4x.



Now try combining "like terms."

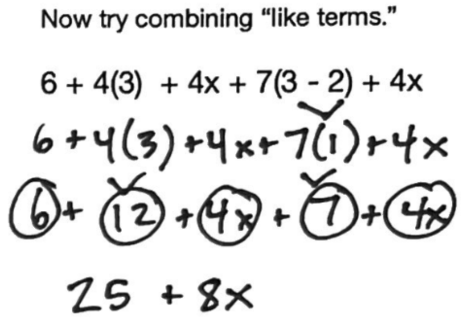
$6 + 4(3) + 4x + 7(3 - 2) + 4x$

$6 + 4(3) + 4x + 7(1) + 4x$

$6 + 12 + 4x + 7 + 4$

25

Now I am going to circle all the numbers - 6 and 12 and 7 - and I am going to put them together. 6 and 12 is 18. 18 plus 7 is 25.



Now try combining "like terms."

$6 + 4(3) + 4x + 7(3 - 2) + 4x$

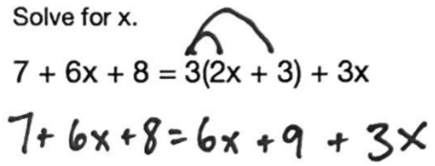
$6 + 4(3) + 4x + 7(1) + 4x$

$6 + 12 + 4x + 7 + 4x$

$25 + 8x$

Then I am going to circle all the variables with their coefficients - 4x and 4x. That makes 8x. My final expression is 25 + 8x. This final expression is much simpler than the original. So now imagine if it were part of an equation you had to solve! It would be way easier to simplify it and combine like terms before you start working backwards to isolate x. We're going to do that on the next slide.

Let's Think (Slide 5): We will use the commutative property across addition to combine like terms.

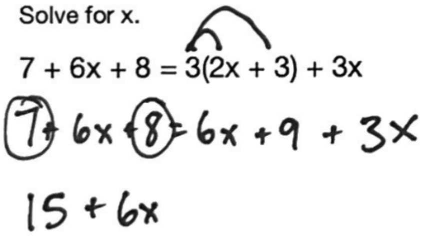


Solve for x.

$7 + 6x + 8 = 3(2x + 3) + 3x$

$7 + 6x + 8 = 6x + 9 + 3x$

This problem wants us to solve for x. Now, BEFORE I start working backwards to solve, I can try to simplify the expression on each side and make this into an easier problem. I can't do the math inside the parentheses because there is a variable there. But I can distribute the factor outside the parentheses. I don't have to but let's do that for now. I will draw my arrows to show how I'm multiplying each part. I get 7 + 6x + 8 = 6x + 9 + 3x.



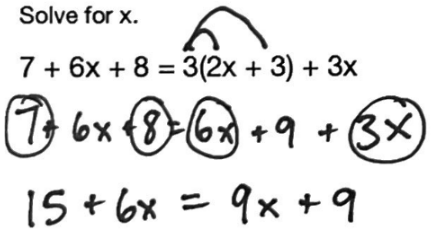
Solve for x.

$7 + 6x + 8 = 3(2x + 3) + 3x$

$7 + 6x + 8 = 6x + 9 + 3x$

$15 + 6x$

Now it would be time to add or subtract so that means it is time to combine like terms. Here's the key. I have NOT even started solving my problem yet. So I'm not working on both sides of the equation and keeping it balanced YET. I am just simplifying the left side to make my life easier and simplifying the right side to make my life easier. They are separate sides. I look over at the left and I collect the numbers 7 and 8. Let's circle those. They make 15 so this side is really 15 + 6x.



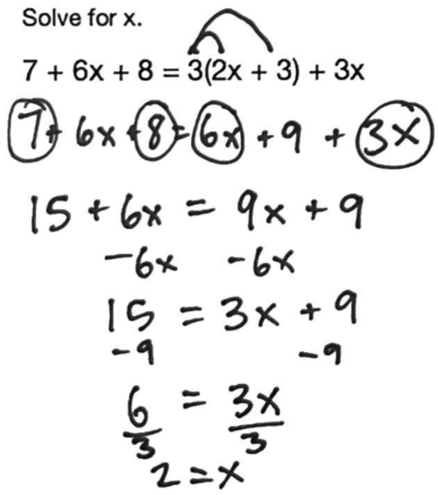
Solve for x.

$7 + 6x + 8 = 3(2x + 3) + 3x$

$\boxed{7} + 6x + \boxed{8} = \boxed{6x} + 9 + \boxed{3x}$

$15 + 6x = 9x + 9$

On the other side, I don't have any plain numbers to collect. But I can collect 6x and 3x. Let me circle them. That makes 9x plus 9. Look at this new equation. 15 + 6x equals 9x + 9. This is WAY WAY easier to solve. You can all work backwards and get this. The thing that made it so easy is that we combined like terms.



Solve for x.

$7 + 6x + 8 = 3(2x + 3) + 3x$

$\boxed{7} + 6x + \boxed{8} = \boxed{6x} + 9 + \boxed{3x}$

$15 + 6x = 9x + 9$

$-6x \quad -6x$

$15 = 3x + 9$

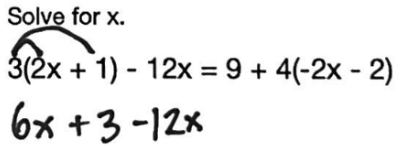
$-9 \quad -9$

$\frac{6}{3} = \frac{3x}{3}$

$2 = x$

Let's finish this up. I can subtract 6x from both sides. I get 15 = 3x + 9. I can subtract 9 from both sides. I get 6 = 3x. I can divide by 3 on both sides. I get 2 = x. Nice! If I hadn't collected like terms, I still could have solved this. But it would have taken a lot of extra steps. So from now on, we will collect like terms, keeping each side of the equation separate, to simplify our equation. Then we can solve.

Let's Think (Slide 6): We have one extra complication that we need to discuss, and that is minus signs! This says, "Since we are using the commutative property across addition, it can help to turn our subtraction into adding the opposite." This might not always be true. But sometimes it can be true. I will show you what I mean. First off, I will do some distribution - since multiplication and division comes before addition and subtraction. I'm not solving yet. I'm just doing some work on the left and doing some work on the right. 3 times 2x is 6x and 3 times 1 is 3. I have all of that minus 12x.

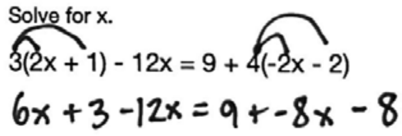


Solve for x.

$3(2x + 1) - 12x = 9 + 4(-2x - 2)$

$6x + 3 - 12x$

On the other side, I have 9 plus this stuff I have to distribute. 4 times negative 2x is negative 8x. Then there is a minus sign and 4 times 2 is 8.

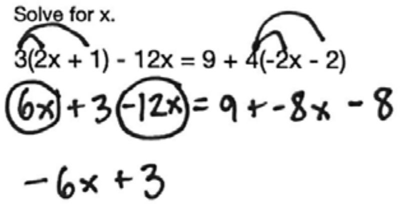


Solve for x.

$3(2x + 1) - 12x = 9 + 4(-2x - 2)$

$6x + 3 - 12x = 9 + -8x - 8$

Now I can collect like terms. And here is where thinking of the minus sign as adding the opposite or in other words, negative, can be helpful. For example, on the left, I can't just circle 6x and 12x because the problem doesn't have us adding 6x and 12x. It has us subtracting 12x. Instead, I am going to circle the whole minus 12x. Now I'm really thinking of it like negative 12x. And I can combine 6x and negative 12x, which leaves me with -6x + 3.



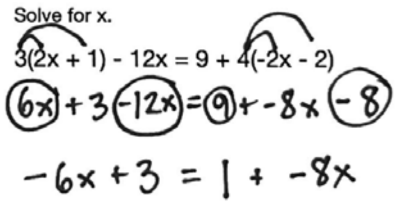
Solve for x.

$3(2x + 1) - 12x = 9 + 4(-2x - 2)$

$\boxed{6x} + 3 \boxed{-12x} = 9 + -8x - 8$

$-6x + 3$

On this other side, I want to circle like terms. I can't just circle 9 and 8 and ignore that this 8 is being subtracted. I am going to circle the whole minus 8. Now I'm really thinking of it like negative 8. Positive 9 and negative 8 cancel so I am left with 1 plus negative 8x.

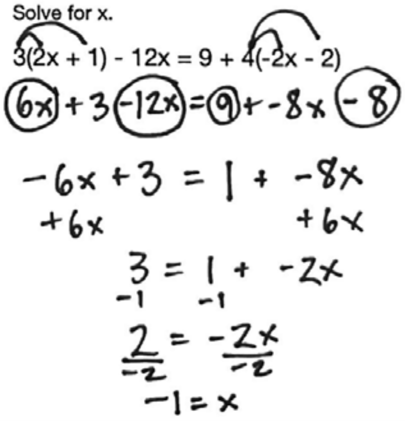


Solve for x.

$3(2x + 1) - 12x = 9 + 4(-2x - 2)$

$\boxed{6x} + 3 \boxed{-12x} = \boxed{9} + -8x \boxed{-8}$

$-6x + 3 = 1 + -8x$



Solve for x.

$3(2x + 1) - 12x = 9 + 4(-2x - 2)$

$6x + 3 - 12x = 9 + -8x - 8$

$-6x + 3 = 1 + -8x$

$+6x \qquad\qquad +6x$

$3 = 1 + -2x$

$-1 \quad -1$

$\frac{2}{-2} = \frac{-2x}{-2}$

$-1 = x$

Now this looks like something we know how to solve pretty easily. I will add 6x to both sides. That gives me 3 = 1 + (-2x). Then I subtract 1 from both sides. That gives me 2 = -2x. I divide by negative 2 on both sides. I get -1 = x.

So, from now, we are going to combine like terms before we start solving for the variable. We are going to include the minus sign and think of a number as negative if we're trying to combine it.

Let's Try It (Slide 7): Let's do some combining like terms to solve equations together. I will walk you through each step.

WARM WELCOME

Today we will solve linear equations by combining like terms.

Let's Review: What is the commutative property?

The commutative property states that…

It works across ____________________________ and __________________________.

Use the commutative property to rearrange the expressions.

5×10 $3 + 2$ $5 + 1x + 1 + 6x + 2$

Let's Talk: We can use the commutative property across addition to help us simplify our expressions.

Simplify the expression below.

$6 + 4(3) + 4x + 7(3 - 2) + 4x$

Now try combining "like terms."

$6 + 4(3) + 4x + 7(3 - 2) + 4x$

Let's Think: **We will use the commutative property across addition to combine like terms.**

Solve for x.

$7 + 6x + 8 = 3(2x + 3) + 3x$

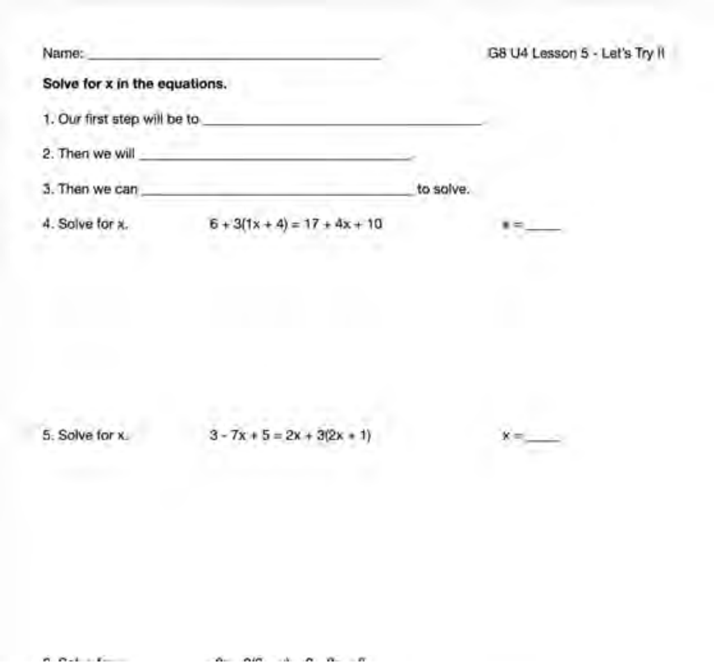
Let's Think: **Since we are using the commutative property across addition, it can help to turn our subtraction into adding the opposite.**

Solve for x.

$3(2x + 1) - 12x = 9 + 4(-2x - 2)$

Let's Try It:

Let's combine some like terms together!



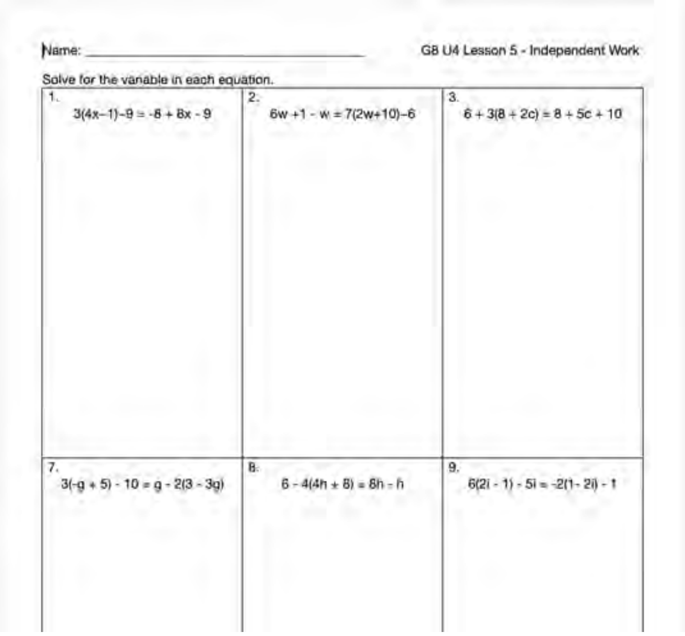
Name: ______________________ G8 U4 Lesson 5 - Let's Try It

Solve for x in the equations.

1. Our first step will be to ______________________.
2. Then we will ______________________.
3. Then we can ______________________ to solve.
4. Solve for x. 6 + 3(1x + 4) = 17 + 4x + 10 x = ____
5. Solve for x. 3 - 7x + 5 = 2x + 3(2x + 1) x = ____

On your Own:

Now it's time for you to do it on your own!



Name: ______________________ G8 U4 Lesson 5 - Independent Work

Solve for the variable in each equation.

1. 3(4x–1)–9 = -8 + 8x - 9	2. 6w +1 - w = 7(2w+10)–6	3. 6 + 3(8 + 2c) = 8 + 5c + 10
7. 3(-g + 5) - 10 = g - 2(3 - 3g)	8. 6 - 4(4h + 8) = 8h - h	9. 6(2i - 1) - 5i = -2(1- 2i) - 1

Name: ____ G8 U4 Lesson 5 - Let’s Try It

Solve for x in the equations.

1. Our first step will be to ______________________________________.

2. Then we will _____________________________________.

3. Then we can _____________________________________ to solve.

4. Solve for x. $3(2x–2)–9 = -6 + 4x - 5$ x = _____

5. Solve for x. $3(h - 8) + 5 = 2h(3 + 4)$ x = _____

6. Solve for x. $9 - 2(6 + x) = 9 + 2x + 6$ x = _____

Name: ____ G8 U4 Lesson 5 - Independent Work

Solve for the variable in each equation.

1. $3(4x-1)-9 = -8 + 8x - 9$

2. $6w + 1 - w = 7(2w+10)-6$

3. $6 + 3(8 + 2c) = 8 + 5c + 10$

4. $3(-g + 5) - 10 = g - 2(3 - 3g)$

5. $6 - 4(4h + 8) = -8h - h$

6. $6(2i - 1) - 5i = -2(1 - 2i) - 1$

Solve for the variable in each equation.

7. $4j + 3 - 2j = 19 - 3(j - 3)$

8. $2k - 4k + 13 = 2(-1 - 6k) + 5$

9. $3(2x-1)-4 = -4 + 4x - 3$

10. $4 + 6w + 1 - w = 7w + 10$

11. $4(-6x + 2)=-4(-5x - x) + 8$

12. $-3a + 3(a+4)= 10 + 2a - 2$

Name: ANSWER KEY

Solve for x in the equations.

1. Our first step will be to distribute.

2. Then we will collect like terms.

3. Then we can work backwards to solve.

4. Solve for x. $3(2x-2)-9 = -6 + 4x - 5$ $x = 2$

$$6x-6-9=-6+4x-5$$
$$6x-15=-11+4x$$
$$+15 \quad +15$$
$$6x=4+4x$$
$$-4x \quad -4x$$
$$\frac{2x}{2}=\frac{4}{2}$$
$$\boxed{x=2}$$

5. Solve for x. $3(h - 8) + 5 = 2h(3 + 4)$ $x = -1\frac{8}{11}$

$$3h-24+5=6h+8h$$
$$3h-19=14h$$
$$-3h \quad -3h$$
$$\frac{-19}{11}=\frac{11h}{11}$$
$$-\frac{19}{11}=h$$
$$\boxed{-1\frac{8}{11}=h}$$

6. Solve for x. $9 - 2(6 + x) = 9 + 2x + 6$ $x = -1\frac{1}{2}$

$$9-12+-2x=9+2x+6$$
$$-3+-2x=3+2x$$
$$+2x \quad +2x$$
$$-3=3+4x$$
$$-3 \quad -3$$
$$-\frac{6}{4}=\frac{4x}{4} \rightarrow -1\frac{2}{4}=x \rightarrow \boxed{-1\frac{1}{2}=x}$$

Name: ANSWER KEY

G8 U4 Lesson 5 - Independent Work

Solve for the variable in each equation.

1.
$3(4x-1)-9 = -8 + 8x - 9$

$12x - 3 - 9 = -8 + 8x - 9$

$12x - 12 = -17 + 8x$

$+12 \quad +12$

$12x = 5 + 8x$

$-8x \quad -8x$

$\frac{4x}{4} = \frac{5}{4}$

$\boxed{x = 1\frac{1}{4}}$

2.
$6w + 1 - w = 7(2w+10)-6$

$6w + 1 - w = 14w + 70 - 6$

$6w + 1 - w = 14w + 64$

$5w + 1 = 14w + 64$

$-1 \quad -1$

$5w = 14w + 63$

$-14w \quad -14w$

$\frac{-9w}{-9} = \frac{63}{-9}$

$\boxed{w = -7}$

3.
$6 + 3(8 + 2c) = 8 + 5c + 10$

$6 + 24 + 6c = 8 + 5c + 10$

$30 + 6c = 18 + 5c$

$-6c \quad -6c$

$30 = 18 - 1c$

$-18 \quad -18$

$\frac{22}{-1} = \frac{-1c}{-1}$

$\boxed{22 = c}$

3.
$3(-g + 5) - 10 = g - 2(3 - 3g)$

$-3g + 15 - 10 = g - 6 + 6g$

$-3g + 5 = -6 + 7g$

$+3g \quad +3g$

$5 = -6 + 10g$

$+6 \quad +6$

$\frac{11}{10} = \frac{10g}{10}$

$10\overline{)11}$ $01\frac{1}{10}$ -10 1

$\boxed{1\frac{1}{10} = g}$

4.
$6 - 4(4h + 8) = -8h - h$

$6 - 16h - 32 = -8h - h$

$-16h - 26 = -8h - h$

$-16h - 26 = -9h$

$+16h \quad +16h$

$\frac{-26}{7} = \frac{7h}{7}$

$7\overline{)26}$ $03\frac{5}{7}$ -21 5

$\boxed{-3\frac{5}{7} = h}$

5.
$6(2i - 1) - 5i = -2(1 - 2i) - 1$

$12i - 6 - 5i = -2 + 4i - 1$

$7i - 6 = -3 + 4i$

$+3 \quad +3$

$7i - 3 = 4i$

$-7i \quad -7i$

$\frac{-3}{-3} = \frac{-3i}{-3}$

$\boxed{1 = i}$

Solve for the variable in each equation.

7.

$4j + 3 - 2j = 19 - 3(j - 3)$

$4j + 3 - 2j = 19 - 3j + 9$

$2j + 3 = 28 - 3j$

$-2j \qquad -2j$

$3 = 28 - 5j$

$-28 \qquad -28$

$\frac{-25}{-5} = \frac{-5j}{-5}$

$\boxed{5 = j}$

8.

$2k - 4k + 13 = 2(-1 - 6k) + 5$

$2k - 4k + 13 = -2 - 12k + 5$

$-2k + 13 = -12k + 3$

$+2k \qquad +2k$

$13 = -10k + 3$

$-3 \qquad -3$

$\frac{10}{-10} = \frac{-10k}{-10}$

$\boxed{-1 = k}$

9.

$3(2x-1)-4 = -4 + 4x - 3$

$6x - 3 - 4 = -4 + 4x - 3$

$6x - 7 = -7 + 4x$

$+7 \qquad +7$

$6x = 4x$

$-4x \qquad -4x$

$\frac{2x}{2} = \frac{0}{2}$

$\boxed{x = 0}$

10.

$4 + 6w + 1 - w = 7w + 10$

$4 + 5w + 1 = 7w + 10$

$5 + 5w = 7w + 10$

$-5w \qquad -5w$

$5\cancel{w} = 2w + 10$

$-10 \qquad -10$

$\frac{-5}{2} = \frac{2w}{2}$

$2\frac{1}{2}$

$2\overline{)5}$

-4

1

$\boxed{-1\frac{1}{2} = w}$

11.

$4(-6x + 2) = -4(-5x - x) + 8$

$-24x + 8 = 20x + 4x + 8$

$-24x + 8 = 24x + 8$

$-8 \qquad -8$

$-24x = 24x$

$-24x \qquad -24x$

$\frac{-48x}{-48} = \frac{0}{-48}$

$\boxed{x = 0}$

12.

$-3a + 3(a+4) = 10 + 2a - 2$

$-3a + 3a + 12 > 10 + 2a - 2$

$0 + 12 = 8 + 2a$

$-8 \qquad -8$

$\frac{4}{2} = \frac{2a}{2}$

$\boxed{2 = a}$

G8 U4 Lesson 6
Determine whether a linear equation has one solution, no solutions, or infinitely many solutions.

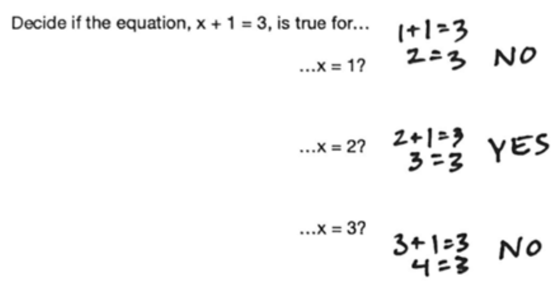
G8 U4 Lesson 6 - Today we will determine whether a linear equation has one solution, no solution, or infinitely many solutions.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will determine whether a linear equation has one solution, no solution, or infinitely many solutions. This is going to be the last lesson before we move into systems of equations, which is really the biggest thing in 8th grade algebra. And we need this lesson to be able to do so let's go.

Let's Review (Slide 3): We know how to plug in values to see if they make the equation true. This is asking us to "decide if the equation, x+1=3, is true for" these different values. What do we do to check if x = 1 is a solution for the equation? Possible Student Answers, Key Points:

- Plug in 1 for x.


Decide if the equation, x + 1 = 3, is true for...

...x = 1? 1+1=3 2=3 NO

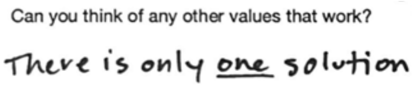
...x = 2? 2+1=3 3=3 YES

...x = 3? 3+1=3 4=3 NO

We put in 1 where we see x. So it is 1 + 1 = 3, which becomes 2 = 3. That is not true so is it a solution? No!

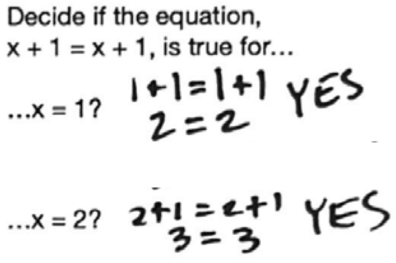
Let's try x = 2. That becomes 2 + 1 = 3. That becomes 3 = 3. That IS true so is it a solution? Yes!

Let's try x = 3. That becomes 3 + 1 = 3. That becomes 4 = 3. That is not true so is it a solution? No!


Can you think of any other values that work?

There is only one solution

Can you think of any other values that work? X = 4? X = 5? That would just get us bigger and bigger. It would still not be equal or true. This might seem really obvious but this equation only 1 solution. Our variable equals a number like we're used to. We get one answer or one solution.


Decide if the equation, x + 1 = x + 1, is true for...

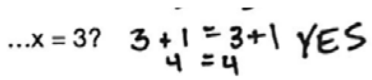
...x = 1? 1+1=1+1 2=2 YES

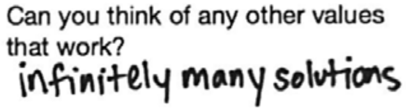
...x = 2? 2+1=2+1 3=3 YES

Let's Talk (Slide 4): Some equations have more than one solution, and some equations have no solution. Let's try two other equations and see what happens when we plug in numbers like we did on the last slide. First, x = 1. It would be 1 + 1 = 1 + 1, which is simplified to 2 = 2. That IS true so it's a solution.

Let's do x = 2 next. It would be 2 + 1 = 2 + 1, which is simplified to 3 = 3. That IS true so it's also solution! Interesting!

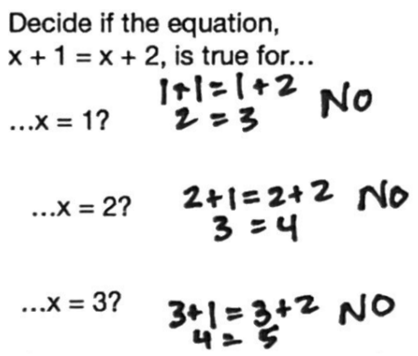
Let's do x = 3 next. It would be 3 + 1 = 3 + 1, which is simplified to 4 = 4. That IS true so it's also solution! "Can you think of any other values that work?" Well, the left side of the equation is the same as the right side of the equation. So it seem likes every value would work, doesn't it? Of course 5 plus 1 would be the same as 5 plus 1 and 6 plus 1 would be the same as 6 plus 1 and we could keep going on and on forever.


...x = 3? 3+1=3+1 4=4 YES


Can you think of any other values that work?

infinitely many solutions

When one side of the equation matches the other side exactly, it will ALWAYS be true so ALL the numbers are solutions. We say it has "infinitely many solutions.



Decide if the equation, $x + 1 = x + 2$, is true for…

…$x = 1$? $1+1=1+2$ $2=3$ No

…$x = 2$? $2+1=2+2$ $3=4$ No

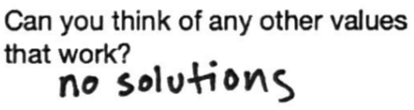
…$x = 3$? $3+1=3+2$ $4=5$ NO

Let’s try the next equation and see how that one works. First, $x = 1$. It would be $1 + 1 = 1 + 2$, which is simplified to $2 = 3$. That is NOT true so it is NOT a solution.

Next up is $x = 2$. It would be $2 + 1 = 2 + 2$, which is simplified to $3 = 4$. That is NOT true so it is NOT a solution.

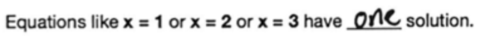
Let’s try $x = 3$. It would be $3 + 1 = 3 + 2$, which is simplified to $4 = 5$. That is NOT true so it is NOT a solution.

Can you think of any other values that work? *Let the students suggest values and substitute them into the equation to see if they are solutions. None of them will work.* There aren’t any values that work because of course x plus one number would never equal x plus another number. Another way to see this is that if we try to solve for x, I would subtract x on both sides. That gives me 1 equals 2, which is impossible. So, $x + 1 = x + 2$ is NEVER true so it NEVER has any solutions. We say it has “no solutions.”



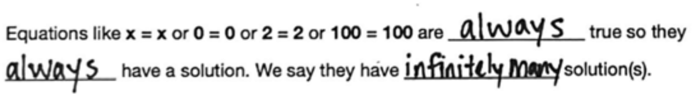
Can you think of any other values that work?
no solutions

Let’s Think (Slide 5): Based on these examples we can notice types. “We can tell how many solutions an equation will have depending on how it looks when it is simplified.” Here is our summary.



Equations like $x = 1$ or $x = 2$ or $x = 3$ have one solution.

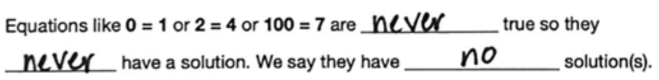
Equations like $x = 1$ or $x = 2$ or $x = 3$ have ONE solution. These are the usual solutions that we have been finding for the last 5 lessons.



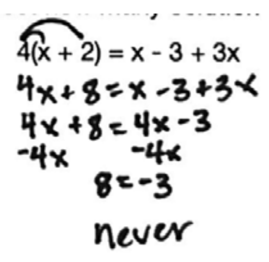
Equations like $x = x$ or $0 = 0$ or $2 = 2$ or $100 = 100$ are always true so they always have a solution. We say they have infinitely many solution(s).

Equations like $x = x$ or $0 = 0$ or $2 = 2$ or $100 = 100$ are ALWAYS true so they ALWAYS have a solution. We say they have INFINITELY MANY solution(s).

Equations like $0 = 1$ or $2 = 4$ or $100 = 7$ are NEVER true so they NEVER have a solution. We say they have NO solution(s). One of the tricks we can use to help ourselves know the solutions is to think about when the simplified equation is true. If it just true for that one number, it has one solution. If it is ALWAYS true that every number is ALWAYS a solution. That’s infinitely many. If it is NEVER true that there is NEVER a solution. We say they have NO solutions.

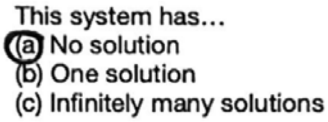


Equations like $0 = 1$ or $2 = 4$ or $100 = 7$ are never true so they never have a solution. We say they have no solution(s).



$4(x + 2) = x - 3 + 3x$
$4x+8=x-3+3x$
$4x+8=4x-3$
$-4x \quad -4x$
$8=-3$
never

Let’s Think (Slide 6): I will model two examples and then we can do some together. This says, “We must try to solve the equations to get it in a form where we can tell how many solutions it has.” So for example, this wants us to “select how many solutions each equation has.” But I can’t just look at these and tell. These look like the same complicated equations we’ve been working on for a while now. So, I am going to start to try and solve them. And as I get towards the end, they will start to look like one of the types we discussed on the last slide. Let’s start with this first equation. I am going to distribute the 4. That gives me $4x + 8 = x - 3 + 3x$. Now I am going to collect like terms on the right side. I add x and 3x, which gives me 4x. That’s $4x + 8 = 4x - 3$. Now this is starting to look like something I can make sense of but let’s keep going. I will subtract 4x from both sides. Now I have 8 equals -3.



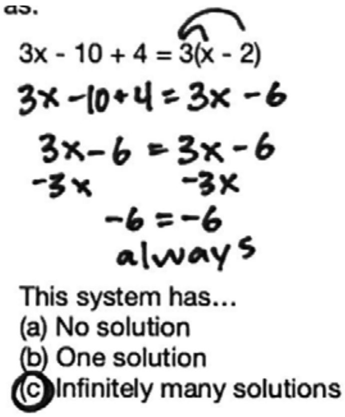
This system has…

[✓ (a)] No solution

(b) One solution

(c) Infinitely many solutions

That will NEVER be true, which means that there is NEVER a solution. I will circle choice (a).



as.

$3x - 10 + 4 = 3(x - 2)$

$3x - 10 + 4 = 3x - 6$

$3x - 6 = 3x - 6$

$-3x \quad -3x$

$-6 = -6$

always

This system has…

(a) No solution

(b) One solution

[✓ (c)] Infinitely many solutions

Let’s do the next one. I will distribute the 3. My new equation is 3x - 10 + 4 = 3x - 6. Next, I will collect like terms. Negative 10 and 4 make negative 6. So I get 3x minus 6 equals 3x minus 6. We can see where this is going.I subtract 3x from both sides. I get negative 6 equals negative 6. Now, that will ALWAYS be true, which means that there is ALWAYS a solution.

I will circle choice (c). So, sometimes we will need to do some solving in order to see how many solutions an equation has.

Let’s Try It (Slide 7): Let’s explore more equations together now. I will walk you through each step.

WARM WELCOME

Today we will determine whether a linear equation has one solution, no solution, or infinitely many solutions.

Let's Review:

We know how to plug in values to see if they make the equation true.

Decide if the equation, $x + 1 = 3$, is true for…

…$x = 1$?

…$x = 2$?

…$x = 3$?

Can you think of any other values that work?

Let's Talk:

Some equations have more than one solution, and some equations have no solution.

Decide if the equation,
$x + 1 = x + 1$, is true for…

…$x = 1$?

…$x = 2$?

…$x = 3$?

Can you think of any other values that work?

Decide if the equation,
$x + 1 = x + 2$, is true for…

…$x = 1$?

…$x = 2$?

…$x = 3$?

Can you think of any other values that work?

Let's Think:

We can tell how many solutions an equation will have depending on how it looks when it is simplified.

Equations like **x = 1** or **x = 2** or **x = 3** have ______ solution.

Equations like **x = x** or **0 = 0** or **2 = 2** or **100 = 100** are _______________ true so they ____________ have a solution. We say they have _________________ solution(s).

Equations like **0 = 1** or **2 = 4** or **100 = 7** are _______________ true so they ____________ have a solution. We say they have _________________ solution(s).

Let's Think:

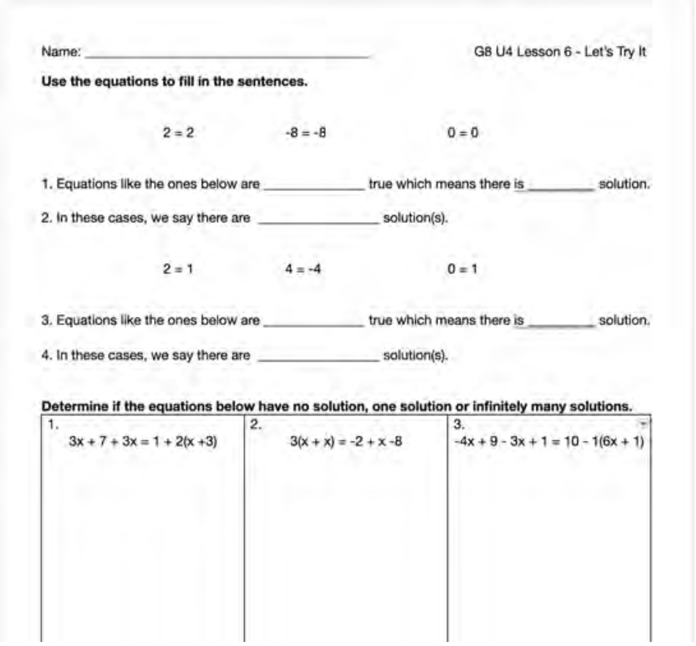
We must try to solve the equation to get it in a form where we can tell how many solutions it has.

Select how many solutions each equation has.

4(x + 2) = x - 3 + 3x	3x - 10 + 4 = 3(x - 2)
This system has… (a) No solution (b) One solution (c) Infinitely many solutions	This system has… (a) No solution (b) One solution (c) Infinitely many solutions

Let's Try It:

Let's explore more equations together!



Name: ______________________________ G8 U4 Lesson 6 - Let's Try It

Use the equations to fill in the sentences.

$2 = 2$ $-8 = -8$ $0 = 0$

1. Equations like the ones below are __________ true which means there is _______ solution.
2. In these cases, we say there are ____________ solution(s).

$2 = 1$ $4 = -4$ $0 = 1$

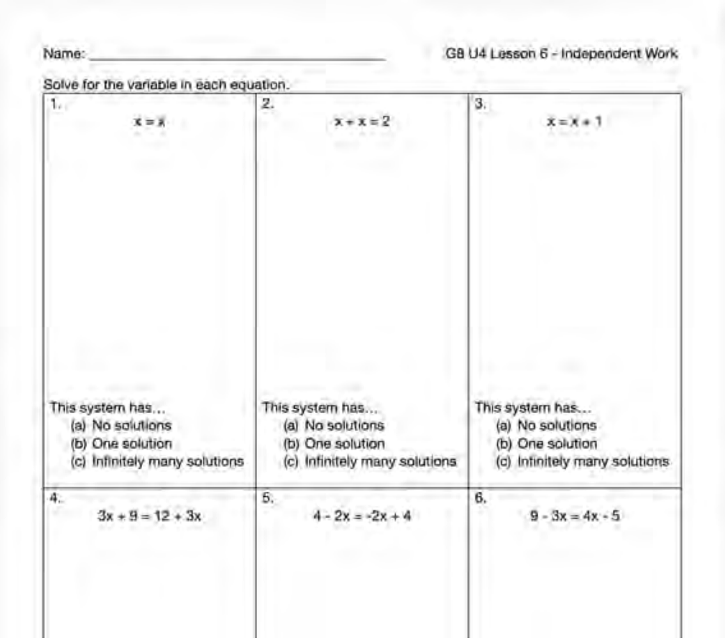
3. Equations like the ones below are __________ true which means there is _______ solution.
4. In these cases, we say there are ____________ solution(s).

Determine if the equations below have no solution, one solution or infinitely many solutions.

1. $3x + 7 + 3x = 1 + 2(x + 3)$	2. $3(x + x) = -2 + x - 8$	3. $-4x + 9 - 3x + 1 = 10 - 1(6x + 1)$

On your Own:

Now it's time for you to do it on your own!



Name: ______________________________ G8 U4 Lesson 6 - Independent Work

Solve for the variable in each equation.

1. $x = x$ This system has… (a) No solutions (b) One solution (c) Infinitely many solutions	2. $x + x = 2$ This system has… (a) No solutions (b) One solution (c) Infinitely many solutions	3. $x = x + 1$ This system has… (a) No solutions (b) One solution (c) Infinitely many solutions
4. $3x + 9 = 12 + 3x$	5. $4 - 2x = -2x + 4$	6. $9 - 3x = 4x - 5$

Name: ____ G8 U4 Lesson 6 - Let’s Try It

Use the equations to fill in the sentences.

2 = 2 -8 = -8 0 = 0

1. Equations like the ones below are ______________ true which means there is _________ solution.

2. In these cases, we say there are _________________ solution(s).

2 = 1 4 = -4 0 = 1

3. Equations like the ones below are ______________ true which means there is _________ solution.

4. In these cases, we say there are _________________ solution(s).

Determine if the equations below have no solution, one solution or infinitely many solutions.

1. $3x + 7 + 3x = 1 + 2(x + 3)$ This system has… (a) No solutions (b) One solution (c) Infinitely many solutions	2. $3(x + x) = -2 + x - 8$ This system has… (a) No solutions (b) One solution (c) Infinitely many solutions	3. $-4x + 9 - 3x + 1 = 10 - 1(6x + 1)$ This system has… (a) No solutions (b) One solution (c) Infinitely many solutions

Name: ____ G8 U4 Lesson 6 - Independent Work

Solve for the variable in each equation.

1\.

$x = x$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

2\.

$x + x = 2$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

3\.

$x = x + 1$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

4\.

$3x + 9 = 12 + 3x$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

5\.

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

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

6\.

$9 - 3x = 4x - 5$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

Solve for the variable in each equation.

7.

$\frac{x+1}{7}$ - 5 = -2

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

8.

7(2 + x) = 7x - 2

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

8.

4x + 5 + 2x = 2(3x + 4)

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

10.

3x + 10 - x = 2(x + 5) - 1

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

11.

20 + 19x = 4x + 8(2x - 1)

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

12.

17 + 2(x - 9) = x -1 + x

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

Name: ANSWER KEY

Use the equations to fill in the sentences.

$2 = 2$ $-8 = -8$ $0 = 0$

1. Equations like the ones below are always true which means there is always a solution.
2. In these cases, we say there are infinitely many solution(s).

$2 = 1$ $4 = -4$ $0 = 1$

3. Equations like the ones below are never true which means there is never a solution.
4. In these cases, we say there are no solution(s).

Determine if the equations below have no solution, one solution or infinitely many solutions.

1.

$3x + 7 + 3x = 1 + 2(x + 3)$

$6x + 7 = 1 + 2x + 6$

$6x + 7 = 2x + 7$

$-2x \qquad -2x$

$4x + 7 = 7$

$-7 \quad -7$

$\frac{4x}{4} = \frac{0}{4}$

$\boxed{x = 0}$

This system has…

(a) No solutions

[✓ (b) One solution]

(c) Infinitely many solutions

2.

$3(x + x) = -2 + x - 8$

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

$6x = -10 + x$

$-x \qquad -x$

$\frac{5x}{5} = \frac{-10}{5}$

$\boxed{x = -2}$

This system has…

(a) No solutions

[✓ (b) One solution]

(c) Infinitely many solutions

3.

$-4x + 9 - 3x + 1 = 10 - 1(6x + 1)$

$-7x + 10 = 10 - 7x - 1$

$-7x + 10 = 9 - 7x$

$+7x \qquad +7x$

$10 = 9$

never

This system has…

[✓ (a) No solutions]

(b) One solution

(c) Infinitely many solutions

Name: ANSWER KEY

G8 U4 Lesson 6 - Independent Work

Solve for the variable in each equation.

1.

$x = x$

$-x \quad -x$

$0 = 0$

always

This system has...
- (a) No solutions
- (b) One solution
- [✓ (c) Infinitely many solutions]

2.

$x + x = 2$

$\frac{2x}{2} = \frac{2}{2}$

$x = 1$

This system has...
- (a) No solutions
- [✓ (b) One solution]
- (c) Infinitely many solutions

3.

$x = x + 1$

$-x \quad -x$

$0 = 1$

never

This system has...
- [✓ (a) No solutions]
- (b) One solution
- (c) Infinitely many solutions

4.

$3x + 9 = 12 + 3x$

$-3x \qquad -3x$

$9 = 12$

never

This system has...
- [✓ (a) No solutions]
- (b) One solution
- (c) Infinitely many solutions

5.

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

$+2x \quad +2x$

$4 = 4$

always

This system has...
- (a) No solutions
- (b) One solution
- [✓ (c) Infinitely many solutions]

6.

$9 - 3x = 4x - 5$

$+3x \quad +3x$

$9 = 7x - 5$

$-5 \qquad -5$

$\frac{4}{7} = \frac{7x}{7}$

$\frac{4}{7} = x$

This system has...
- (a) No solutions
- [✓ (b) One solution]
- (c) Infinitely many solutions

Solve for the variable in each equation.

7.

$\frac{x+1}{7} - 5 = -2$

$+5 \quad +5$

$\frac{x+1}{7} = 3$

$\times 7 \quad \times 7$

$x+1 = 21$

$-1 \quad -1$

$x = 20$

This system has…

(a) No solutions
[✓ (b) One solution]
(c) Infinitely many solutions

8.

$7(2 + x) = 7x - 2$

$14 + 7x = 7x - 2$

$-7x \quad -7x$

$14 = -2$

never

This system has…

[✓ (a) No solutions]
(b) One solution
(c) Infinitely many solutions

8.

$4x + 5 + 2x = 2(3x + 4)$

$2x + 5 = 6x + 8$

$-5 \quad -5$

$2x = 6x + 3$

$-6x \quad -6x$

$\frac{-4x}{-4} = \frac{3}{-4}$

$x = -\frac{3}{4}$

This system has…

(a) No solutions
[✓ (b) One solution]
(c) Infinitely many solutions

10.

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

$3x + 10 - x = 2x + 10 - 1$

$2x + 10 = 2x + 9$

$-2x \quad -2x$

$10 = 9$

never

This system has…

[✓ (a) No solutions]
(b) One solution
(c) Infinitely many solutions

11.

$20 + 19x = 4x + 8(2x - 1)$

$20 + 19x = 4x + 16x - 8$

$20 + 19x = 20x - 8$

$+8 \quad +8$

$28 + 19x = 20x$

$-19x \quad -19x$

$28 = x$

This system has…

(a) No solutions
[✓ (b) One solution]
(c) Infinitely many solutions

12.

$17 + 2(x - 9) = x - 1 + x$

$17 + 2x - 18 = x - 1 + x$

$2x - 1 = 2x - 1$

$-2x \quad -2x$

$-1 = -1$

always

This system has…

(a) No solutions
(b) One solution
[✓ (c) Infinitely many solutions]

G8 U4 Lesson 7

Understand what a system of equations is. Determine whether a system of equations will have one solution, no solution or infinitely many solutions using graphs.

CITYTUTOR DC

G8 U4 Lesson 7 - Today we will understand what a system of equations is and determine whether a system of equations will have one solution, no solutions or infinitely many solutions using graphs.

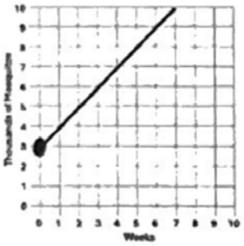
Warm Welcome (Slide 1): Tutor choice

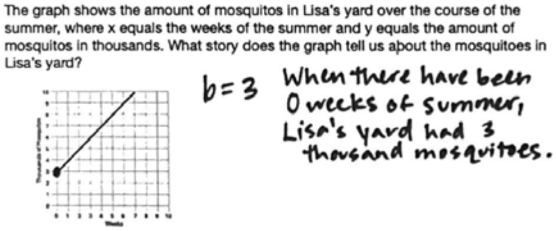
Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will understand what a system of equations is and determine whether a system of equations will have one solution, no solutions or infinitely many solutions using graphs. This is very exciting because systems of equations is really the height of algebra. This is as complicated as it gets. There will be variations on this concept throughout the year. But we're exploring the big idea of algebra for this year now!

Let's Review (Slide 3): We know that graphs can be used to represent real life relationships. In our last unit, we spent many lessons on both proportions and linear relationships. Let's review one. Read along silently with me while I read out loud. *Read the problem silently.* Before we answer the question. Let's ask ourselves this - what parts of the graph could we find to make up the story? What elements should we look for on our graph? Possible Student Answers, Key Points:

- We can find the slope.
- We should look for the y-intercept.

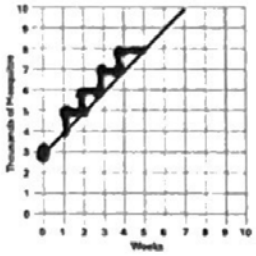
There are two main things we learned to look for in linear relationship: the y-intercept and the slope. The y-intercept is where the line crosses the y-axis. It is also where x = 0. It often tells us where things begin because the x-axis often begins at zero. The y-intercept on this graph is here. *Mark a point at (0,3).* So in this case, it is 3.



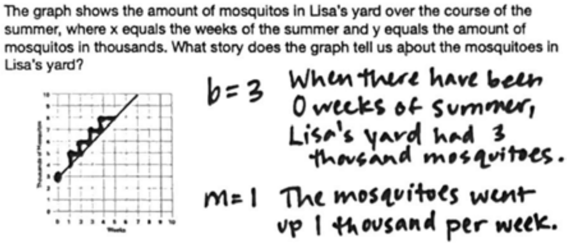

The graph shows the amount of mosquitos in Lisa's yard over the course of the summer, where x equals the weeks of the summer and y equals the amount of mosquitos in thousands. What story does the graph tell us about the mosquitoes in Lisa's yard?

b=3 When there have been 0 weeks of summer, Lisa's yard had 3 thousand mosquitoes.

Equations for linear relationships are usually written in the form y=mx+b and b in the y-intercept so I am going to write b = 3. But 3 what? I turn this into a sentence with words from the story. When there have been 0 weeks of summer, Lisa's yard had 3 thousand mosquitoes.



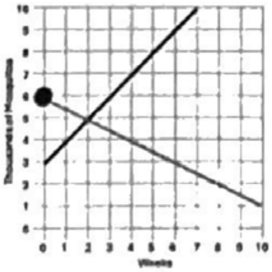
The other part of the graph is the slope. That is measure in rise over run or change in y over change in x. We can use the equation: y_2 minus y_1 over x_2 minus x_1. But I am just going to mark it like a staircase for now because this line has a constant slope which means it has goes up and goes over, goes up and goes over, goes up and goes over.


The graph shows the amount of mosquitos in Lisa's yard over the course of the summer, where x equals the weeks of the summer and y equals the amount of mosquitos in thousands. What story does the graph tell us about the mosquitoes in Lisa's yard?

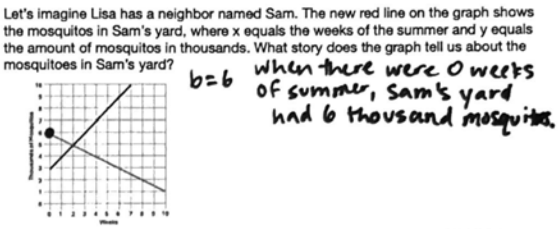
b=3 When there have been 0 weeks of summer, Lisa's yard had 3 thousand mosquitoes.

m=1 The mosquitoes went up 1 thousand per week.

In this case, it goes up 1 thousand mosquitos for every 1 week. We write that as m equals 1. But 1 what? I turn this into a sentence with words from the story. The mosquitos went up 1 thousand mosquitoes per week. It is so cool that we can show phenomenon in the real world with both numbers and a picture!



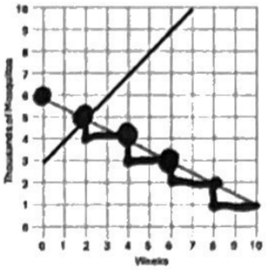
Let's Talk (Slide 4): Now we are going to take this to the next level. Because that last slide only had one relationship or what would be one equation. A SYSTEM of equations is two or more equations that use the same set of variables. Read along silently with me while I read out loud. *Read the problem silently.* Before we worry about the "system" part of all this. Let's first just name that we can do all the same analysis for the red line that we did for the black line. So, we can still find the y-intercept. It is here. *Mark a point at (0,6).*



Let's imagine Lisa has a neighbor named Sam. The new red line on the graph shows the mosquitos in Sam's yard, where x equals the weeks of the summer and y equals the amount of mosquitos in thousands. What story does the graph tell us about the mosquitoes in Sam's yard?

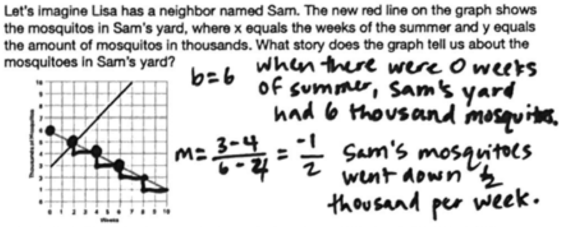
$b=6$ when there were 0 weeks of summer, Sam's yard had 6 thousand mosquitos.

So, b = 6 and I know when there were 0 weeks of summer, Sam had 6 thousand mosquitos in his yard.



The slope in this case is going down. I'm going to mark 2 points to see it. *Mark (4,4) and (6,3).*

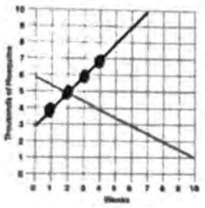
Then we can do m equals y_2 minus y_1 over x_2 minus x_1, which is 3 minus 4 over 6 minus 4. That's negative 1 over 2. So, the mosquito population at Sam's is going down. We can see that in the picture. Maybe he's using some sort of bug spray or something. But it is going down one half thousand mosquitoes per week. The other thing we could calculate for this one is an x-intercept. We don't do that now. But you get the idea - we can have a whole additional line, which would be its own table and its own equation and its own story. But it shares the same variables, which means it shares the same context. In this case, both lines are about thousands of mosquitos each week of summer. It's very cool!



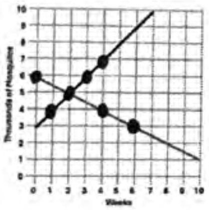
Let's imagine Lisa has a neighbor named Sam. The new red line on the graph shows the mosquitos in Sam's yard, where x equals the weeks of the summer and y equals the amount of mosquitos in thousands. What story does the graph tell us about the mosquitoes in Sam's yard?

$b=6$ when there were 0 weeks of summer, Sam's yard had 6 thousand mosquitos.

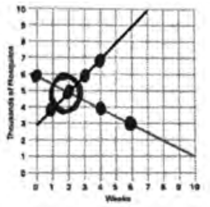
$m=\frac{3-4}{6-4}=\frac{-1}{2}$ Sam's mosquitoes went down $\frac{1}{2}$ thousand per week.



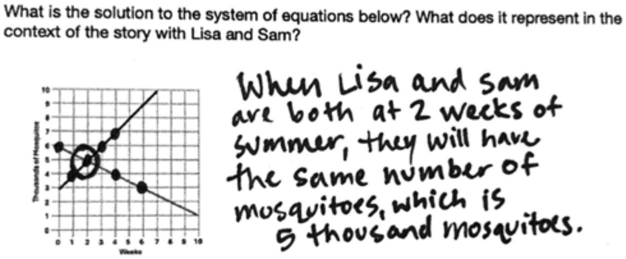
Let's Think (Slide 5): The solution to a system of equations is the point that satisfies all the equations. It is where all the lines meet. It helps to remember that in past lessons, a line could have lots of solutions, right? Every point on the black line is a solution to the equation for the black line. *Draw points along the black line. Be sure to include (2,5) in your points.*



The red line also has tons of solutions. Every point on the red line is a solution to the equation for the red line. *Draw points along the red line. Be sure to include (2,5) in your points.* So, it makes sense that the solution to the whole system is the point that satisfies all the equations. In other words, it has to be a point that goes on all the lines. And that is going to be where all the lines meet.



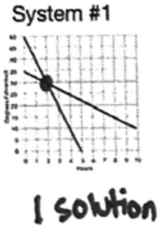
This says, "What is the solution to the system of equations below? What does it represent in the contest of the story with Lisa and Sam?" The point that is on both lines is where these lines meet. Right here. *Circle (2,5).*



What is the solution to the system of equations below? What does it represent in the context of the story with Lisa and Sam?

When Lisa and Sam are both at 2 weeks of summer, they will have the same number of mosquitoes, which is 5 thousand mosquitoes.

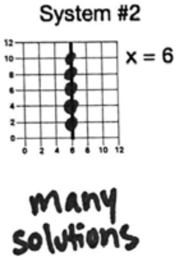
That is when the black line and the red line have the same x and the same y. In the context of this story, that is when there is the same number of mosquitos at the same number of weeks. *Point to the labels for axes as you are using those words.* We can write, "When Lisa and Sam are both at 2 weeks of summer, they will have the same number of mosquitoes, which is 5 thousand mosquitoes."



System #1

1 solution

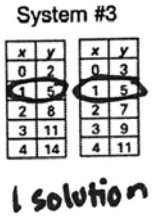
Let's Think (Slide 6): Now, there are situations where the system won't have a nice point like that. "We can think about where lines might meet to see if the system has no solution, one solution or many solutions." This is asking us to "determine how many solutions each system has." Let's look. In system #1, this looks like the graph we already saw. I see one point where they meet right here. *Mark a point at (2,30).* So this system has 1 solution.



System #2

many solutions

Okay, this system has a graph and an equation. Let's think about where they might meet. If I graph x = 6, I draw a line where x is always 6. That is the same as this line already drawn, right? Every point on this line matches every point in this equation. This could be a solution. *Mark a point on the line.* This could be a solution and so on. *Mark many points on the line.* So this system has infinitely many points that are the same. It has infinitely many solutions.



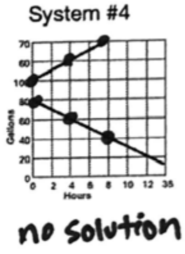
System #3

x	y
0	2
1	5
2	8
3	11
4	14

x	y
0	3
1	5
2	7
3	9
4	11

1 solution

Let's look at the next one. These are tables but it works the same way. All of these are points and we want the point that is the same. Let me give you 10 seconds to look for it. *Wait for 10 seconds.* It is (1,5). That is the point where they will meet because it is the same point for both of them. This table is all the solutions for one equation. This table is all the solutions for one equation. But this one point is the solution to the whole system. It has one solution.



System #4

no solution

Last one! Now we are looking for a point that works for both lines. But notice that none of the points on the top line… *Mark points on the top line.* …are the same as points on the bottom line. *Mark points on the bottom line.* The lines don't meet and they aren't going to meet if we keep going on in time. So this system has no solution.

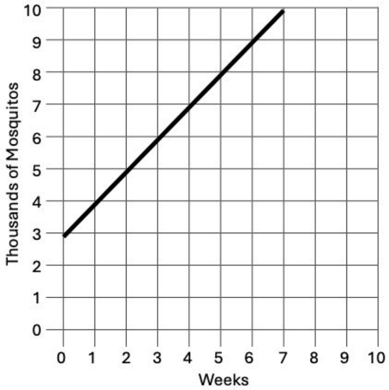
Let's Try It (Slide 7): Let's identify more solutions to systems together. I will walk you through each step.

WARM WELCOME

Today we will understand what a system of equations is and determine whether a system of equations will have one solution, no solutions or infinitely many solutions using graphs.

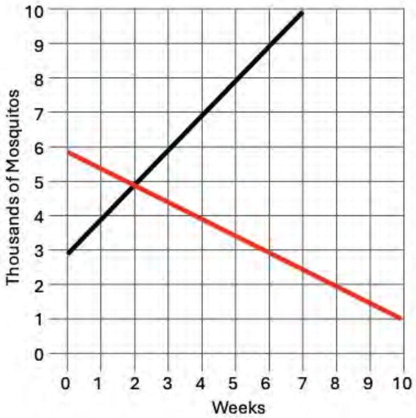
Let's Review: We know that graphs can be used to represent real life relationships.

The graph shows the amount of mosquitos in Lisa's yard over the course of the summer, where x equals the weeks of the summer and y equals the amount of mosquitos in thousands. What story does the graph tell us about the mosquitoes in Lisa's yard?



Let's Talk: A system of equations is two or more equations that use the same set of variables.

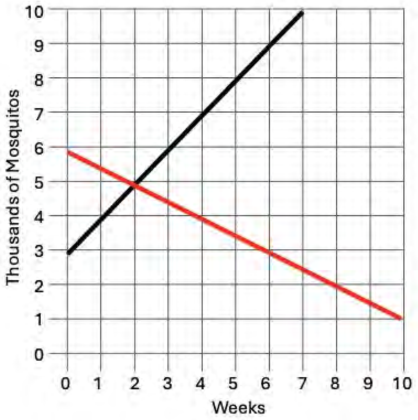
Let's imagine Lisa has a neighbor named Sam. The new red line on the graph shows the mosquitos in Sam's yard, where x equals the weeks of the summer and y equals the amount of mosquitos in thousands. What story does the graph tell us about the mosquitoes in Sam's yard?



Let's Talk:

The solution to a system of equations is the point that satisfies all the equations. It is where all the lines meet.

What is the solution to the system of equations below? What does it represent in the context of the story with Lisa and Sam?

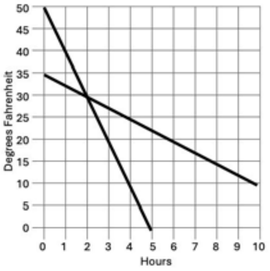


Let's Think:

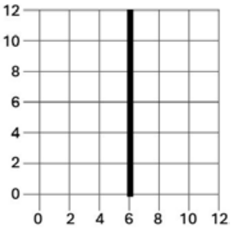
We can think about where lines might meet to see if the system has no solution, one solution or many solutions.

Determine how many solutions each system has.

System #1



System #2



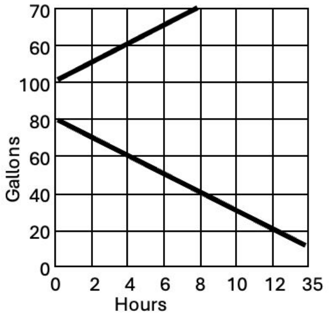
x = 6

System #3

x	*y*
0	2
1	5
2	8
3	11
4	14

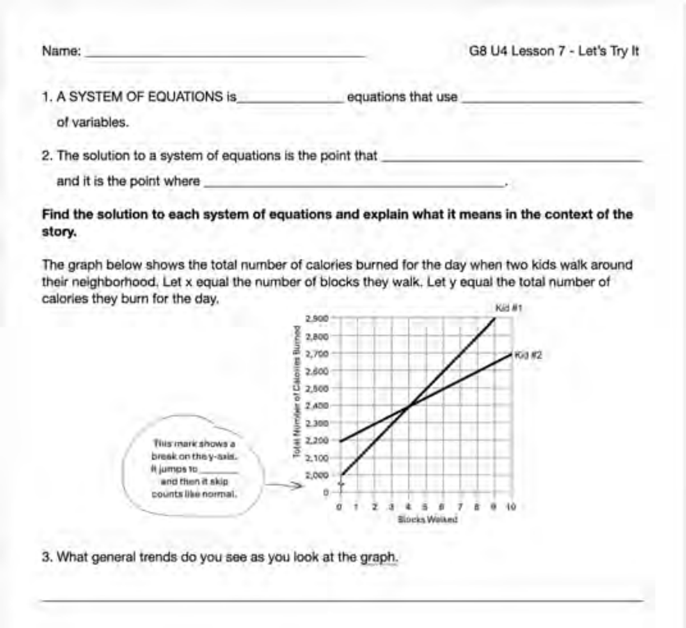
x	*y*
0	3
1	5
2	7
3	9
4	11

System #4



Let’s Try It:

Let’s identify more solutions to systems together!



Name: ______________________________ G8 U4 Lesson 7 - Let’s Try It

1. A SYSTEM OF EQUATIONS is____________ equations that use __________________ of variables.

2. The solution to a system of equations is the point that ________________________

and it is the point where ______________________________.

Find the solution to each system of equations and explain what it means in the context of the story.

The graph below shows the total number of calories burned for the day when two kids walk around their neighborhood. Let x equal the number of blocks they walk. Let y equal the total number of calories they burn for the day.

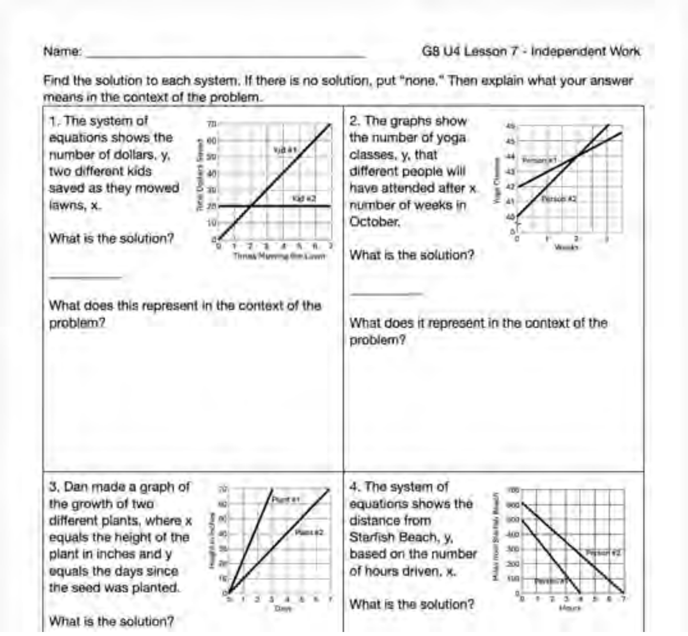
This mark shows a break on the y-axis. It jumps to ______ and then it skip counts like normal.

3. What general trends do you see as you look at the graph.

____

On your Own:

Now it’s time for you to do it on your own!



Name: ______________________________ G8 U4 Lesson 7 - Independent Work

Find the solution to each system. If there is no solution, put “none.” Then explain what your answer means in the context of the problem.

1. The system of equations shows the number of dollars, y, two different kids saved as they mowed lawns, x.

What is the solution?

____

What does this represent in the context of the problem?

2. The graphs show the number of yoga classes, y, that different people will have attended after x number of weeks in October.

What is the solution?

____

What does it represent in the context of the problem?

3. Dan made a graph of the growth of two different plants, where x equals the height of the plant in inches and y equals the days since the seed was planted.

What is the solution?

4. The system of equations shows the distance from Starfish Beach, y, based on the number of hours driven, x.

What is the solution?

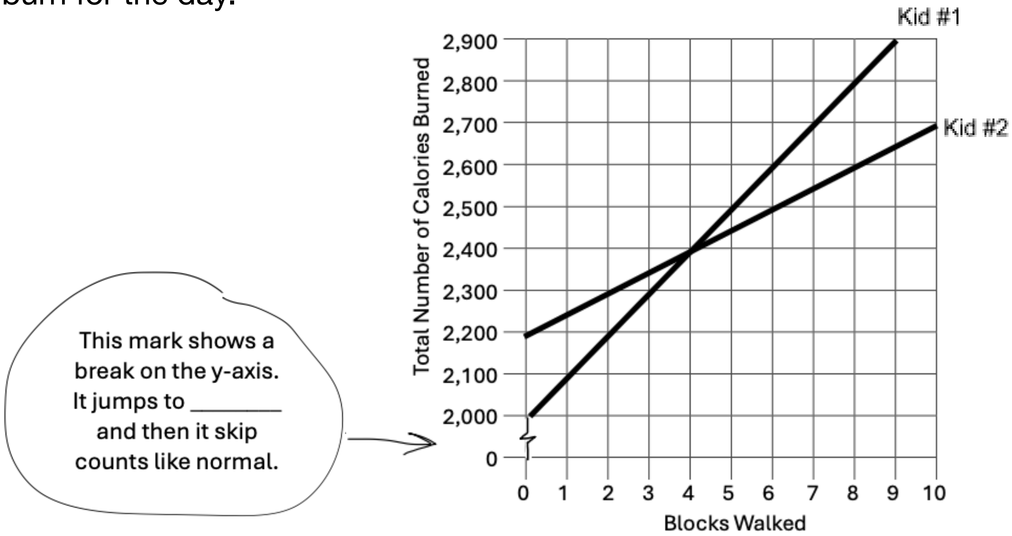
Name: ____ G8 U4 Lesson 7 - Let’s Try It

1. A SYSTEM OF EQUATIONS is_______________ equations that use _________________________ of variables.

2. The solution to a system of equations is the point that _____________________________________ and it is the point where ____.

Find the solution to each system of equations and explain what it means in the context of the story.

The graph below shows the total number of calories burned for the day when two kids walk around their neighborhood. Let x equal the number of blocks they walk. Let y equal the total number of calories they burn for the day.



This mark shows a break on the y-axis. It jumps to _______ and then it skip counts like normal.

3. What general trends do you see as you look at the graph.

____

____

4. What is the solution to the system? (____, ____)

5. What does the solution represent in the context of the story?

____

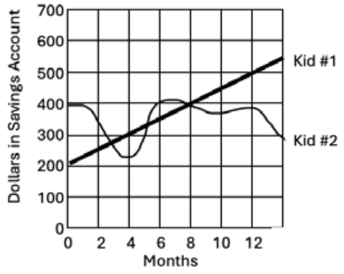
____

____

Determine whether each system has no solutions, one solution or multiple solutions.

Each of the graphs below shows the amount of money that different kids had in their savings accounts after a number of months in 2023. Let x equal the number of months. Let y equal the number of dollars in their savings accounts.

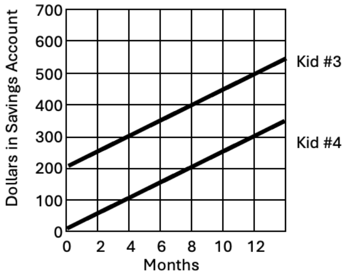
6.



This system has ________
solution(s).

What does that mean in the context of the graph?

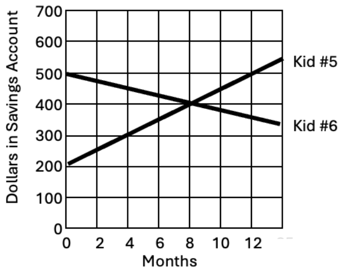
7.



This system has ________
solution(s).

What does that mean in the context of the graph?

8.



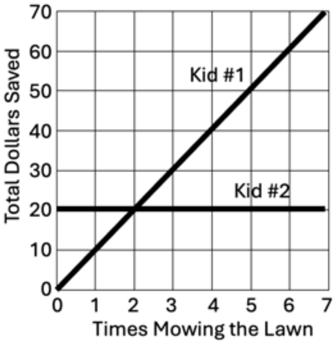
This system has ________
solution(s).

What does that mean in the context of the graph?

Name: ____ G8 U4 Lesson 7 - Independent Work

Find the solution to each system. If there is no solution, put “none.” Then explain what your answer means in the context of the problem.

1. The system of equations shows the number of dollars, y, two different kids saved as they mowed lawns, x.

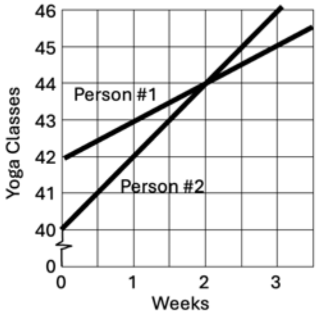


What is the solution?

____

What does this represent in the context of the problem?

2. The graphs show the number of yoga classes, y, that different people will have attended after x number of weeks in October.

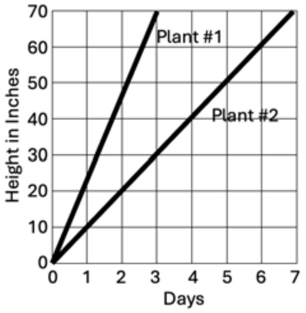


What is the solution?

____

What does it represent in the context of the problem?

3. Dan made a graph of the growth of two different plants, where x equals the height of the plant in inches and y equals the days since the seed was planted.

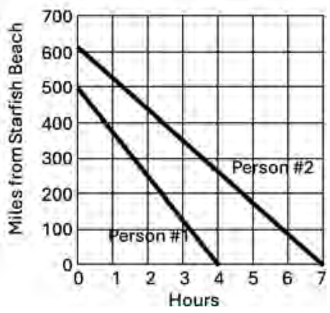


What is the solution?

____

What does this represent in the context of the problem?

4. The system of equations shows the distance from Starfish Beach, y, based on the number of hours driven, x.



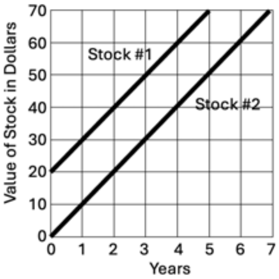
What is the solution?

____

What does this represent in the context of the problem?

Circle from the multiple choice to indicate if the system of equations has no solution, one solution or many solutions.

5.



This system has…

(a) No solution
(b) One solution
(c) Many solutions

6.

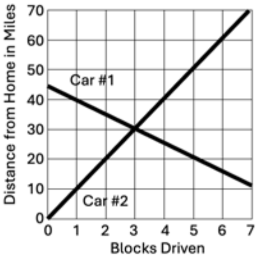
x	*y*
0	0
1	5
2	10
3	15
4	20

x	*y*
0	5
1	7.5
2	10
3	12.5
4	15

This system has…

(a) No solution
(b) One solution
(c) Many solutions

7.



This system has…

(a) No solution
(b) One solution
(c) Many solutions

8.

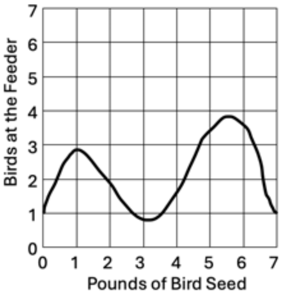
x = 3 and

This system has…

(a) No solution
(b) One solution
(c) Many solutions

9.

y = 2 and



This system has…

(a) No solution
(b) One solution
(c) Many solutions

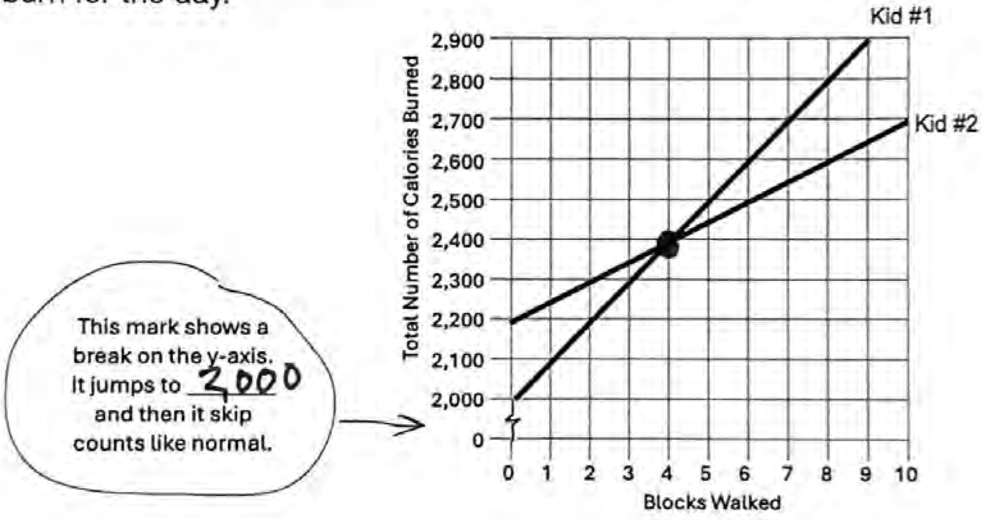
Name: ANSWER KEY

1. A SYSTEM OF EQUATIONS is 2 or more equations that use the same of variables.

2. The solution to a system of equations is the point that satisfies all equations and it is the point where all the lines meet.

Find the solution to each system of equations and explain what it means in the context of the story.

The graph below shows the total number of calories burned for the day when two kids walk around their neighborhood. Let x equal the number of blocks they walk. Let y equal the total number of calories they burn for the day.



3. What general trends do you see as you look at the graph.

Kid #1 starts at 2,000 and increases a lot.

Kid #2 starts at 2,200 and increases a little more slowly.

4. What is the solution to the system? (4, 2400

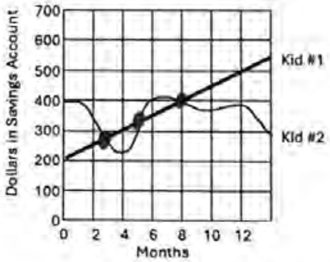
5. What does the solution represent in the context of the story?

Both kids will have burned the same number of calories, which is 2,400, when they have walked the same amount of 4 blocks.

Determine whether each system has no solutions, one solution or multiple solutions.

Each of the graphs below shows the amount of money that different kids had in their savings accounts after a number of months in 2023. Let x equal the number of months. Let y equal the number of dollars in their savings accounts.

6.

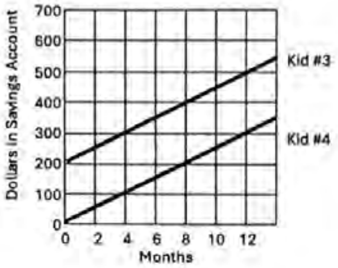


This system has MANY solution(s).

What does that mean in the context of the graph?

There are many times when kid #1 and kid #2 have the same amount of money at the same time.

7.

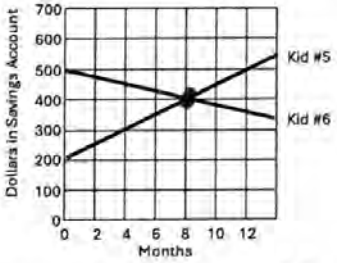


This system has no solution(s).

What does that mean in the context of the graph?

There is no time when both kid #3 and kid #4 have the same amount of money as each other.

8.



This system has one solution(s).

What does that mean in the context of the graph?

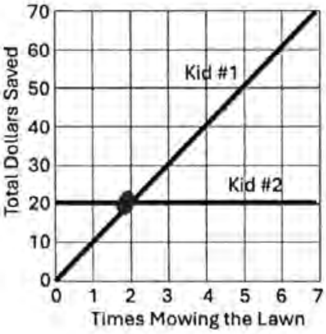
There is one time, which is at 8 months, when kid #5 and #6 both have the same amount of money, which is $400.

Name: ANSWER KEY

G8 U4 Lesson 7 - Independent Work

Find the solution to each system. If there is no solution, put "none." Then explain what your answer means in the context of the problem.

1. The system of equations shows the number of dollars, y, two different kids saved as they mowed lawns, x.



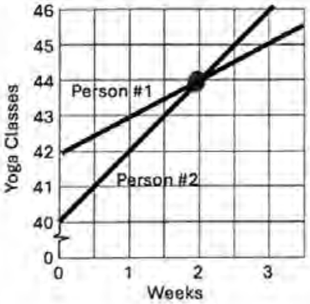
What is the solution?

(2, 20)

What does this represent in the context of the problem?

When both kids have mowed 2 lawns, they will have the same amount of money saved, which is $20.

2. The graphs show the number of yoga classes, y, that different people will have attended after x number of weeks in October.



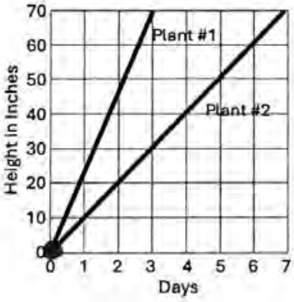
What is the solution?

(2, 44)

What does it represent in the context of the problem?

When both people have done yoga for 2 weeks in October, they will both have done 44 classes total.

3. Dan made a graph of the growth of two different plants, where x equals the height of the plant in inches and y equals the days since the seed was planted.



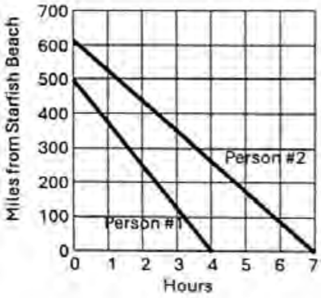
What is the solution?

(0, 0)

What does this represent in the context of the problem?

When both plants have grown for 0 days, they will be at the same height, which is 0 inches.

4. The system of equations shows the distance from Starfish Beach, y, based on the number of hours driven, x.



What is the solution?

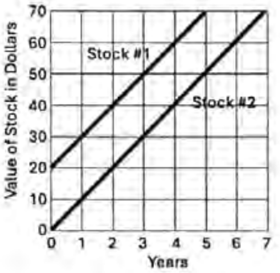
none

What does this represent in the context of the problem?

There is no point at which person #1 and #2 will be at the same distance from Starfish Beach at the same time.

Circle from the multiple choice to indicate if the system of equations has no solution, one solution or many solutions.

5.



This system has...
[✓ (a) No solution]
(b) One solution
(c) Many solutions

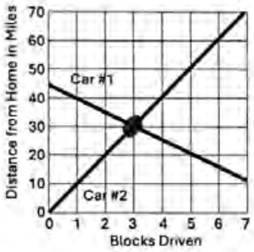
6.

x	y
0	0
1	5
2	10
3	15
4	20

x	y
0	5
1	7.5
2	10
3	12.5
4	15

This system has...
(a) No solution
[✓ (b) One solution]
(c) Many solutions

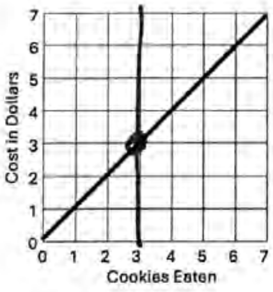
7.



This system has...
(a) No solution
[✓ (b) One solution]
(c) Many solutions

8.

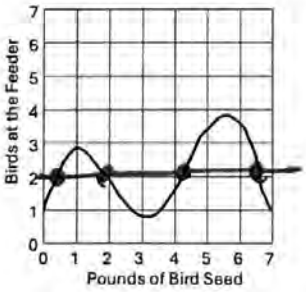
x = 3 and



This system has...
(a) No solution
[✓ (b) One solution]
(c) Many solutions

9.

y = 2 and



This system has...
(a) No solution
(b) One solution
[✓ (c) Many solutions]

G8 U4 Lesson 8

Determine if a point is a solution to a system of equations and explain its meaning.

G8 U4 Lesson 8 - Today we will determine if a point is a solution to a system of equations and explain its meaning.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will determine if a point is a solution to a system of equations and explain its meaning. You already know how to determine if a point is a solution to one equation so you're not going to have any trouble with two or more equations. Let's go!

Let's Review (Slide 3): We know to plug coordinates into an equation to see if it is a solution. We can do these very quickly. It is asking, "Is (5,21) a solution to the equation: y = 3x + 6?" We put 21 in place of y. So it is 21 equals 3 times 5 for x plus 6. Now we do the multiplication 21 = 15 + 6. 15 plus 6 is 21. 21 equals 21! Yay! It works. The equation is true so (5,21) is a solution.

Is (5,21) a solution to the equation: $y = 3x + 6$?

$21 = 3(5) + 6$
$21 = 15 + 6$
$21 = 21$
YES

Let's do the next one. It's still asking, "Is (5,21) a solution to the equation?" But the equation is different. We will write 21 equals 4 times 5 plus 1. I do the multiplication and I get 21 equals 20 plus 1. That's 21 equals 21!

Is (5,21) a solution to the equation: $y = 4x + 1$

$21 = 4(5) + 1$
$21 = 20 + 1$
$21 = 21$
NO

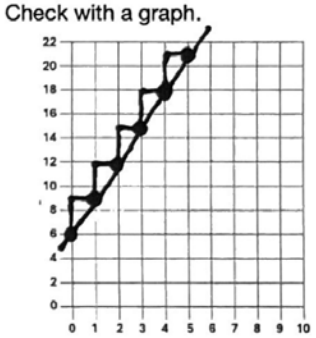
Another true equation! So, is it a solution? Yes! Now, we treated them as separate equations. But on the next slide, we are going to list them together. They will still be the same equations. But now we're going to put them together and call them a system.

Let's Talk (Slide 4): This says, "We can plug coordinates into each equation in a system to see if it is a solution." That's actually what we did on the last slide. We plugged the coordinates into each equation. If they were a solution to each equation then they are a solution to the whole system. "Is (5,21) a solution to the system below? Yes.

Is (5,21) a solution to the system below?

$y = 3x + 6$
$y = 4x + 1$
YES

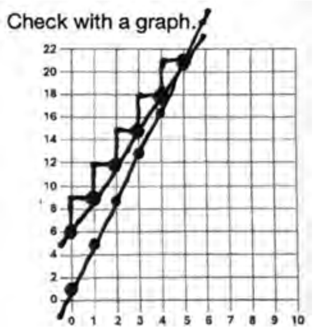
Check with a graph.



But let's graph it just to be sure. The first equation is in the form, y=mx+b, so I know this has a y - intercept of 6. *Put a dot at (0,6).* And then the slope is 3. So it goes up 3 over 1 and up 3 over 1 and up 3 over one. *Keep putting dots at this slope until the end of the graph. Then draw a line through them.* That's y = 3x +6. I am going to write that on the line so I know what it is.

x	Y
0	6
1	9
2	12
3	15
4	18
5	21

Another way I could have done this is with a table. When I plug in 0, I get 6. When I plug in 1, I get 9. When I plug in 2, I get 12. When I plug in 3, I get 15. When I plug in 4, I get 18. When I plug in 5, I get 21.



Next, let’s graph y = 4x + 1. This equation is also in the form, y=mx+b, so I know the y-intercept is 1. *Put a dot at (0,4).* Then the slope is 4. So it goes up 4 over 1 and up 4 over 1 and up 4 over 1. *Keep putting dots at this slope until the end of the graph. Then draw a line through them.* That’s y = 4x + 1. I am going to write that on the line so I know what it is.

x	Y
0	1
1	5
2	9
3	13
4	17
5	21

If I had made a table, I would have started it the same way as the last table. I plug in 0, and I get 1. I plug in 1, and I get 5. I plug in 2, and I get 9. I plug in 3, and I get 13. I plug in 4, and I get 17. I plug in 5, and I get 21.

Either way, we have this common point, (5,21). It worked when we plugged it into both equations separately. It worked when we looked for it on the graph for both equations in the same system.

Is (0,2) a solution to the system below?

$3y + 2x = 6 \longrightarrow 3(2) + 2(0) = 6$

$y = -4x + 1$

$6 + 0 = 6$

$6 = 6$

YES

Let’s Think (Slide 5): Equations can be written in any form, and we can still plug in the coordinate to check if it is a solution. This is asking, “Is (0,2) a solution to the system below?” We just plug in the coordinates to both equations. 3 times 2 plus 2 times 0 equals 6. Next step, we’ll multiply. We get 6 plus 0 equals 6, which is 6 equals 6. So, it is a solution to that equation.

$2 = -4(0) + 1$

$2 = 1$

NO

Let’s do the next equation. 2 = -4(0) + 1. We do the multiplication first. 2 = 0 + 1, which is 2 equals 1. Uh-oh. It doesn’t give us a true equation.

So (0,2) is a solution to the first equation but not the second equation. That means it’s NOT a solution to the whole system. But really to do this work, you are not doing any math that you haven’t done before, right? You are going to be great at this!

Let’s Try It (Slide 6): Let’s check some solutions to systems of equations together. I will walk you through each step.

WARM WELCOME

Today we will determine if a point is a solution to a system of equations and explain its meaning.

Let's Review:

We know to plug coordinates into an equation to see if it is a solution.

Is (5,21) a solution to the equation: $y = 3x + 6$?

Is (5,21) a solution to the equation: $y = 4x + 1$

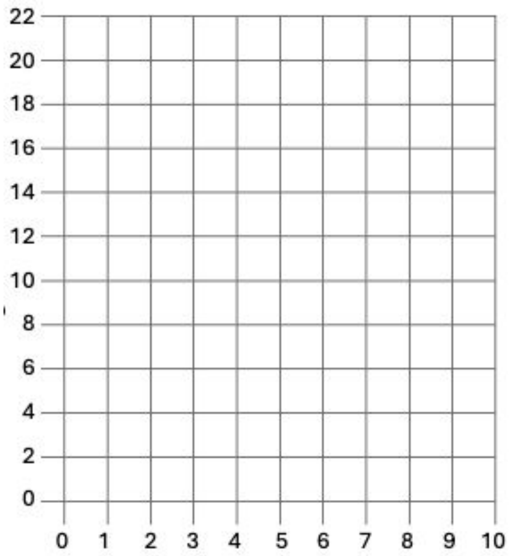
Let's Talk:

We can plug coordinates into each equation in a system to see if it is a solution.

Is (5,21) a solution to the system below?

$$y = 3x + 6$$
$$y = 4x + 1$$

Check with a graph.



Let's Think:

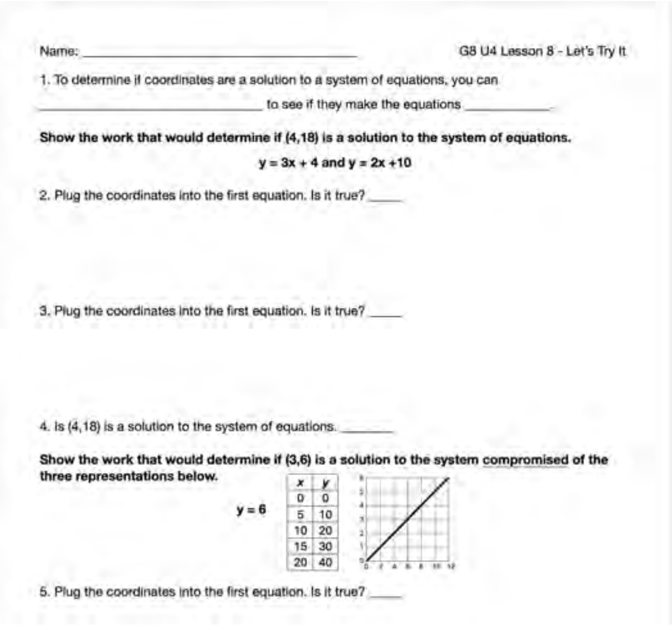
Equations can be written in any form, and we can still plug in the coordinate to check if it is a solution.

Is (0,2) a solution to the system below?

$$3y + 2x = 6$$
$$y = -4x + 1$$

Let's Try It:

Let's check some solutions to systems of equations together!



Name: ______________________ G8 U4 Lesson 8 - Let's Try It

1. To determine if coordinates are a solution to a system of equations, you can ______________________ to see if they make the equations __________.

Show the work that would determine if (4,18) is a solution to the system of equations.

$y = 3x + 4$ and $y = 2x + 10$

2. Plug the coordinates into the first equation. Is it true? _____

3. Plug the coordinates into the first equation. Is it true? _____

4. Is (4,18) is a solution to the system of equations. ________

Show the work that would determine if (3,6) is a solution to the system compromised of the three representations below.

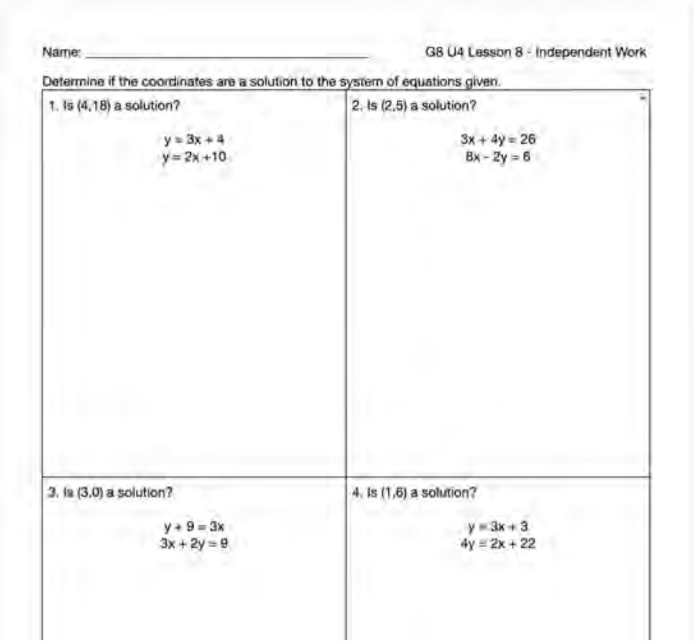
$y = 6$

x	y
0	0
5	10
10	20
15	30
20	40

5. Plug the coordinates into the first equation. Is it true? _____

On your Own:

Now it’s time for you to do it on your own!



Name: ______________________________

G8 U4 Lesson 8 - Independent Work

Determine if the coordinates are a solution to the system of equations given.

1. Is (4,18) a solution?

$y = 3x + 4$
$y = 2x + 10$

2. Is (2,5) a solution?

$3x + 4y = 26$
$8x - 2y = 6$

3. Is (3,0) a solution?

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

4. Is (1,6) a solution?

$y = 3x + 3$
$4y = 2x + 22$

Name: ____ G8 U4 Lesson 8 - Let’s Try It

1. To determine if coordinates are a solution to a system of equations, you can ________________________________ to see if they make the equations ____________.

Show the work that would determine if (4,18) is a solution to the system of equations.

$y = 3x + 4$ and $y = 2x + 10$

2. Plug the coordinates into the first equation. Is it true? _____

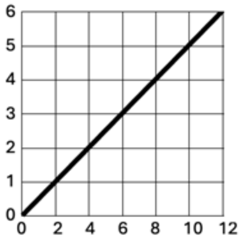
3. Plug the coordinates into the first equation. Is it true? _____

4. Is (4,18) is a solution to the system of equations. ________

Show the work that would determine if (3,6) is a solution to the system compromised of the three representations below.

$y = 6$

x	y
0	0
5	10
10	20
15	30
20	40



5. Plug the coordinates into the first equation. Is it true? _____

6. Write an equation for the table. Plug the coordinates into the equation. Is it true? _____

7. Look for the point on the line that is graphed. Is it a solution? ______

8. Is (3,6) is a solution to the system of equations? ________

Name: ____________________________________ G8 U4 Lesson 8 - Independent Work

Determine if the coordinates are a solution to the system of equations given.

1. Is (4,18) a solution?

$$y = 3x + 4$$
$$y = 2x +10$$

2. Is (2,5) a solution?

$$3x + 4y = 26$$
$$8x - 2y = 6$$

3. Is (3,0) a solution?

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

4. Is (1,6) a solution?

$$y = 3x + 3$$
$$4y = 2x + 22$$

Determine if the coordinates are a solution to the system of equations given.

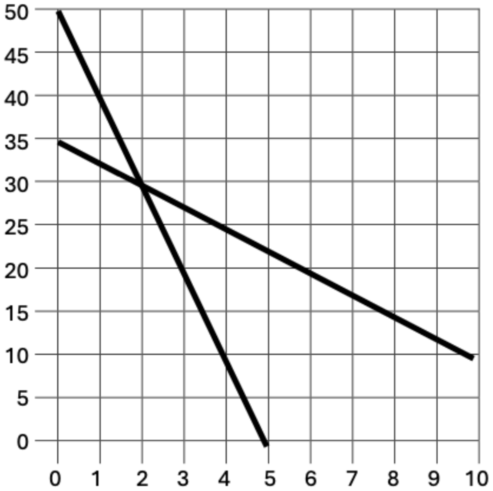
5. Is (2,10) a solution?

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

6. Is (1,6) a solution?

$y = 6x$
$y = 2x + 4$
$3x - 3y = 15$

7. Is (2,30) a solution?



8. Is (10,40) a solution?

x	y
0	0
1	4
2	8
3	12

and $y = 3x + 1x$

Name: ANSWER KEY

G8 U4 Lesson 8 - Let's Try It

1. To determine if coordinates are a solution to a system of equations, you can substitute to see if they make the equations true.

Show the work that would determine if (4,18) is a solution to the system of equations.

$y = 3x + 4$ and $y = 2x + 10$

2. Plug the coordinates into the first equation. Is it true? NO

$y=3x+4$
$18=3(4)+4$
$18=12+4$
$18 \neq 16$

3. Plug the coordinates into the first equation. Is it true? YES

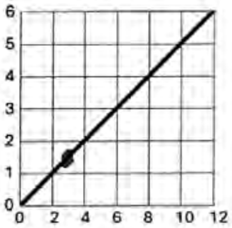
$y=2x+10$
$18=2(4)+10$
$18=8+10$
$18=18$

4. Is (4,18) is a solution to the system of equations. NO

Show the work that would determine if (3,6) is a solution to the system compromised of the three representations below.

$y = 6$

x	y
0	0
5	10
10	20
15	30
20	40



5. Plug the coordinates into the first equation. Is it true? YES

$y=6$
$6=6$

6. Write an equation for the table. Plug the coordinates into the equation. Is it true? YES

$x \cdot 2=y$
$3 \cdot 2=6$
$6=6$

7. Look for the point on the line that is graphed. Is it a solution? NO

8. Is (3,6) is a solution to the system of equations? NO

Name: ANSWER KEY

G8 U4 Lesson 8 - Independent Work

Determine if the coordinates are a solution to the system of equations given.

1. Is (4,18) a solution? NO

$$y = 3x + 4$$
$$y = 2x + 10$$

① $18 = 3(4) + 4$

$18 = 12 + 4$

$18 = 16$ NO

2. Is (2,5) a solution? YES

$$3x + 4y = 26$$
$$8x - 2y = 6$$

① $3(2) + 4(5) = 26$

$6 + 20 = 26$

$26 = 26$ YES

② $8(2) - 2(5) = 6$

$16 - 10 = 6$

$6 = 6$ YES

3. Is (3,0) a solution? YES

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

① $y + 9 = 3x$

$0 + 9 = 3(3)$

$9 = 9$ YES

② $3x + 2y = 9$

$3(3) + 2(0) = 9$

$9 + 0 = 9$

$9 = 9$ YES

4. Is (1,6) a solution? YES

$$y = 3x + 3$$
$$4y = 2x + 22$$

① $y = 3x + 3$

$6 = 3(1) + 3$

$6 = 3 + 3$

$6 = 6$ YES

② $4y = 2x + 22$

$4(6) = 2(1) + 22$

$24 = 2 + 22$

$24 = 24$ YES

Determine if the coordinates are a solution to the system of equations given.

5. Is (2,10) a solution? YES

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

① $x = 2$
$2 = 2$ YES

② $y = 3x + 4$
$10 = 3(2) + 4$
$10 = 6 + 4$
$10 = 10$ YES

6. Is (1,6) a solution? NO

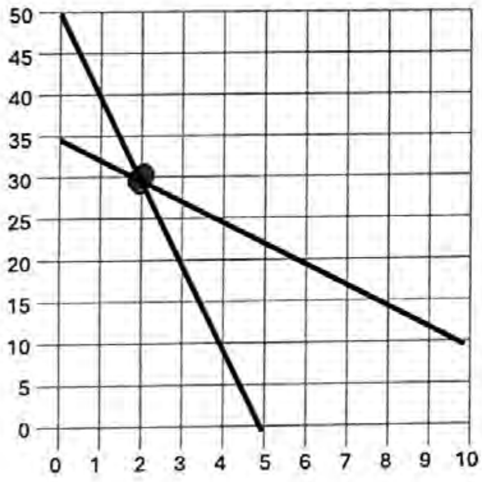
$y = 6x$
$y = 2x + 4$
$3x - 3y = 15$

① $6 = 6(1)$
$6 = 6$ YES

② $6 = 2(1) + 4$
$6 = 2 + 4$
$6 = 6$ YES

③ $3(1) - 3(6) = 15$
$3 - 18 = 15$
$-15 = 15$ NO

7. Is (2,30) a solution? YES



8. Is (10,40) a solution? YES

x	y
0	0
1	4
2	8
3	12

$y = 4x$
$40 = 4(10)$
$40 = 40$ YES

and y = 3x + 1x

$40 = 3(10) + 1(10)$
$40 = 30 + 10$
$40 = 40$ YES

G8 U4 Lesson 9

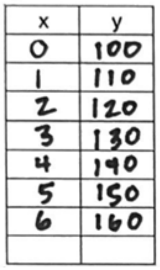
Understand how to find a solution to a system of equations by setting two expressions equal to each other.

CITYTUTOR DC

G8 U4 Lesson 9 - Today we will understand how to find a solution to a system of equations by setting two expressions equal to each other.

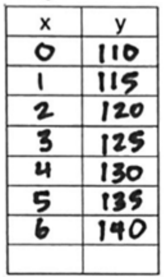
Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will understand how to find a solution to a system of equations by setting two expressions equal to each other. This is going to reach back to our last unit on linear equations. We know how to find the solution to one equation, and now we're going to find the solutions to two or more. Let's go!



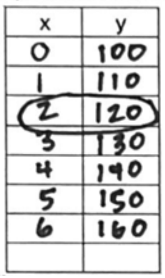
x	y
0	100
1	110
2	120
3	130
4	140
5	150
6	160

Let's Review (Slide 3): We can see the solution to a system of equations on a table. Read the problem silently along with me while I read it out loud. *Read the problem.* We already have tables set up for us here. Let's start plugging in numbers. We'll start with John. At 0 weeks, John already has $100 in his savings account. So I am going to write (0,100). Each week he gets $10. So in week 1, he'll have $110. Then in week 2, he'll have $120. In week 3, he'll have $130. In week 4, he'll have $140. In week 5, he'll have $130. In week 6, he'll have $160. *Be sure to leave the last row of the table for the expression we will add at the end of the slide.*

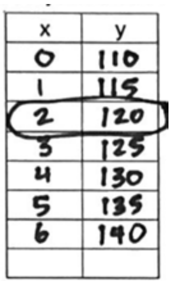


x	y
0	110
1	115
2	120
3	125
4	130
5	135
6	140

Now let's do Roy. At 0 weeks, Roy already has $110 in his savings account. So I am going to write (0,110). Each week he gets $5. So in week 1, he'll have $115. Then in week 2, he'll have $120. In week 3, he'll have $125. In week 4, he'll have $130. In week 5, he'll have $135. In week 6, he'll have $140. *Be sure to leave the last row of the table for the expression we will add at the end of the slide.*

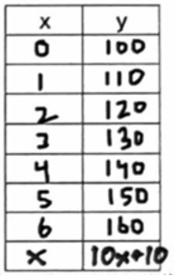


x	y
0	100
1	110
2	120
3	130
4	140
5	150
6	160



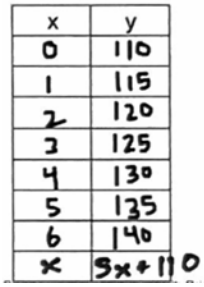
x	y
0	110
1	115
2	120
3	125
4	130
5	135
6	140

Now look at the table! We can see where John will catch up to Roy. When they are both at week 2, they will both have $120. That's our solution! This is review of work we've done before. We're just doing it with two stories in the same context instead of one. But let's think about what we've done here and use it to come up with a strategy for trickier problems.



x	y
0	100
1	110
2	120
3	130
4	140
5	150
6	160
x	10x+10

Let's Talk (Slide 4): This says, "When expressions equal the same variable, we can set them equal to each other and solve." We have the exact same story with the table filled in the same way as on our last slide. Here's what I want to point out. For John, every y in the column was essentially multiplying the number of weeks times 10 plus the $100 he started out with at the beginning. So the equation for John is y = 10x + 100. And I could even write that in as a row on my table. We always had an x. And then the y was always 10x + 100.



x	y
0	110
1	115
2	120
3	125
4	130
5	135
6	140
x	5x+110

We could think of Roy's the same way. We always had an x. And then the y for Roy was always 5x + 110. The equation is y = 5x + 110. And I could put that on my table. We always had an x. And then the y was always 5x + 110.

In the past, when we only had one equation, it wasn't super useful to put an expression on our table. And we generally won't do it for systems either. But it does help us see that with systems we are really looking for where this y expression equals this y expression. Then the x will equal the x. That's just like we were looking for 120 equal to 120 and 2 equal to 2. Let's see what happens when I set the expressions equal to each other and solve. I'll write 10x + 100 = 5x + 110. I subtract 100 from both sides. That gives me 10x = 5x + 10. I subtract 5x from both sides. That gives me 5x = 10. I divide by 5 on both sides. That gives me x = 2. That is the same value for x that we came up with on the table, right?!?!? Awesome! So next time, we don't have to make a table! We can solve algebraically by setting the expressions equal to each other.

$$\begin{aligned} 10x + 100 &= 5x + 110 \\ -100 \quad & \quad -100 \\ 10x &= 5x + 10 \\ -5x \quad & \quad -5x \\ 5x &= 10 \\ \frac{5x}{5} &= \frac{10}{5} \\ & \boxed{x = 2} \end{aligned}$$

$$\begin{aligned} y &= 10x + 100 \\ y &= 10(2) + 100 \\ y &= 20 + 100 \\ & \boxed{y = 120} \end{aligned}$$

That gave us x so let's plug x into one of the equations to find y. That would be y = 10(2) + 100. That's y = 20 + 100 or y = 120. That's the same answer.

$$\begin{aligned} y &= 5x + 110 \\ y &= 5(2) + 110 \\ y &= 10 + 110 \\ & \boxed{y = 120} \end{aligned}$$

And let's check our other equation just to be sure. That would be y = 5(2) + 110. That gives us y = 10 + 110. That's y = 120. Same answer again! So, we can set up tables and fill in lots of values like we did on the last slide. Or if the expressions equal the same variable, we can set them equal to each other and solve them algebraically. In this case, we had both expressions equal to y. So we set them equal to each other and then we crunched those numbers.

$$\begin{aligned} 4x - 6 &= 2x + 10 \\ +6 \quad & \quad +6 \\ 4x &= 2x + 16 \\ -2x \quad & \quad -2x \\ \frac{2x}{2} &= \frac{16}{2} \\ & \boxed{x = 8} \end{aligned}$$

Let's Think (Slide 5): We just said this, "If we can solve for one variable algebraically, we can use it to solve for the other variable." This says, "What is the solution to the system?" We have two equations. They are both set equal to y. So we know that the solution is when they are both equal to each other. I will write 4x - 6 = 2x + 10. I add 6 to both sides. That's 4x = 2x + 16. I subtract 2x from both sides. That's 2x = 16. I divide by 2 on both sides. I get x = 8. The idea is that if I were to make tables for both of these and keep plugging in numbers, I get the same y when x was 8.

$$\begin{aligned} y &= 4x - 6 \\ y &= 4(8) - 6 \\ y &= 32 - 6 \\ & \boxed{y = 26} \end{aligned}$$

Now we have one more step to find the y. We take an equation and plug in x equals 8. It doesn't matter which equation we do. Let's do y = 4x - 6. That would be y = 4(8) - 6. I do the multiplication first. It is y = 32 - 6 then y = 26.

What is the solution to the system? (8 , 26) So, the solution to this system is (8,26).

$$\begin{aligned} y &= 2x + 10 \\ y &= 2(8) + 10 \\ y &= 16 + 10 \\ & \boxed{y = 26} \end{aligned}$$

Let's plug that into the second equation and check if it's right. That would be 26 = 2(8) + 10. 2 times 8 is 16 so I have 26 = 16 + 10. Then 26 = 26. It is a solution! This is way easier than putting all my numbers on a table!

Let's Try It (Slide 6): Let's find solutions to systems of equations together. I will walk you through each step.

WARM WELCOME

Today we will understand how to find a solution to a system of equations by setting two expressions equal to each other.

Let's Review:

We can see the solution to a system of equations on a table.

John started out with $100 in his savings account. His parents pay him $10 every week he does chores. Roy started out with $110 in his savings account. But his parents pay him $5 every time week he does chores. Let x be the number of weeks and y be the number of dollars. At which point will John and Roy have the same amount of money at the same time?

x	y

x	y

Let's Talk:

When expressions equal the same variable, we can set them equal to each other and solve algebraically.

John started out with $100 in his savings account. His parents pay him $10 every week he does chores. Roy started out with $110 in his savings account. But his parents pay him $5 every time week he does chores. Let x be the number of weeks and y be the number of dollars. At which point will John and Roy have the same amount of money at the same time?

x	y
0	100
1	110
2	120
3	130
4	140
5	150
6	160

x	y
0	110
1	115
2	120
3	125
4	130
5	135
6	140

Let's Think:

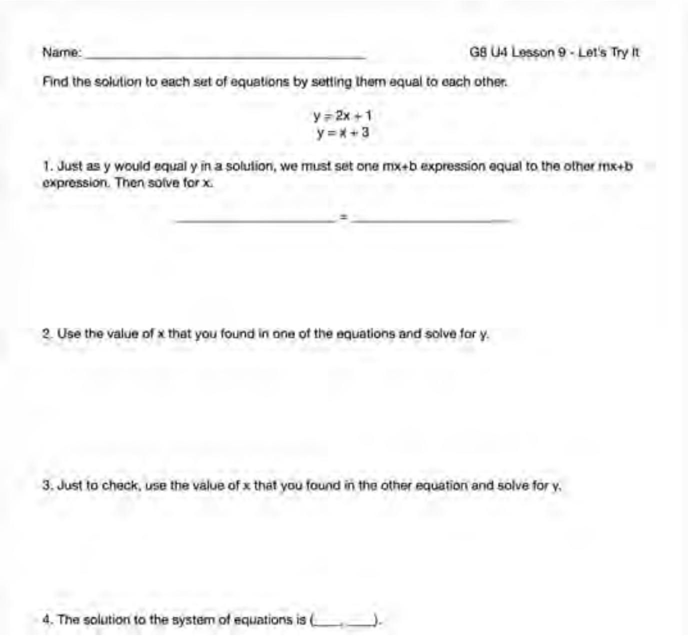
If we can solve for one variable algebraically, we can use it to solve for the other variable.

What is the solution to the system? (____, ____)

$y = 4x - 6$
$y = 2x + 10$

Let's Try It:

Let's find solutions to systems of equations together!



Name: ______________________________ G8 U4 Lesson 9 - Let's Try It

Find the solution to each set of equations by setting them equal to each other.

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

1. Just as y would equal y in a solution, we must set one mx+b expression equal to the other mx+b expression. Then solve for x.

_______________ = _______________

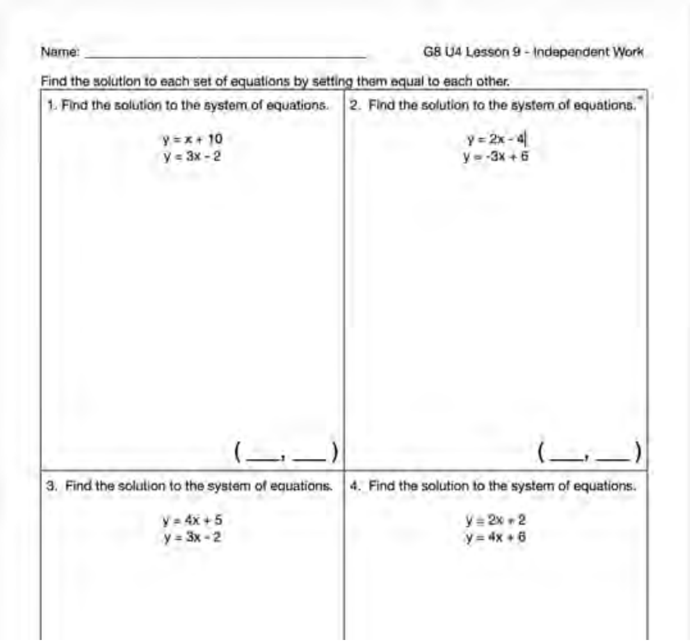
2. Use the value of x that you found in one of the equations and solve for y.

3. Just to check, use the value of x that you found in the other equation and solve for y.

4. The solution to the system of equations is (___, ___).

On your Own:

Now it’s time for you to do it on your own!



Name: ____________________

G8 U4 Lesson 9 - Independent Work

Find the solution to each set of equations by setting them equal to each other.

1. Find the solution to the system of equations.

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

(___, ___)

2. Find the solution to the system of equations.

$y = 2x - 4$
$y = -3x + 6$

(___, ___)

3. Find the solution to the system of equations.

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

4. Find the solution to the system of equations.

$y = 2x + 2$
$y = 4x + 6$

Find the solution to each set of equations by setting them equal to each other.

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

1. Just as y would equal y in a solution, we must set one mx+b expression equal to the other mx+b expression. Then solve for x.

______________________ = ______________________

2. Use the value of x that you found in one of the equations and solve for y.

3. Just to check, use the value of x that you found in the other equation and solve for y.

4. The solution to the system of equations is (____, ____).

Find the solution to each set of equations by setting them equal to each other.

1. Find the solution to the system of equations.

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

(___, ___)

2. Find the solution to the system of equations.

$y = 2x - 4$
$y = -3x + 6$

(___, ___)

3. Find the solution to the system of equations.

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

(___, ___)

4. Find the solution to the system of equations.

$y = 2x + 2$
$y = 4x + 6$

(___, ___)

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

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

(___, ___)

6. Find the solution to the system of equations.

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

(___, ___)

7. Find the solution to the system of equations.

$y = x + 11$
$y = 12x$

(___, ___)

8. Find the solution to the system of equations.

$y = x + 1$
$y = 2x - 7$

(___, ___)

Name: ANSWER KEY

G8 U4 Lesson 9 - Let's Try It

Find the solution to each set of equations by setting them equal to each other.

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

1. Just as y would equal y in a solution, we must set one mx+b expression equal to the other mx+b expression. Then solve for x.

$2x + 1 = x + 3$

$-x \quad\quad -x$

$x + 1 = 3$

$-1 \quad\quad -1$

$\boxed{x = 2}$

2. Use the value of x that you found in one of the equations and solve for y.

$y = 2x + 1$

$y = 2(2) + 1$

$y = 4 + 1$

$\boxed{y = 5}$

3. Just to check, use the value of x that you found in the other equation and solve for y.

$y = x + 3$

$5 = 2 + 3$

$5 = 5$

4. The solution to the system of equations is (2 , 5).

Name: ANSWER KEY

G8 U4 Lesson 9 - Independent Work

Find the solution to each set of equations by setting them equal to each other.

1. Find the solution to the system of equations.

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

$x + 10 = 3x - 2$
$+2 \qquad +2$
$x + 12 = 3x$
$-x \qquad -x$
$\frac{12}{2} = \frac{2x}{2}$
$\boxed{6 = x}$
$y = x + 10$
$y = 6 + 10$
$\boxed{y = 16}$

(6 , 16)

2. Find the solution to the system of equations.

$y = 2x - 4$
$y = -3x + 6$

$2x - 4 = -3x + 6$
$+4 \qquad +4$
$2x = -3x + 10$
$+3x \qquad +3x$
$\frac{5x}{5} = \frac{10}{5}$
$\boxed{x = 2}$
$y = 2(2) - 4$
$y = 4 - 4$
$\boxed{y = 0}$

(2 , 0)

3. Find the solution to the system of equations.

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

$4x + 5 = 3x - 2$
$+2 \qquad +2$
$4x + 7 = 3x$
$-4x \qquad -4x$
$\frac{7}{-1} = \frac{-1x}{-1}$
$\boxed{-7 = x}$
$y = 3(-7) - 2$
$y = -21 - 2$
$\boxed{y = -23}$

(-7 , -23)

4. Find the solution to the system of equations.

$y = 2x + 2$
$y = 4x + 6$

$2x + 2 = 4x + 6$
$-2 \qquad -2$
$2x = 4x + 4$
$-2x \qquad -2x$
$0 = 2x + 4$
$-4 \qquad -4$
$\frac{-4}{2} = \frac{2x}{2}$
$\boxed{-2 = x}$
$y = 2(-2) + 2$
$y = -4 + 2$
$\boxed{y = -2}$

(-2 , -2)

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

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

$2x + 4 = 3x - 2$
$+2 \qquad +2$
$2x + 6 = 3x$
$-2x \qquad -2x$
$\boxed{6 = x}$

$y = 3(6) - 2$
$y = 18 - 2$
$\boxed{y = 16}$

(6 , 16)

6. Find the solution to the system of equations.

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

$-2x + 3 = 3x - 2$
$+2x \qquad +2x$
$3 = 5x - 2$
$+2 \qquad +2$
$\frac{5}{5} = \frac{5x}{5}$
$\boxed{1 = x}$

$y = 3(1) - 2$
$y = 3 - 2$
$\boxed{y = 1}$

(1 , 1)

7. Find the solution to the system of equations.

$y = x + 11$
$y = 12x$

$x + 11 = 12x$
$-x \qquad -x$
$\frac{11}{11} = \frac{11x}{11}$
$\boxed{1 = x}$

$y = 12(1)$
$\boxed{y = 12}$

(1 , 12)

8. Find the solution to the system of equations.

$y = x + 1$
$y = 2x - 7$

$x + 1 = 2x - 7$
$+7 \qquad +7$
$x + 8 = 2x$
$-x \qquad -x$
$\boxed{8 = x}$

$y = 2(8) - 7$
$y = 16 - 7$
$\boxed{y = 9}$

(8 , 9)

G8 U4 Lesson 10
Solve equations with fractions.

CITYTUTOR DC

G8 U4 Lesson 10 - Today we will solve equations with fractions.

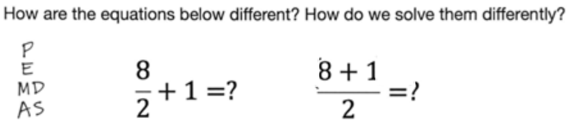
Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will solve equations with fractions. This is a little pause from our systems of equations work because our next lesson on systems of equations is going to have fractions come up. Today we're going to review some fraction ideas that hopefully you have seen before so that we are ready for the next lesson.

Let's Review (Slide 3): Order of operations is the foundation for solving expressions. What is order of operations? Possible Student Answers, Key Points:

- It is PEMDAS.
- It is the order that you have to do your math in.
- It means do parentheses then exponents then multiplication and division then addition and subtraction.

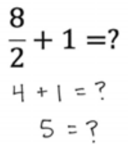
The acronym that we use for order of operations is PEMDAS, where P stands for parentheses, E stands for exponents, MD stands for multiplication and division and AS stands for addition and subtraction. We use order of operations to evaluate expressions, working forward. But on our next slide, when we are working backwards to solve for a variable, we still use order of operations - just in the opposite direction. So we have to be clear on how PEMDAS words. And it gets especially confusing when fractions start to show up. So, let's look at these two problems.


How are the equations below different? How do we solve them differently?

P
E
MD
AS

$\frac{8}{2}+1=?$ $\frac{8+1}{2}=?$

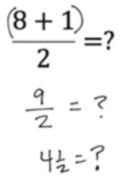
This says, "How are the equations below different? How do we solve them differently?" The first thing that I hope you notice is that in the first equation we have 8 over 2 and then there is addition. But in the second equation we also have the addition over 2. These two problems are not the same. We can think of the 8 over 2 like 8 halves. But we can also think of it like 8 over 2. And with PEMDAS, that means we will do that part first. We will do the division before the addition. 8 divided by 2 is 4. So we have 4 + 1 = ?. Our answer is 5 = ?.


$\frac{8}{2}+1=?$

$4+1=?$

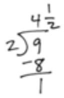
$5=?$

But in the next problem, even though multiplication and division always come before addition and subtraction, we aren't going to divide by 2. We have a whole amount over the 2, which means we can almost think of it like there are parentheses holding this whole amount over the 2. We would need to do this part first and then divide by 2. 8 + 1 is 9 so this is 9 over 2 = ?. Now we can divide. I do that off to the side 9 divided by 2. My answer is 4 and a half equals question mark. There are two big ideas here. First, we are thinking of the denominator of our fraction as division. Second, if there is more than one thing in the numerator then it is like that whole amount is in parentheses together.


$\frac{(8+1)}{2}=?$

$\frac{9}{2}=?$

$4\frac{1}{2}=?$


$2\overline{)9}$ $4\frac{1}{2}$

-8

1

Let's Talk (Slide 4): Now, this has already come up, and we've discussed it in earlier lessons too. But it is worth reviewing. "We work backwards from Order of Operations to solve equations." So, instead of doing what is inside the parentheses first, we work backwards from what is outside the parentheses first. Instead of doing multiplication and division first then addition and subtraction, we work backwards from the addition and subtraction first then multiplication and division. Now, this question is asking, "How are the equations below different? How do we solve them differently?" And that's super important to think about because they look kind of the same. They have all the same digits. But in the first equation, we just have x over 2 then we add 1.

$\frac{x}{2}+1=12$ $\quad$ $\frac{(x+1)}{2}=12$

But in the second equation, we have all of this, x + 1, over 2. To help myself, I am going to put parentheses around that part. That helps me see that it is together over 2.

$$\frac{x}{2}+1=12$$
$$-1 \quad -1$$
$$\frac{x}{2}=11$$
$$\cdot 2 \quad \cdot 2$$
$$\boxed{x=22}$$

Now, let's work backwards from PEMDAS to solve. When we are working backwards, we look at the addition and subtraction first so I will do minus 1 on both sides. That gives me x over 2 equals 11. It looks like we have this denominator of 2 left. But if we think of it as dividing by 2 then it is easy to do the opposite operation. I am going to multiply by 2 on this side so I have to multiply by 2 on this side. I get x = 22. Great!

$$\frac{(x+1)}{2}=12$$
$$\cdot 2 \quad \cdot 2$$
$$x+1=24$$
$$-1 \quad -1$$
$$\boxed{x=23}$$

This next problem is different. Since I have x + 1 together over the 2, I can't just subtract 1 away. I have to deal with this denominator first. That's why putting parentheses is nice. It helps me see that I have to deal with this part outside the parentheses first when I'm working backwards. So, I will multiply each side times 2. That leaves me with x + 1 = 24.

Now I subtract 1 from both sides and I get x = 23. Parentheses were really helpful here. And if we are working backwards from Order of Operations to solve then we have to work on the part outside the parentheses first.

Let's Think (Slide 5): Let's take this one step further with some other fractional representations. This says, "To cancel out multiplication by a fraction, we can multiply by the reciprocal." Now, that is when we are thinking of the fraction as a fraction instead of a dividing number. But let's see where this comes up. In this first equation, the fraction is going to be multiplied times x and x only. So we just work backwards starting with the addition. I will subtract 4 from each side. We get 2 thirds x equals 2. This is where the reciprocal comes in. To cancel out that 2 thirds, we will multiply by 3 over 2 on both sides. Just to convince you this works, 3 x 2 makes 6 in the numerator and 2 x 3 makes 6 in the denominator. That's 6 over 6 which is just 1. In other words we just have x on this side. 2 x 3 is 6 divided by 2 is 3. Our answer is x = 3.

$$\frac{2}{3}x+4=6$$
$$-4 \quad -4$$
$$\frac{3}{2}\cdot\frac{2}{3}x=2\cdot\frac{3}{2}$$
$$x=\frac{6}{2}$$
$$\boxed{x=3}$$

$$\frac{3}{2}\cdot\frac{2}{3}(x+4)=6\cdot\frac{3}{2}$$
$$x+4=\frac{18}{2}$$
$$x+4=9$$
$$-4 \quad -4$$
$$\boxed{x=5}$$

Now, for the next problem, x + 4 is together in parentheses. When we work backwards, we have to take care of this 2 thirds first. That is the part outside the parentheses. I will multiply this whole thing by the reciprocal 3 over 2 on both sides. We know that cancels out on the left and we are left with x + 4. On the right, 6 x 3 is 18 divided by 2 is 9. We get x + 4 = 9. I subtract 4 from both sides. I get x = 5. We don't get the same answer because with parentheses, this is a totally different problem.

$$\frac{(2x+4)}{3}=6$$
$$\cdot 3 \quad \cdot 3$$
$$2x+4=18$$
$$-4 \quad -4$$
$$\frac{2x}{2}=\frac{14}{2}$$
$$\boxed{x=7}$$

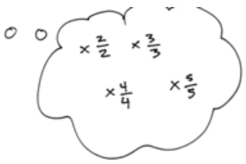
Final problem! We still have a 2 and a 3 kind of. But now they are broken up. Remember that we said we'd think of this whole amount in the numerator as if it is in parentheses. So to work backwards, I will multiply by 3 on each side. I get 2x + 4 = 18. I will subtract 4 on both sides. I get 2x = 14. I divide by 2 on both sides and I get x = 7. Again, it is a totally different problem because the parentheses were in a different spot and sometimes we think of the denominator as part of a fraction and we cancel with the reciprocal. Sometimes we think of the denominator as a dividing number and we cancel by multiplying.

Let's Think (Slide 6): Now we have one more fraction complication we will need to master to be super systems of equations solvers. This says, "Sometimes we will need to create common denominators to combine like terms." So for example, in this problem. We have a denominator of 3 for just a section of the expression. I can't get rid of it by multiplying the whole thing by 3. At least not until I get rid of the 2x that is outside all that over here. *Circle the 2x.*

$$\enclose{circle}{2x} + \frac{5x-4}{3} = 6$$

This is going to get a bit complicated! First, I want to remind you of something that you probably first started hearing about in like 3rd grade. *Draw a thought bubble to the side.* We know we can multiply the top and the bottom of a fraction by the same number and get an equivalent form. That means it is the same value just written a different way. 1 half times 2 over 2 is 2 fourths, which is still the same. We can multiply any number times 2 over 2 or times 3 over 3 or times 4 over 4. *Write those examples in the thought bubble.*

$$\enclose{circle}{2x} + \frac{5x-4}{3} = 6$$



For this problem, it would be super nice if this 2x had a denominator of 3. Because I can add things with like denominators. So, I am going to multiply 2x times 3 over 3. Now, I'm not going to do that to both sides of the equation because I'm not working backwards yet. I'm just writing the fraction in an equivalent form. It's like if I were changing 1 + 4 into 5. Or 2 x 1 into 2. When I do this I get 6x over 3 plus the rest of the expression equals 6.

$$\frac{3}{3}\cdot\enclose{circle}{2x} + \frac{5x-4}{3} = 6$$

$$\frac{6x}{3} + \frac{5x-4}{3} = 6$$

And now I can finally combine like terms and make the equation look like something that we know how to solve. First, I will add these fractions. I get 6x + 5x - 4 over 3 equals 6.

$$\frac{3}{3}\cdot\enclose{circle}{2x} + \frac{5x-4}{3} = 6$$

$$\frac{6x}{3} + \frac{5x-4}{3} = 6$$

$$\frac{6x+5x-4}{3} = 6$$

Now, finally, I can multiply by 3 on each side. I get 6x + 5x - 4 equals 18. I will combine 6x and 5x. I get 11x - 4 equals 18. I will add 4 to both sides. 11x = 22. I divide by 11 on both sides. I get x = 2.

$$\frac{3}{3}\cdot\enclose{circle}{2x} + \frac{5x-4}{3} = 6$$

$$\frac{6x}{3} + \frac{5x-4}{3} = 6$$

$$\begin{aligned} \frac{6x+5x-4}{3} &= 6 \\ \cdot 3 \quad &\quad \cdot 3 \\ 6x+5x-4 &= 18 \\ 11x-4 &= 18 \\ +4 \quad &\quad +4 \\ \frac{11x}{11} &= \frac{22}{11} \\ \boxed{x=2} \end{aligned}$$

Let's Try It (Slide 7): Let's solve some equations with fractions together. I will walk you through each step.

WARM WELCOME

Today we will solve equations with fractions.

Let's Review:

Order of operations is the foundation for solving expressions.

How are the equations below different? How do we solve them differently?

$$\frac{8}{2} + 1 =? \qquad \frac{8+1}{2} =?$$

Let's Talk:

We work backwards from Order of Operations to solve equations.

How are the equations below different? How do we solve them differently?

$$\frac{x}{2} + 1 = 12 \qquad \frac{x+1}{2} = 12$$

Let's Think:

To cancel out multiplication by a fraction, we can multiply by the reciprocal.

Solve for x.

$$\frac{2}{3}x + 4 = 6 \qquad \frac{2}{3}(x + 4) = 6 \qquad \frac{2x + 4}{3} = 6$$

Let's Think:

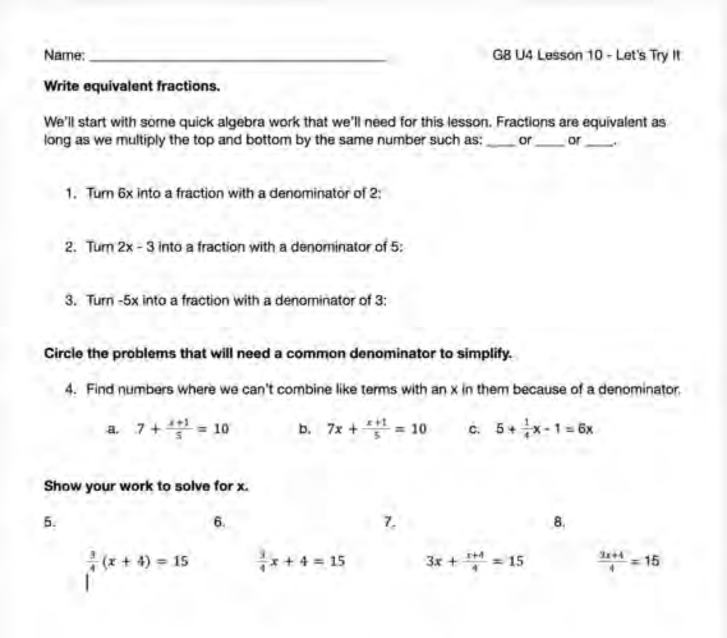
Sometimes we will need to create common denominators to combine like terms.

Solve for x.

$$2x + \frac{5x - 4}{3} = 6$$

Let’s Try It:

Let’s solve some equations with fractions together!



Name: ______________________________ G8 U4 Lesson 10 - Let’s Try It

Write equivalent fractions.

We’ll start with some quick algebra work that we’ll need for this lesson. Fractions are equivalent as long as we multiply the top and bottom by the same number such as: ____ or ____ or ____.

1. Turn 6x into a fraction with a denominator of 2:
2. Turn 2x - 3 into a fraction with a denominator of 5:
3. Turn -5x into a fraction with a denominator of 3:

Circle the problems that will need a common denominator to simplify.

4. Find numbers where we can’t combine like terms with an x in them because of a denominator.

a. $7 + \frac{x+1}{5} = 10$ b. $7x + \frac{x+1}{5} = 10$ c. $5 + \frac{1}{4}x - 1 = 6x$

Show your work to solve for x.

5. $\frac{3}{4}(x + 4) = 15$

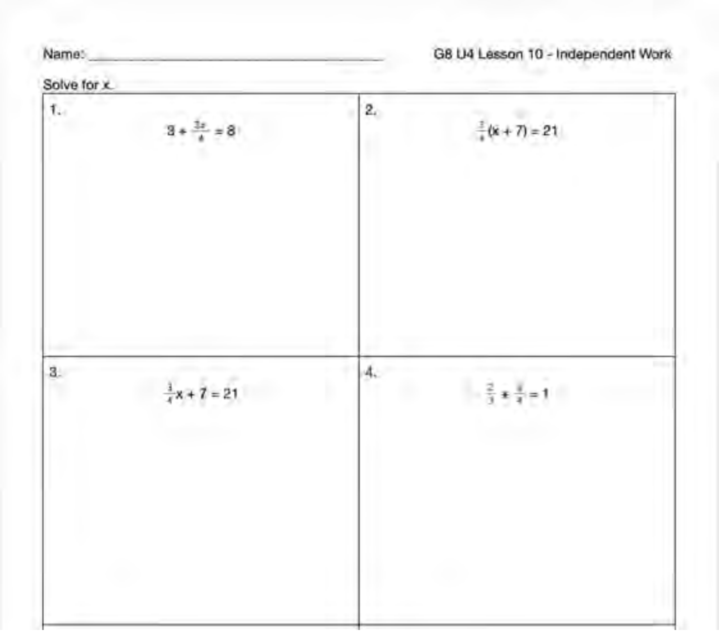
6. $\frac{3}{4}x + 4 = 15$

7. $3x + \frac{x+4}{4} = 15$

8. $\frac{3x+4}{4} = 15$

On your Own:

Now it’s time for you to do it on your own!



Name: ______________________________ G8 U4 Lesson 10 - Independent Work

Solve for x.

1. $3 + \frac{3x}{4} = 8$	2. $\frac{3}{4}(x + 7) = 21$
3. $\frac{3}{4}x + 7 = 21$	4. $\frac{2}{3} + \frac{x}{4} = 1$

Write equivalent fractions.

We'll start with some quick algebra work that we'll need for this lesson. Fractions are equivalent as long as we multiply the top and bottom by the same number such as: ____ or ____ or ____.

1. Turn 6x into a fraction with a denominator of 2:
2. Turn 2x - 3 into a fraction with a denominator of 5:
3. Turn -5x into a fraction with a denominator of 3:

Find the problems that will need a common denominator to simplify.

4. Circle the equations where we can't combine like terms with an x in them because of a denominator.

a. $7 + \frac{x+1}{5} = 10$ b. $7x + \frac{x+1}{5} = 10$ c. $5 + \frac{1}{4}x - 1 = 6x$

Show your work to solve for x.

5. $\frac{3}{4}(x + 4) = 15$

6. $\frac{3}{4}x + 4 = 15$

7. $3x + \frac{x+4}{4} = 15$

8. $\frac{3x+4}{4} = 15$

Name: ____

Solve for x.

1. $3 + \frac{2x}{4} = 8$

2. $\frac{3}{4}(x + 7) = 21$

3. $\frac{3}{4}x + 7 = 21$

4. $\frac{2}{3} + \frac{x}{4} = 1$

5. $\frac{2x+3}{6} = 5$

6. $(4 - 2x)\frac{4}{5} = 8$

Solve for x.

7.

$$3x + \frac{2x - 2}{4} = 8$$

8.

$$3 + \frac{2x-2}{4} = 8$$

9.

$$\frac{x + 1}{4} + 2x = 7$$

10.

$$4\left(\frac{2x-2}{4} + x\right) = 8$$

11.

$$\frac{3}{4}(4x + 7) + x = 2$$

12.

$$\frac{1}{4}x + 6 + 4x = 5x$$

Name: ANSWER KEY

G8 U4 Lesson 10 - Let's Try It

Write equivalent fractions.

We'll start with some quick algebra work that we'll need for this lesson. Fractions are equivalent as long as we multiply the top and bottom by the same number such as: $\frac{2}{2}$ or $\frac{3}{3}$ or $\frac{4}{4}$.

1. Turn 6x into a fraction with a denominator of 2: $(6x)\times\frac{2}{2}=\frac{12x}{2}$
2. Turn 2x - 3 into a fraction with a denominator of 5: $(2x-3)\cdot\frac{5}{5}=\frac{10x-15}{5}$
3. Turn -5x into a fraction with a denominator of 3: $(-5x)\cdot\frac{3}{3}=\frac{-15x}{3}$

Find the problems that will need a common denominator to simplify.

4. Circle the equations where we can't combine like terms with an x in them because of a denominator.

a. $7+\frac{x+1}{5}=10$ [✓ b. $7x+\frac{x+1}{5}=10$] c. $5+\frac{1}{4}x-1=6x$

Show your work to solve for x.

5.

$\frac{4}{3}\cdot\frac{3}{4}(x+4)=15\cdot\frac{4}{3}$

$x+4=\frac{60}{3}$

$x+4=20$

$-4\quad -4$

$\boxed{x=16}$

6.

$\frac{3}{4}x+4=15$

$-4\quad -4$

$\frac{4}{3}\cdot\frac{3}{4}x=11\cdot\frac{4}{3}$

$x=\frac{44}{3}$

$\boxed{x=16\frac{2}{3}}$

$16\frac{2}{3}$

$3\overline{)44}$

-3

14

-12

2

7.

$\frac{4}{4}\cdot 3x+\frac{x+4}{4}=15$

$\frac{12x}{4}+\frac{x+4}{4}=15$

$\frac{12x+x+4}{4}=15$

$\cdot 4\quad \cdot 4$

$12x+x+4=60$

$13x+4=60$

$-4\quad -4$

$13x=56$

$\boxed{x=4\frac{4}{13}}$

04

$13\overline{)56}$

52

4

8.

$\frac{3x+4}{4}=15$

$\cdot 4\quad \cdot 4$

$3x+4=60$

$-4\quad -4$

$3x=54$

$\boxed{x=18}$

18

$3\overline{)54}$

-3

24

-24

00

Name: ANSWER KEY

G8 U4 Lesson 10 - Independent Work

Solve for x.

1.

$$3 + \frac{2x}{4} = 8$$

$$-3 \qquad -3$$

$$\frac{2x}{4} = 5$$

$$\cdot 4 \qquad \cdot 4$$

$$\frac{2x}{2} = \frac{20}{2}$$

$$\boxed{x = 10}$$

2.

$$\frac{4}{3} \cdot \frac{3}{4}(x + 7) = 21 \cdot \frac{4}{3}$$

$$x + 7 = \frac{84}{3}$$

$$x + 7 = 28$$

$$-7 \qquad -7$$

$$\boxed{x = 21}$$

$$\begin{array}{r} 28 \\ 3\overline{)84} \\ -6 \\ \hline 24 \\ -24 \\ \hline 00 \end{array}$$

3.

$$\frac{3}{4}x + 7 = 21$$

$$-7 \qquad -7$$

$$\frac{4}{3} \cdot \frac{3}{4}x = 14 \cdot \frac{4}{3}$$

$$x = \frac{56}{3}$$

$$\boxed{x = 18\frac{2}{3}}$$

$$\begin{array}{r} 18 \\ 3\overline{)56} \\ -3\downarrow \\ \hline 26 \\ -24 \\ \hline 2 \end{array}$$

4.

$$\frac{2}{3} + \frac{x}{4} = 1$$

$$-\frac{2}{3} \qquad -\frac{2}{3}$$

$$4 \cdot \frac{x}{4} = \frac{1}{3} \cdot 4$$

$$x = \frac{4}{3}$$

$$\boxed{x = 1\frac{1}{3}}$$

5.

$$\frac{2x+3}{6} = 5$$

$$\cdot 6 \qquad \cdot 6$$

$$2x + 3 = 30$$

$$-3 \qquad -3$$

$$\frac{2x}{2} = \frac{27}{2}$$

$$\boxed{x = 13\frac{1}{2}}$$

6.

$$(4 - 2x)\frac{4}{5} = 8$$

$$\cdot \frac{5}{4} \qquad \cdot \frac{5}{4}$$

$$4 - 2x = \frac{40}{4}$$

$$4 - 2x = 10$$

$$-4 \qquad -4$$

$$\frac{-2x}{-2} = \frac{6}{-2}$$

$$\boxed{x = -3}$$

Solve for x.

7.

$$\frac{4}{4} \cdot 3x + \frac{2x-2}{4} = 8$$

$$\frac{12x}{4} + \frac{2x-2}{4} = 8$$

$$\frac{12x+2x-2}{4} = 8$$

$$\cdot 4 \qquad \cdot 4$$

$$12x + 2x - 2 = 32$$

$$14x \underset{+2}{-2} = \underset{+2}{32}$$

$$\frac{14x}{14} = \frac{34}{14} \qquad \boxed{x = 2\frac{6}{14}}$$

8.

$$3 + \frac{2x-2}{4} = 8$$

$$-3 \qquad -3$$

$$\frac{2x-2}{4} = 5$$

$$\cdot 4 \qquad \cdot 4$$

$$2x - 2 = 20$$

$$+2 \qquad +2$$

$$\frac{2x}{2} = \frac{22}{2}$$

$$\boxed{x = 11}$$

9.

$$\frac{x+1}{4} + 2x \cdot \frac{4}{4} 7$$

$$\frac{x+1}{4} + \frac{8x}{4} = 7$$

$$\frac{9x+1}{4} = 7$$

$$\cdot 4 \qquad \cdot 4$$

$$9x \underset{-1}{+1} = \underset{-1}{28}$$

$$\frac{9x}{9} = \frac{27}{9}$$

$$\boxed{x = 3}$$

10.

$$4\left(\frac{2x-2}{4} + x\right) = 8$$

$$\frac{8x-8}{4} + 4x \cdot \frac{4}{4} = 8$$

$$\frac{8x-8}{4} + \frac{16x}{4} = 8$$

$$4 \cdot \frac{24x-8}{4} = 8 \cdot 4$$

$$24x \underset{+8}{-8} = \underset{+8}{32}$$

$$\frac{24x}{24} = \frac{40}{24}$$

$$x = 1\frac{16}{24} \longrightarrow \boxed{1\frac{2}{3} = x}$$

11.

$$\frac{3}{4}(4x + 7) + x = 2$$

$$\frac{12x+21}{4} + x \cdot \frac{4}{4} = 2$$

$$\frac{12x+21}{4} + \frac{4x}{4} = 2$$

$$4 \cdot \frac{16x+21}{4} = 2 \cdot 4$$

$$16x + 21 = 8$$

$$-21 \qquad -21$$

$$\frac{16x}{16} = \frac{-13}{16} \qquad \boxed{x = -\frac{13}{16}}$$

12.

$$\frac{1}{4}x + 6 + 4x = 5x$$

$$4\frac{1}{4}x + 6 = 5\cancel{x}$$

$$-4\frac{1}{4}x \qquad -4\frac{1}{4}x$$

$$\frac{4}{3} \cdot 6 = \frac{3}{4}x \cdot \frac{4}{3}$$

$$\frac{24}{3} = x$$

$$\boxed{8 = x}$$

G8 U4 Lesson 11
Find the solution for a system of equations using substitution.

CITYTUTOR DC

G8 U4 Lesson 11 - Today we will find the solution for a system of equations using substitution.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will find the solution for a system of equations using substitution. There's one big idea we will need to understand and then we're just using the skills we already have. So you're going to do great! Let's get started!

$$
\begin{aligned}
15x + 90 &= 10x + 105 \\
-90 \quad & \quad -90 \\
15x &= 10x + 15 \\
-10x \quad & \quad -10x \\
5x &= 15 \\
\tfrac{5x}{5} &= \tfrac{15}{5} \\
\boxed{x = 3}
\end{aligned}
$$

Let's Review (Slide 3): In our last lesson, we learned that we can set expressions equal to each other to solve a system. Read the problem silently along with me in your head while I read the problem out loud. *Read the problem.* How can I set up an equation to solve this system? Possible Student Answers, Key Points:

- Put one expression equal to the other.
- Write 15x + 90 = 10x + 105

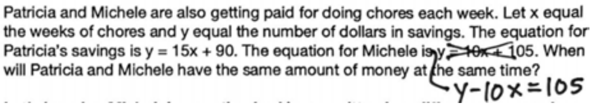
Both of these equations are already written equal to y. So we can just put one y expression to the other y expression. I will write 15x + 90 = 10x + 105. Now I can solve. We can subtract 90 from both sides. 15x = 10x + 15. Now I will subtract 10x from both sides. I get 5x = 15. I divide by 5 on both sides. I get x = 3.

$$
\begin{aligned}
y &= 15x + 90 \\
y &= 15(3) + 90 \\
y &= 45 + 90 \\
&\boxed{y = 135} \qquad (3,135)
\end{aligned}
$$

That's only part of my solution. Now I will use x = 3 to find the y. I will take this first equation and plug in x = 3. It is y = 15(3) + 90. 15 times 3 is 45 so it's y = 45 + 90. I can do that off to the side and I get y = 135.

My solution is (3,135), which means that when Patricia and Michele have both done 3 weeks of chores then they will both have 145 dollars. Now we are going to take this exact same problem and tweak it a little on the next slide.

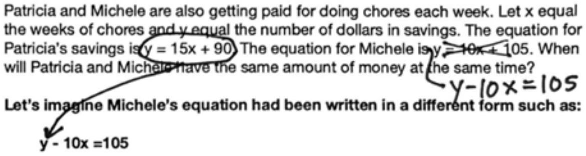
Let's Talk (Slide 4): This says, "We can also use substitution to solve algebraically." I will show you what this means. We have the exact same story as before. But then it says, "Let's imagine Michele's equation had been written in a different form such as: y - 10x =100." Imagine this other equation for Michele wasn't given to us. *Cross out y =10x + 105 in the story problem.*



Patricia and Michele are also getting paid for doing chores each week. Let x equal the weeks of chores and y equal the number of dollars in savings. The equation for Patricia's savings is y = 15x + 90. The equation for Michele is y ~~= 10x +~~ 105. When will Patricia and Michele have the same amount of money at the same time?

y-10x=105

Even though it's not obvious that we can just set these expressions equal to each other, we still know that whatever we got for y in the equation could be plugged in for y in the other equation. For example, if y = 2 for this equation… *Point to Patricia's equation.* …then we can plug in y = 2 for this equation. *Point to Michele's equation.* Well, we don't have anything nice and simple like y = 2. But we can still plug in what we know y equals from one equation into the other equation. That is called substitution because we are going to substitute the y. Let me show you what I mean. I am going to put in what I know y equals, which is right here. *Circle the expression 15x + 90 and draw an error to the y in the other equation.* I am going to substitute this y right here.



Patricia and Michele are also getting paid for doing chores each week. Let x equal the weeks of chores and y equal the number of dollars in savings. The equation for Patricia's savings is y = 15x + 90. The equation for Michele is y ~~= 10x +~~ 105. When will Patricia and Michele have the same amount of money at the same time?

y-10x=105

Let's imagine Michele's equation had been written in a different form such as:

y - 10x =105

$$\overset{\swarrow}{y} - 10x = 105$$

$$15x + 90 - 10 = 105$$

$$15x + 80 = 105$$

$$-80 \qquad -80$$

$$\frac{15x}{15} = \frac{45}{15}$$

$$\boxed{x = 3}$$

Let's rewrite this. Now y is 15x + 90 so we get 15x + 90 - 10x = 105. No problem! I combine like terms which are the 15x minus 10x. That's 5x + 90 = 105. I subtract 90 from both sides. That's 5x = 15. I divide by 5 on both sides and I get x = 3! That's the same answer we got on the last slide.

$$y - 10(3) = 105$$

$$y - 30 = 105$$

$$+30 \qquad +30$$

$$\boxed{y = 135}$$

I can plug it back into an equation like we did last time to find y. Let's use this second equation. It would be y - 10(3) = 105. That's the same as y - 30 = 105. I add 30 to both sides and I get y = 135. It is the same solution! It would have the same meaning! So, the big idea here is that if our equations aren't written in y = mx +b form and we can't set them equal to each other, we can use substitution instead.

Let's Think (Slide 5): Sometimes we will need to find an equivalent form of one equation before we can do substitution. Now, I will warn you - once we get to this level of Mathematics, our numbers can get really unfriendly. That is totally fine. The real secret is just to write clearly and in an organized way. I'll show you. This says, "What is the solution to the system?" I see that neither of my equations are written in y=mx+b form. And in fact, this is a really common way that equations are written. It is called standard form, where we have a multiplier of x and a multiplier of y. If we want to substitute a value of x or y, we are going to have to do some math first to find an equivalent form of one of the equations. I am going to solve this first equation for y. Let me write it over to the side of my paper: 4x + 3y = 7. Let's solve for y. I will subtract 4x from both sides. Then 3y = 7 - 4x. Now I will divide by 3 on both sides. I get y equals 7 - 4x over 3. Here are the messy numbers I was talking about. But we're not going to crunch these out. Let's leave them as they are and see how our equations work out.

$$4x + 3y = 7$$

$$-4x \qquad -4x$$

$$\frac{3y}{3} = \frac{7-4x}{3}$$

$$\boxed{y = \frac{7-4x}{3}}$$

$$3x + 5y = 8$$

$$3x + 5\left(\frac{7-4x}{3}\right) = 8$$

Now that we have a "y equals equation" we can substitute. Let me write the other equation to the side to give myself a guide. I will keep 3x plus. But now when I substitute y, I am going to need parentheses so that it is 5 times the whole amount. I will write 5 times "7 - 4x over 3" in parentheses equals 8.

$$3x + 5y = 8$$

$$3x + 5\left(\frac{7-4x}{3}\right) = 8$$

$$3x + \frac{35-20x}{3} = 8$$

Again, this is not that friendly-looking. First, let's distribute the 5. I get 3x + (35 - 20x) over 3 equals 8. You know distribution so this is not a big deal.

$$3x + 5y = 8$$

$$3x + 5\left(\frac{7-4x}{3}\right) = 8$$

$$\frac{3}{3} \cdot 3x + \frac{35-20x}{3} = 8$$

$$\frac{9x}{3} + \frac{35-20x}{3} = 8$$

Now normally, our next step would be to combine like terms. But that is hard because we have this fraction with a denominator of 3. This is the only really new algebra we are going to do that you haven't done before. I am going to turn 3x into a fraction with a denominator of 3 so I can add it to this other fraction. It might look complicated by it is actually really simple. For fractions, we always multiply the top and bottom by the same number. So I am going to multiply 3x times 3 over 3. That gives me 9x over 3.

$$3x+5y=8$$
$$3x+5\left(\frac{7-4x}{3}\right)=8$$
$$\frac{3}{3}\cdot 3x+\frac{35-20x}{3}=8$$
$$\frac{9x}{3}+\frac{35-20x}{3}=8$$

If I put that in my equation then I have 9x over 3 plus 35 minus 20x over 3 equals 8. I can put that altogether now that they have the same denominators. So it is all of 9x plus 35 minus 20x over 3 equals 8.

$$3x+5y=8$$
$$3x+5\left(\frac{7-4x}{3}\right)=8$$
$$\frac{3}{3}\cdot 3x+\frac{35-20x}{3}=8$$
$$\frac{9x+35-20x}{3}=8$$
$$\cdot 3 \qquad \cdot 3$$
$$9x+35-20x=24$$
$$-11x+35=24$$
$$-35 \quad -35$$
$$\frac{-11x}{-11}=\frac{-11}{-11}$$
$$\boxed{x=1}$$

It is easy from here on out, I promise. We just work backwards. First, to work backwards from dividing by 3, I will multiply by 3 on each side. That gives me 9x plus 35 minus 20x equals 24. Finally I can combine like terms! 9x and negative 20x is negative 11x plus 35 equals 24. I subtract 35 from both sides and get negative 11x equals negative 11. I divide by negative 11 on both sides and get x equals 1. Isn't that crazy? We did all that algebra and eventually landed at 1. I told you that we could make this friendly!

$$4x+3y=7$$
$$4(1)+3y=7$$
$$4+3y=7$$
$$-4 \quad -4$$
$$\frac{3y}{3}=\frac{3}{3}$$
$$\boxed{y=1}$$

The final step is figuring out y. I am going to plug x = 1 into an equation. I'll start with 4x + 3y = 7. That would be 4(1) + 3y = 7. That's 4 + 3y = 7. I subtract 4 from both sides. I get 3y = 3. I divide by 3 on both sides. I get y = 1. The solution to this system is (1,1).

Let's review the steps we did here. First, I rewrote one equation so it was equal to a variable. *Point to that step. You could even label it "Step #1."* Second, I substituted that into the other equation. *Point to that step. You could even label it "Step #2."* Third, I plugged that answer into an equation to find the other variable. *Point to that step. You could even label it "Step #3."*That is what you're going to do every time you want to use substitution. Sometimes you can skip the 1st step if it is already written in a friendly way. If it is not written in a friendly way then you might have to use a little bit of equivalent fractions to make it easier to work with.

Let's Try It (Slide 6): Let's find solutions to systems of equations together. I will walk you through each step.

WARM WELCOME

Today we will find the solution for a system of equations using substitution.

Let's Review:

We can set expressions equal to each other to solve a system.

Patricia and Michele are also getting paid for doing chores each week. Let x equal the weeks of chores and y equal the number of dollars in savings. The equation for Patricia's savings is $y = 15x + 90$. The equation for Michele is $y = 10x + 105$. When will Patricia and Michele have the same amount of money at the same time?

Let's Talk:

We can also use substitution to solve algebraically.

Patricia and Michele are also getting paid for doing chores each week. Let x equal the weeks of chores and y equal the number of dollars in savings. The equation for Patricia's savings is $y = 15x + 90$. The equation for Michele is $y = 10x + 105$. When will Patricia and Michele have the same amount of money at the same time?

Let's imagine Michele's equation had been written in a different form such as:

$$y - 10x = 105$$

Let’s Think:

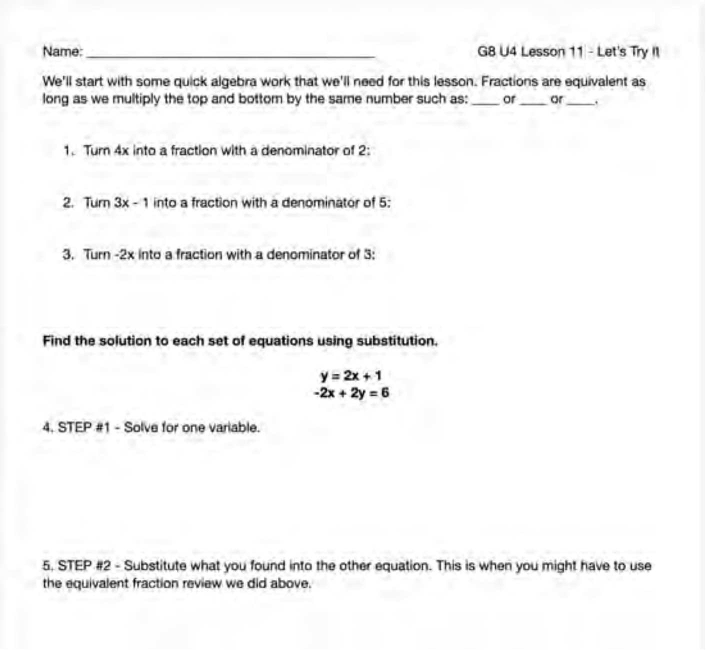
Sometimes we will need to find an equivalent form of one equation before we do substitution.

What is the solution to the system? (____, ____)

$4x + 3y = 7$
$3x + 5y = 8$

Let’s Try It:

Let’s find solutions to systems of equations together!



Name: ________________________ G8 U4 Lesson 11 - Let's Try It

We'll start with some quick algebra work that we'll need for this lesson. Fractions are equivalent as long as we multiply the top and bottom by the same number such as: ____ or ____ or ____.

1. Turn 4x into a fraction with a denominator of 2:
2. Turn 3x - 1 into a fraction with a denominator of 5:
3. Turn -2x into a fraction with a denominator of 3:

Find the solution to each set of equations using substitution.

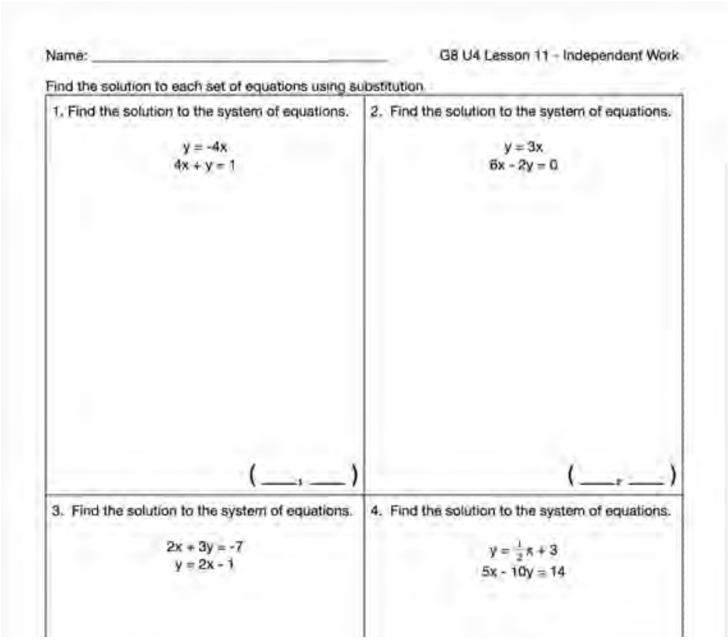
$y = 2x + 1$
$-2x + 2y = 6$

4. STEP #1 - Solve for one variable.

5. STEP #2 - Substitute what you found into the other equation. This is when you might have to use the equivalent fraction review we did above.

On your Own:

Now it’s time for you to do it on your own!



Name: ______________________________ G8 U4 Lesson 11 - Independent Work

Find the solution to each set of equations using substitution.

1. Find the solution to the system of equations.

$y = -4x$
$4x + y = 1$

(___ , ___)

2. Find the solution to the system of equations.

$y = 3x$
$6x - 2y = 0$

(___ , ___)

3. Find the solution to the system of equations.

$2x + 3y = -7$
$y = 2x - 1$

4. Find the solution to the system of equations.

$y = \frac{1}{2}x + 3$
$5x - 10y = 14$

We'll start with some quick algebra work that we'll need for this lesson. Fractions are equivalent as long as we multiply the top and bottom by the same number such as: ____ or ____ or ____.

1. Turn 4x into a fraction with a denominator of 2:

2. Turn 3x - 1 into a fraction with a denominator of 5:

3. Turn -2x into a fraction with a denominator of 3:

Find the solution to each set of equations using substitution.

$$y = 2x + 1$$
$$-2x + 2y = 6$$

4. STEP #1 - Solve for one variable.

5. STEP #2 - Substitute what you found into the other equation. This is when you might have to use the equivalent fraction review we did above.

6. STEP #3 - Use what you got in #2 to find the other variable by putting it into an equation.

Find the solution to each set of equations using substitution.

$$7x - 8y = -12$$
$$-4x + 2y = 3$$

4. STEP #1 - Solve for one variable.

5. STEP #2 - Substitute what you found into the other equation. This is when you might have to use the equivalent fraction review we did above.

6. STEP #3 - Use what you got in #2 to find the other variable by putting it into an equation.

Find the solution to each set of equations using substitution.

1. Find the solution to the system of equations.

$$y = 4x$$
$$4x + y = 1$$

(___, ___)

2. Find the solution to the system of equations.

$$y = 3x$$
$$6x + 2y = 0$$

(___, ___)

3. Find the solution to the system of equations.

$$2x + 3y = -7$$
$$y = 2x - 1$$

(___, ___)

4. Find the solution to the system of equations.

$$y = \frac{1}{2}x + 3$$
$$11x + 10y = 14$$

(___, ___)

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

$x - 3y = -9$
$2x + 7y = 8$

(___, ___)

6. Find the solution to the system of equations.

$4x + 2y = 8$
$8x - y = 1$

(___, ___)

7. Find the solution to the system of equations.

$2x + y = -4$
$3x - 2y = -6$

(___, ___)

8. Find the solution to the system of equations.

$6x - 8y = 5$
$12x + 10y = 23$

(___, ___)

Name: ANSWER KEY

We'll start with some quick algebra work that we'll need for this lesson. Fractions are equivalent as long as we multiply the top and bottom by the same number such as: $\frac{2}{2}$ or $\frac{5}{5}$ or $\frac{3}{3}$.

1. Turn 4x into a fraction with a denominator of 2: $4x \times \frac{2}{2} = \frac{8x}{2}$
2. Turn 3x - 1 into a fraction with a denominator of 5: $3x-1 \times \frac{5}{5} = \frac{15x-5}{5}$
3. Turn -2x into a fraction with a denominator of 3: $-2x \times \frac{3}{3} = \frac{-6x}{3}$

Find the solution to each set of equations using substitution.

$y = 2x + 1$
$-2x + 2y = 6$

4. STEP #1 - Solve for one variable.

We can skip this because we have $y=2x+1$.

5. STEP #2 - Substitute what you found into the other equation. This is when you might have to use the equivalent fraction review we did above.

$$-2x + 2y = 6$$
$$-2x + 2(2x+1) = 6$$
$$-2x + 4x + 2 = 6$$
$$2x \underset{-2}{+2} = \underset{-2}{6}$$

$$\frac{2x}{2} = \frac{4}{2}$$
$$\boxed{x=2}$$

6. STEP #3 - Use what you got in #2 to find the other variable by putting it into an equation.

$$-2x + 2y = 6$$
$$-2(2) + 2y = 6$$
$$\underset{+4}{-4} + 2y = \underset{+4}{6}$$
$$\frac{2y}{2} = \frac{10}{2}$$
$$\boxed{y=5}$$

Find the solution to each set of equations using substitution.

7x - 8y = -12
-4x + 2y = 3

4. STEP #1 - Solve for one variable.

$$7x - 8y = -12$$
$$-7x \qquad -7x$$
$$\frac{-8y}{-8} = \frac{-12 - 7x}{-8}$$
$$y = \frac{-12 - 7x}{-8}$$

5. STEP #2 - Substitute what you found into the other equation. This is when you might have to use the equivalent fraction review we did above.

$$-4x + 2\left(\frac{-12 - 7x}{-8}\right) = 3$$
$$\frac{-8}{-8} \times {}^{-}4x + \frac{-24 - 14x}{-8} = 3$$
$$\frac{32x}{-8} + \frac{-24 - 14x}{-8} = 3$$

$$\frac{32x - 24 - 14x}{-8} = 3$$
$$\times -8 \qquad \times -8$$
$$32x - 24 - 14x = -24$$
$$+24 \qquad +24$$
$$32x - 14x = 0$$
$$\frac{18x}{18} = \frac{0}{18} \qquad \boxed{x = 0}$$

6. STEP #3 - Use what you got in #2 to find the other variable by putting it into an equation.

$$-4x + 2y = 3$$
$$-4(0) + 2y = 3$$
$$0 + \frac{2y}{2} = \frac{3}{2}$$
$$\boxed{y = 1\tfrac{1}{2}}$$

Name: ANSWER KEY

G8 U4 Lesson 11 - Independent Work

Find the solution to each set of equations using substitution.

1. Find the solution to the system of equations.

$$y = 4x$$
$$4x + y = 1$$

#2

$4x + 4x = 1$

$\frac{8x}{8} = \frac{1}{8}$

$\boxed{x = \frac{1}{8}}$

#3

$y = 4x$

$y = 4\left(\frac{1}{8}\right)$

$y = \frac{4 \div 4}{8 \div 4}$

$\boxed{y = \frac{1}{2}}$

$\left(\underline{\frac{1}{8}}, \underline{\frac{1}{2}} \right)$

2. Find the solution to the system of equations.

$$y = 3x$$
$$6x + 2y = 0$$

#2

$6x + 2(3x) = 0$

$6x + 6x = 0$

$\frac{12x}{12} = \frac{0}{12}$

$\boxed{x = 0}$

#3

$y = 3(0)$

$\boxed{y = 0}$

$\left(\underline{0}, \underline{0} \right)$

3. Find the solution to the system of equations.

$$2x + 3y = -7$$
$$y = 2x - 1$$

#2

$2x + 3(2x - 1) = -7$

$2x + 6x - 3 = -7$

$8x - 3 = -7$
$\quad +3 \quad\; +3$

$\frac{8x}{8} = -\frac{4 \div 4}{8 \div 4}$

$\boxed{x = -\frac{1}{2}}$

#3

$y = 2\left(-\frac{1}{2}\right) - 1$

$y = -1 - 1$

$\boxed{y = -2}$

$\left(\underline{-\frac{1}{2}}, \underline{-2} \right)$

4. Find the solution to the system of equations.

$$y = \frac{1}{2}x + 3$$
$$11 + 10y = 14$$

#2

$11x + 10\left(\frac{1}{2}x + 3\right) = 14$

$11x + 5x + 30 = 14$

$16x + 30 = 14$
$\quad -30 \quad -30$

$\frac{16x}{16} = \frac{-16}{16}$

$\boxed{x = -1}$

#3

$y = \frac{1}{2}(-1) + 3$

$y = -\frac{1}{2} + 3$

$\boxed{y = 2\frac{1}{2}}$

$\left(\underline{-1}, \underline{2\frac{1}{2}} \right)$

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

x - 3y = -9
2x + 7y = 8

#1

$x - 3y = -9$
$-x \quad -x$
$\frac{-3y}{-3} = \frac{-9 - x}{-3}$
$y = \frac{-9 - x}{-3}$

#2

$2x + 7y = 8$
$2x + 7\left(\frac{-9-x}{-3}\right) = 8$
$2x + \frac{-63 - 7x}{-3} = 8$
$\frac{-3x}{-3}$
$\frac{-6x}{-3} + \frac{-63-7x}{-3} = 8$
$\frac{-6x - 63 - 7x}{-3} = 8$
$\cdot -3 \quad \cdot -3$
$-13x - 63 = -24$
$+63 \quad +63$
$\frac{-13x}{-13} = \frac{39}{-13}$
$\boxed{x = -3}$

#3

$x - 3y = -9$
$-3 - 3y = -9$
$+3 \quad +3$
$\frac{-3y}{-3} = \frac{-6}{-3}$
$\boxed{y = 2}$

(-3 , 2)

6. Find the solution to the system of equations.

4x + 2y = 8
8x - y = 1

#1

$8x - y = 1$
$-8x \quad -8x$
$\frac{-y}{-1} = \frac{1 - 8x}{-1}$
$y = -1 + 8x$

#3

#2

$4x + 2y = 8$
$4x + 2(-1 + 8x) = 8$
$4x - 2 + 16x = 8$
$+2 \quad +2$
$\frac{20x}{20} = \frac{10}{20}$
$\boxed{x = \frac{1}{2}}$

#3

$8\left(\frac{1}{2}\right) - y = 1$
$4 - y = 1$
$-4 \quad -4$
$\frac{-y}{-1} = \frac{-3}{-1}$
$\boxed{y = 3}$

($\frac{1}{2}$, 3)

7. Find the solution to the system of equations.

2x + y = -4
3x - 2y = -6

#1

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

#2

$3x - 2y = -6$
$3x - 2(-4 - 2x) = 6$
$3x + 8 + 4x = 6$
$7x + 8 = -6$
$-8 \quad -8$
$\frac{7x}{7} = \frac{-14}{7}$
$\boxed{x = -2}$

#3

$2(-2) + y = -4$
$-4 + y = -4$
$+4 \quad +4$
$\boxed{y = 0}$

(-2 , 0)

8. Find the solution to the system of equations.

6x - 8y = 5
12x + 10y = 23

#1

$6x - 8y = 5$
$-6x \quad -6x$
$\frac{-8y}{-8} = \frac{5 - 6x}{-8}$
$y = \frac{5 - 6x}{-8}$

#3

$12x + 10\left(\frac{5-6x}{-8}\right) = 23$
$\frac{-8}{-8} \cdot 12x + \frac{50 - 60x}{-8} = 23$
$\frac{-96}{-8}x + \frac{50 - 60x}{-8} = 23$
$\frac{-96x + 50 - 60x}{-8} = 23$
$\cdot -8 \quad \cdot -8$
$-96x + 50 - 60x = -184$
$-156x + 50 = -184$
$-50 \quad -50$
$\frac{-156x}{-156} = \frac{-234}{-156}$

$156\overline{)234}$ 001
-156
78

$\boxed{1\frac{78}{156} = x}$

#3

$6\left(1\frac{1}{2}\right) - 8y = 5$
$9 - 8y = 5$
$-9 \quad -9$
$\frac{-8y}{-8} = \frac{-4}{-8}$
$\boxed{y = \frac{1}{2}}$

($1\frac{1}{2}$, $\frac{1}{2}$)

G8 U4 Lesson 12
Find the solution for a system of equations using elimination.

G8 U4 Lesson 12 - Today we will find the solution for a system of equations using elimination.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will find the solution for a system of equations using elimination. We already know how to find a solution with substitution. But sometimes this other method will be easier. Let's go!

$$\begin{array}{l} x - y = 11 \\ \quad +y \quad +y \\ x = 11 + y \end{array}$$

Let's Review (Slide 3): We already know we can solve a system of equations by substituting the variable in one equation with information from the other equation. Read the problem silently along with me in your head while I read it out loud. *Read the problem.* Let's review substitution so we know the answer when we go to the next slide and explore the next strategy. For my first step, I solve for one of the variables. The easiest one to solve for is x - y = 11. I add y to both sides, and I get x equals 11 + y.

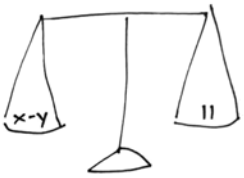
$$\begin{array}{l} 2x + y = 19 \\ 2(11+y) + y = 19 \\ 22 + 2y + y = 19 \\ 22 + 3y = 19 \\ -22 \qquad -22 \\ \frac{3y}{3} = \frac{-3}{3} \\ \boxed{y = -1} \end{array}$$

Now I can plug that value in for x. I get 2 times the whole amount of 11 + y in parentheses. That equals 19. I will need to distribute the 2. I get 22 + 2y + y =19. I can combine like terms and get 22 + 3y = 19. Then I subtract 22 from each side. I get 3y = -3. I divide by 3 on each side. That gives me y = -1.

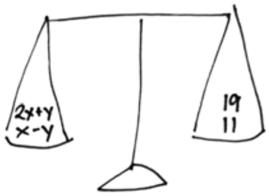
$$\begin{array}{l} 2x + y = 19 \\ 2x + (-1) = 19 \\ \quad +1 \quad +1 \\ \frac{2x}{2} = \frac{20}{2} \\ \boxed{x = 10} \end{array}$$

The final step is that I will have to plug that into an original equation. I will take 2x + y = 19. I will put -1 in place of y. To solve this problem I will add 1 to both sides. I get 2x equals 20. I divide by 2 on each side. Then I get x = 10. So the solution with substitution is (10, -1). Now I'm going to teach you elimination and we should get the same answer.

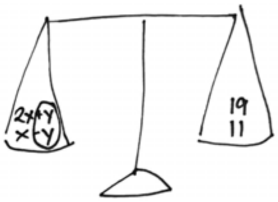
Let's Talk (Slide 4): This is what I was saying when we started, "We can also solve a system of equation using a strategy called elimination." We have the exact same problem about Rachel and John with the exact same equations that we did on our last slide. But before I show you what elimination is, I want us to agree on one idea. Over all of our units, we have talked about how the equal sign means both sides are the same. We can think of it like a balance.



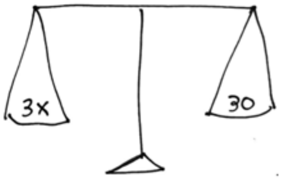
We can put one equation on the balance and the equal sign tells us it is the same on both sides.



My other equation also has an equal sign. It is also balanced. So if I put it on my balance then it will stay balanced because I am putting the same amount on each side.



What this shows us is we can add up all the left sides of the equations and all the right sides of the equations and we'll get one balanced equation. But - and this is the coolest part - sometimes parts of those equations will cancel eachother out. Like in this example, plus y and minus y cancel. So when I add these up, I get 2x plus x, which is 3x on the left. I am going to draw a new balance to show how that works. I get 3x on the left. On the right, I add 19 and 11 and I get 20.



Now I have a brand new equation, 3x = 30 and I can solve it and find x and use that to find y and so on.

$$\begin{array}{r} 2x + y = 19 \\ + \ x - y = 11 \\ \hline \dfrac{3x}{3} = \dfrac{30}{3} \\ \boxed{x = 10} \end{array}$$

Let me show you how this would look numerically. I will write down both equations with the x's and the y's and the equal signs lined up. Then I circle where it is canceling. Then I add up the rest. 2x plus x is 3x. 19 plus 11 is 30. I get 3x = 30.

Now I divide by 3 on each side. I get x = 10.

$$\begin{array}{l} 2x + y = 19 \\ 2(10) + y = 19 \\ 20 + y = 19 \\ -20 \qquad -20 \\ \boxed{y = -1} \end{array}$$

My last step is the same step we did in our last lesson with substitution. Once I know one variable, I use it to find y. Let's use 2x + y = 19. I plug in x = 10. I get 2 times 10 plus y equals 19. That's the same as 20 plus y equals 19. I subtract 20 from both sides. I get x = -1. The solution to this system is (10, -1). That the same as we got on the last slide! So it works!

Let's Think (Slide 5): The greatest thing about this new strategy is that it's simple addition. But we have one more thing to understand written here: "Sometimes we will need to multiply one or more equations to set up the cancellation." I'll show you what this means. Here we have a system of equations. If I just add these up, there isn't going to be anything that cancels. I'll get 15x plus 4y equals 54. That is impossible to solve. So I have to multiply one of these equations to turn it into something that WILL cancel. It would be nice if one of these 2y was negative, right? Then positive 2y and negative 2y will cancel. So, I am going to multiply each side of this bottom equation times -1.

$$\begin{array}{l} 7x + 2y = 24 \\ -1(8x + 2y) = (30)(-1) \end{array}$$

$$\begin{array}{l} 7x + 2y = 24 \\ -8x - 2y = -30 \end{array}$$

Then I keep 7x + 27 = 24. But my next equation becomes -8x-2y=-30.

$$\begin{array}{l} 7x + 2y = 24 \\ -8x - 2y = -30 \end{array}$$

Now I can cancel! Let me circle that part that cancels.

$$\begin{array}{rcl} 7x + 2y &=& 24 \\ -8x - 2y &=& -30 \\ \hline \frac{-1x}{-1} &=& \frac{-6}{-1} \\ && \boxed{x=6} \end{array}$$

I get -1x = -6. I will divide by -1 on both sides. I get x = 6.

$$\begin{array}{rcl} 7x + 2y &=& 24 \\ 7(6) + 2y &=& 24 \\ 42 + 2y &=& 24 \\ -42 && -42 \\ \frac{2y}{2} &=& \frac{-18}{2} \\ \boxed{y=-9} && \end{array}$$

Just like always, I plug that x into one of my original equations, and I'll get y. Let's use 7x+2y=24. I rewrite it as 7 times 6 plus 2y equals 24. That's 42 plus 2y equals 24. I will subtract 42 from each side. I get 2y equals -18. I divide by 2 on each side. I get y = -9. The solution to this system is (6,-9).

We're going to do one more. And I promise this one is as complicated as it can get. Again, I have a system of equations. If I just add these up, there isn't going to be anything that cancels. I'll get 8x minus 7y equals 12. That's impossible to solve. So I have to multiply to make this into something that will cancel. But I can't really think of anything to multiply just one equation to turn it into something that would cancel with the other. I can't multiply 3x to make negative 5x. I can't multiply -2y to make positive 5y. So, I am going to have to multiply BOTH equations. I do this by thinking of a number that I could easily make with what I have. That's called a common multiple. If I multiply each side of my top equation times negative 5, I will get negative 15x. And then I can multiply each side of my bottom equation times 3, and I will get a positive 15x. Those will cancel. I'm not writing this down yet because I just want to make sure you understand the idea. I decided to get negative 15x on top and positive 15x on the bottom so I'll have something that cancels.

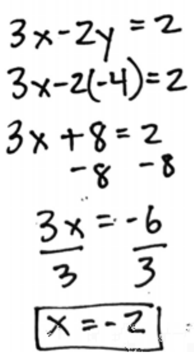
$$\begin{array}{l} \mathbf{-5}(3x - 2y) = 2(\mathbf{-5}) \\ \mathbf{3}(5x - 5y) = 10(\mathbf{3}) \end{array}$$

Let's write this out. I multiply each side of the top equation by -5. I multiply each side of the bottom equation by 3.

$$\begin{array}{rcl} -15x + 10y &=& -10 \\ 15x - 15y &=& 30 \\ \hline \frac{-5y}{-5} &=& \frac{20}{-5} \\ \boxed{y=-4} && \end{array}$$

For the top equation, that gives me -15x+10y=-10. For the bottom equation, that gives me 15x -15y = 30. Now I have something that will cancel. Let me circle -15x and 15x to show they cancel out.

That leaves me with -5y = 20. I divide by -5 on each side. I get y = –4.



$3x-2y=2$

$3x-2(-4)=2$

$3x+8=2$

$\quad -8 \quad -8$

$\frac{3x}{3}=\frac{-6}{3}$

$\boxed{x=-2}$

The final step is plugging that value in. Let’s use 3x-2y=2. I would get 3x - 2 times -4 equals 2. That simplifies to 3x + 8 = 2. I subtract 8 on both sides. I get 3x = -6. I divide by 3 on both sides. That gives me x = -2. My solution is (-2,-4).

The big idea is that we might need to multiply one or more equation to set up the cancellation we want to do to solve the system.

Let’s Try It (Slide 6): Let’s find more solutions to systems of equations together. I will walk you through each step.

WARM WELCOME

Today we will find the solution for a system of equations using elimination.

Let's Review:

We can solve a system of equations by substituting the variable in one equation with information from the other equation.

Two people use equation to represent the amount they spent on clothes in dollars, y, compared to the amount they spend on toys in dollars, x, using the equations below. Rachel uses the equation, x - y = 11. Jacob uses the equation, 2x + y = 19. What would the quantities be when Rachel and Jacob spend an equal amount on both clothes and toys?

Let's Talk:

We can also solve a system of equations using a strategy called elimination.

Two people use equation to represent the amount they spent on clothes in dollars, y, compared to the amount they spend on toys in dollars, x, using the equations below. Rachel uses the equation, x - y = 11. Jacob uses the equation, 2x + y = 19. What would the quantities be when Rachel and Jacob spend an equal amount on both clothes and toys?

Let's Think:

Sometimes we will need to multiply one or more equations to set up the cancellation.

What is the solution to the system? (____, ____)

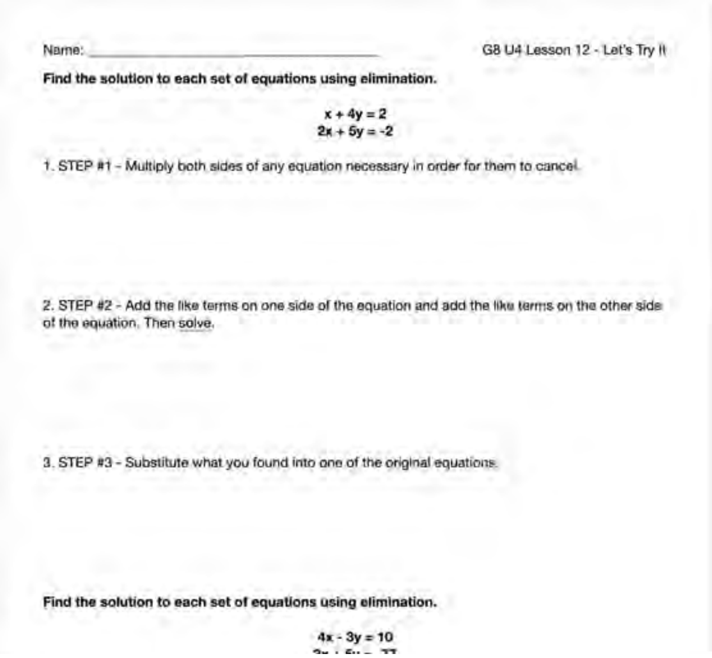
$7x + 2y = 24$
$8x + 2y = 30$

What is the solution to the system? (____, ____)

$3x - 2y = 2$
$5x - 5y = 10$

Let's Try It:

Let's find solutions to systems of equations together!



Name: ______________________

G8 U4 Lesson 12 - Let's Try It

Find the solution to each set of equations using elimination.

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

1. STEP #1 - Multiply both sides of any equation necessary in order for them to cancel.

2. STEP #2 - Add the like terms on one side of the equation and add the like terms on the other side of the equation. Then solve.

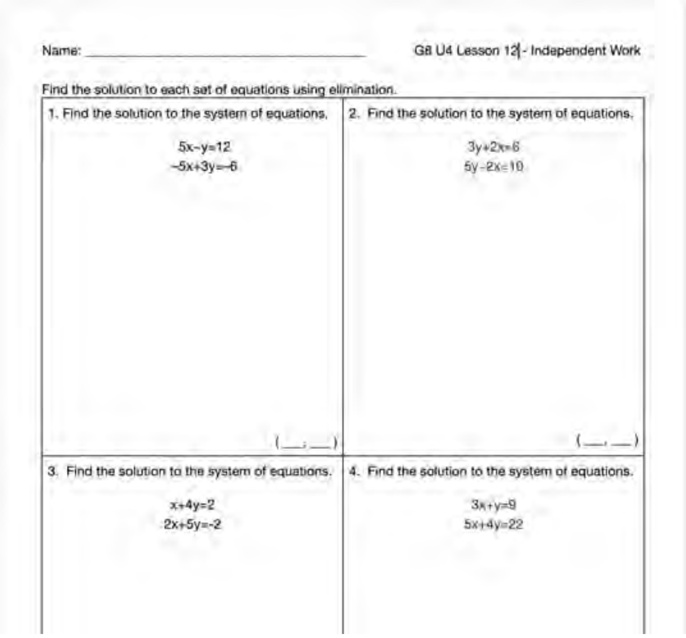
3. STEP #3 - Substitute what you found into one of the original equations.

Find the solution to each set of equations using elimination.

$4x - 3y = 10$

On your Own:

Now it’s time for you to do it on your own!



Name: ____________________

G8 U4 Lesson 12 - Independent Work

Find the solution to each set of equations using elimination.

1. Find the solution to the system of equations.

$5x-y=12$
$-5x+3y=-6$

(___; ___)

2. Find the solution to the system of equations.

$3y+2x=6$
$5y-2x=10$

(___, ___)

3. Find the solution to the system of equations.

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

4. Find the solution to the system of equations.

$3x+y=9$
$5x+4y=22$

Name: ____ G8 U4 Lesson 12 - Let's Try It

Find the solution to each set of equations using elimination.

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

1. STEP #1 - Multiply both sides of any equation necessary in order for them to cancel.

2. STEP #2 - Add the like terms on one side of the equation and add the like terms on the other side of the equation. Then solve.

3. STEP #3 - Substitute what you found into one of the original equations.

Find the solution to each set of equations using elimination.

$$4x - 3y = 10$$
$$3x + 5y = -7$$

4. STEP #1 - Multiply both sides of any equation necessary in order for them to cancel.

5. STEP #2 - Add the like terms on one side of the equation and add the like terms on the other side of the equation. Then solve.

6. STEP #3 - Substitute what you found into one of the original equations.

Name: ____ G8 U4 Lesson 12 - Independent Work

Find the solution to each set of equations using elimination.

1. Find the solution to the system of equations.

$5x-y=12$
$-5x+3y=-6$

(___, ___)

2. Find the solution to the system of equations.

$3y+2x=6$
$5y-2x=10$

(___, ___)

3. Find the solution to the system of equations.

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

(___, ___)

4. Find the solution to the system of equations.

$3x+y=9$
$5x+4y=22$

(___, ___)

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

$$2x+y=7$$
$$x-2y=6$$

(___, ___)

6. Find the solution to the system of equations.

$$4x + 2y = 8$$
$$8x - y = 1$$

(___, ___)

7. Find the solution to the system of equations.

$$3x-9y=6$$
$$2x-2y=8$$

(___, ___)

8. Find the solution to the system of equations.

$$3x+2y=12$$
$$-4x+3y=1$$

(___, ___)

Name: ANSWER KEY

Find the solution to each set of equations using elimination.

$$-2(x + 4y) = 2(-2)$$
$$2x + 5y = -2$$

1. STEP #1 - Multiply both sides of any equation necessary in order for them to cancel.

$$-2x + -8y = -4$$
$$2\cancel{x} + 5y = -2$$

2. STEP #2 - Add the like terms on one side of the equation and add the like terms on the other side of the equation. Then solve.

$$\frac{-3y}{-3} = \frac{-6}{-3}$$
$$\boxed{y = 2}$$

3. STEP #3 - Substitute what you found into one of the original equations.

$$x + 4y = 2$$
$$x + 4(2) = 2$$
$$x + 8 = 2$$
$$-8 \quad -8$$
$$\boxed{x = -6}$$

Find the solution to each set of equations using elimination.

$$3(4x - 3y) = 10(3)$$
$$-4(3x + 5y) = -7(-4)$$

4. STEP #1 - Multiply both sides of any equation necessary in order for them to cancel.

$$12x - 9y = 30$$
$$-12x - 20y = 28$$

5. STEP #2 - Add the like terms on one side of the equation and add the like terms on the other side of the equation. Then solve.

$$\frac{-29y}{-29} = \frac{58}{-29}$$

$$\boxed{y = -2}$$

6. STEP #3 - Substitute what you found into one of the original equations.

$$4x - 3y = 10$$

$$4(x) - 3(-2) = 10$$

$$4x + 6 = 10$$

$$ +6 \qquad +6$$

$$\frac{4x}{4} = \frac{16}{4}$$

$$\boxed{x = 4}$$

Name: ANSWER KEY

G8 U4 Lesson 12 - Independent Work

Find the solution to each set of equations using elimination.

1. Find the solution to the system of equations.

$$5x-y=12$$
$$-5x+3y=-6$$

$$\frac{+2y}{2}=\frac{6}{2}$$

$$\boxed{y=3}$$

$$5x-y=12$$
$$5x-3=12$$
$$+3 \quad +3$$
$$\frac{5x}{5}=\frac{15}{5}$$
$$\boxed{x=3}$$

(3, 3)

2. Find the solution to the system of equations.

$$3y+2x=6$$
$$5y-2x=10$$

$$\frac{8y}{8}=\frac{16}{8}$$

$$\boxed{y=2}$$

$$3y+2x=6$$
$$3(2)+2x=6$$
$$6+2x=6$$
$$-6 \quad -6$$
$$\frac{2x}{2}=\frac{0}{2}$$
$$\boxed{x=0}$$

(0, 2)

3. Find the solution to the system of equations.

$$-2(x+4y)=2(-2)$$
$$2x+5y=-2$$

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

$$\frac{-3y}{-3}=\frac{-6}{-3}$$

$$\boxed{y=2}$$

$$x+4y=2$$
$$x+4(2)=2$$
$$x+8=2$$
$$-8 \quad -8$$
$$\boxed{x=-6}$$

(−6, 2)

4. Find the solution to the system of equations.

$$-4(3x+y)=9(-4)$$
$$5x+4y=22$$

$$-12x-4y=-36$$
$$5x+4y=22$$

$$\frac{-7x}{-7}=\frac{-14}{-7}$$

$$\boxed{x=2}$$

$$3x+y=9$$
$$3(2)+y=9$$
$$6+y=9$$
$$-6 \quad -6$$
$$\boxed{y=3}$$

(2, 3)

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

$2x+y=7$

$-2(x-2y=6)(-2)$

$2x + y = 7$

$-2x + 4y = -12$

$\frac{5y}{-5} = \frac{-5}{-5}$

$\boxed{y=1}$

$2x + y = 7$

$2x + 1 = 7$

$-1 \quad -1$

$\frac{2x}{2} = \frac{6}{2}$

$\boxed{x=3}$

(3 , 1)

6. Find the solution to the system of equations.

$4x + 2y = 8$

$2(8x - y = (1)2$

$16x - 2y = 2$

$\frac{20x}{20} = \frac{10}{20}$

$\boxed{x=\frac{1}{2}}$

$4x + 2y = 8$

$4(\frac{1}{2}) + 2y = 8$

$2 + 2y = 8$

$-2 \quad -2$

$\frac{2y}{2} = \frac{6}{2}$

$\boxed{y=3}$

($\frac{1}{2}$, 3)

7. Find the solution to the system of equations.

$-2(3x-9y=6)(-2)$

$3(2x-2y=8(3)$

$-6x + 18y = -12$

$6x - 6y = 24$

$\frac{12y}{12} = \frac{12}{12}$

$\boxed{y=1}$

$3x - 9y = 6$

$3x - 9(1) = 6$

$3x - 9 = 6$

$+9 \quad +9$

$\frac{3x}{3} = \frac{15}{3}$ $\boxed{x=5}$

(5 , 1)

8. Find the solution to the system of equations.

$-3(3x+2y=(12)-3$

$2(-4x+3y=1(2)$

$-9x - 6y = -36$

$-8x + 6y = 2$

$\frac{-17x}{-17} = \frac{-34}{-17}$

$\boxed{x=2}$

$3x + 2y = 12$

$3(2) + 2y = 12$

$6 + 2y = 12$

$-6 \quad -6$

$\frac{2y}{2} = \frac{6}{2}$ $\boxed{y=3}$

(2 , 3)

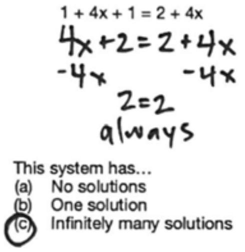
G8 U4 Lesson 13

Determine whether a system of equations will have one solution, no solutions or infinitely many solutions using equations.

G8 U4 Lesson 13 - Today we will determine whether a system of equations will have one solution, no solutions or infinitely many solutions using equations.

Warm Welcome (Slide 1): Tutor choice

Frame the Learning/Connect to Prior Learning (Slide 2): In today's lesson, we will determine whether a system of equations will have one solution, no solutions or infinitely many solutions using equations. This is basically a chance to practice what we've already learned. You're going to do great!



$1 + 4x + 1 = 2 + 4x$

$4x + 2 = 2 + 4x$

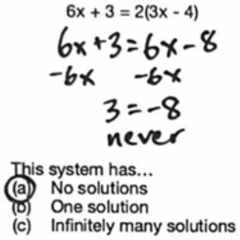
$-4x \quad -4x$

$2 = 2$

always

This system has...
(a) No solutions
(b) One solution
[✓ (c)] Infinitely many solutions

Let's Review (Slide 3): We know how to determine how many solutions an equation has. Let's work through these examples to refresh our memory. First, I will combine like terms. 1 and 1 is 2. So I get 4x + 2 = 2 + 4x. I will subtract 4x from both sides. I get 2 = 2. That is always true, which means this will always have a number that works. And that is infinitely many solutions.



$6x + 3 = 2(3x - 4)$

$6x + 3 = 6x - 8$

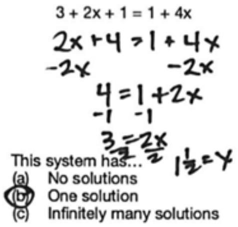
$-6x \quad -6x$

$3 = -8$

never

This system has...
[✓ (a)] No solutions
(b) One solution
(c) Infinitely many solutions

Let's do the next one. Here we have to distribute. We'll get 6x + 3 equals 6x - 8. I am going to subtract 6x from both sides. That gives us 3 = -8. That is never possible, right? So there will never be a solution. That means NO solutions.



$3 + 2x + 1 = 1 + 4x$

$2x + 4 = 1 + 4x$

$-2x \quad -2x$

$4 = 1 + 2x$

$-1 \quad -1$

$3 = 2x$

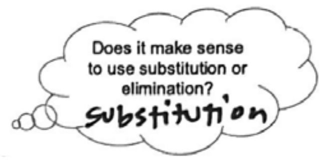
$\frac{3}{2} = \frac{2x}{2}$

$1\frac{1}{2} = x$

This system has...
(a) No solutions
[✓ (b)] One solution
(c) Infinitely many solutions

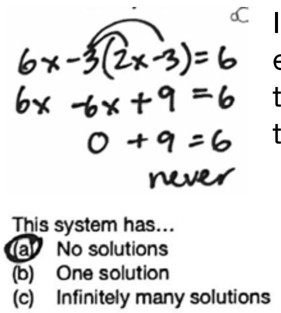
Last one. Let's combine like terms. We get 2x + 4 = 1 + 4x. Let's subtract 2x from both sides. We get 4 = 1 + 2x. Then we subtract 1 from each side. We get 3 = 2x. We divide by 2 on each side. That's 1 and 1 half equals x. That is one solution.

Let's Talk (Slide 4): We can determine the number of solutions for a system of equations just by trying to solve it with substitution. Let's try out this set. We are going to try to solve it just like we always do. Now that we've learned two strategies, we will have to ask ourselves this question, "Does it make sense to use substitution or elimination?" Now, we see that one equation is already set equal to y. So that would make it very easy to substitute. Let's do that.



Does it make sense to use substitution or elimination?

substitution



$6x - 3(2x - 3) = 6$

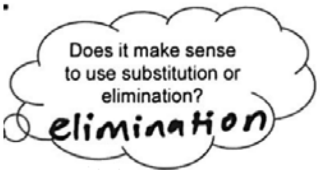
$6x - 6x + 9 = 6$

$0 + 9 = 6$

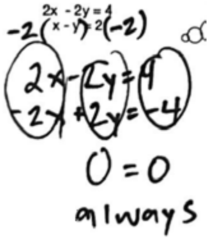
never

This system has...
[✓ (a)] No solutions
(b) One solution
(c) Infinitely many solutions

I am going to rewrite 6x - 3 times the whole amount of 2x - 3 in parentheses equals 6. Let's distribute the 3. We get 6x - 6x + 9 = 6. When we combine like terms, the 6x - 6x just cancels. We get 9 = 6. That's impossible. That's NEVER true. So there's never a solution. There's no solution. The big idea is we go about solving the system of equations like we've learned. And just like we've learned, if it looks a certain way then we will know if it doesn't have a solution.



Let's Think (Slide 5): We can determine the number of solutions for a system of equations just by trying to solve it with elimination. Once again, we will have to ask ourselves this question, "Does it make sense to use substitution or elimination?" In this case, both equations are written in standard form with the x's and y's all on one side. And it would be easy to multiply one equation so that part of it can cancel. Let's do that.



I am going to multiply the bottom equation by -2 on each side. Then we'd have 2x - 2y = 4 and we'd have -2x + 2y = -4. We are going to add these together. But let's circle the parts that cancel. 2x and -2x cancel. -2y and 2y cancel. But actually, 4 and -4 cancel too, don't they. Or we could think of it as 0 + 0 = 0.

This system has…
(a) No solutions
(b) One solution
[✓ (c) Infinitely many solutions]

0 = 0 is always true. So this always has a solution. It has infinitely many solutions.

So, we are going to solve all our systems of equations like normal, choosing between substitution or elimination. And sometimes we'll get equations that are always true with infinitely many solutions and sometimes we'll get equations that are never true with no solutions. And then sometimes we'll just get our usual one solution.

Let's Try It (Slide 6): Let's determine the number of solutions for systems of equations together. I will walk you through each step.

WARM WELCOME

Today we will determine whether a system of equations will have one solution, no solutions or infinitely many solutions using equations.

Let’s Review:

We know how to determine how many solutions an equation has.

Determine the number of solutions.

$$1 + 4x + 1 = 2 + 4x$$

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

Determine the number of solutions.

$$6x + 3 = 2(3x - 4)$$

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

Determine the number of solutions.

$$3 + 2x + 1 = 1 + 4x$$

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

Let’s Talk:

We can determine the number of solutions for a system of equations just by trying to solve it with substitution.

Determine the number of solutions.

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

Does it make sense to use substitution or elimination?

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

Let's Think:

We can determine the number of solutions for a system of equations just by trying to solve it with elimination.

Determine the number of solutions.

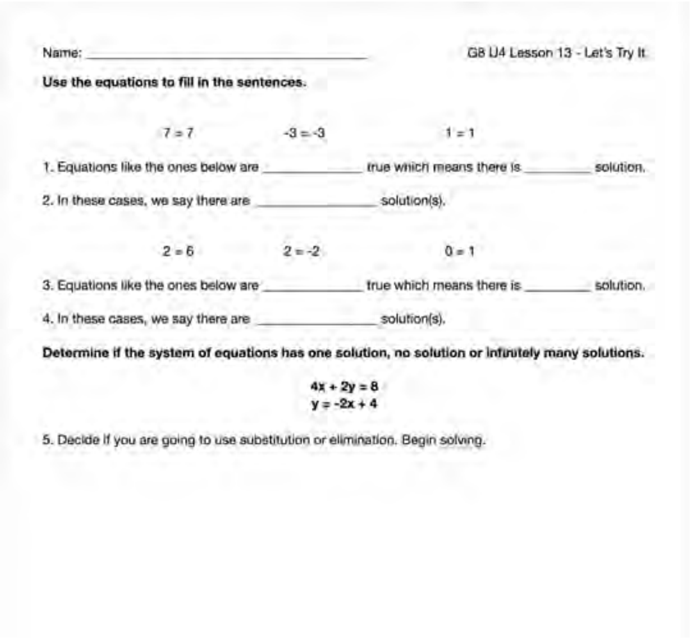
Does it make sense to use substitution or elimination?

$$\begin{aligned} 2x - 2y &= 4 \\ -x + y &= -2 \end{aligned}$$

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

Let's Try It:

Let's determine the number of solutions for systems of equations together!



Name: ______________________ G8 U4 Lesson 13 - Let's Try It

Use the equations to fill in the sentences.

7 = 7 -3 = -3 1 = 1

1. Equations like the ones below are __________ true which means there is ________ solution.

2. In these cases, we say there are ____________ solution(s).

2 = 6 2 = -2 0 = 1

3. Equations like the ones below are __________ true which means there is ________ solution.

4. In these cases, we say there are ____________ solution(s).

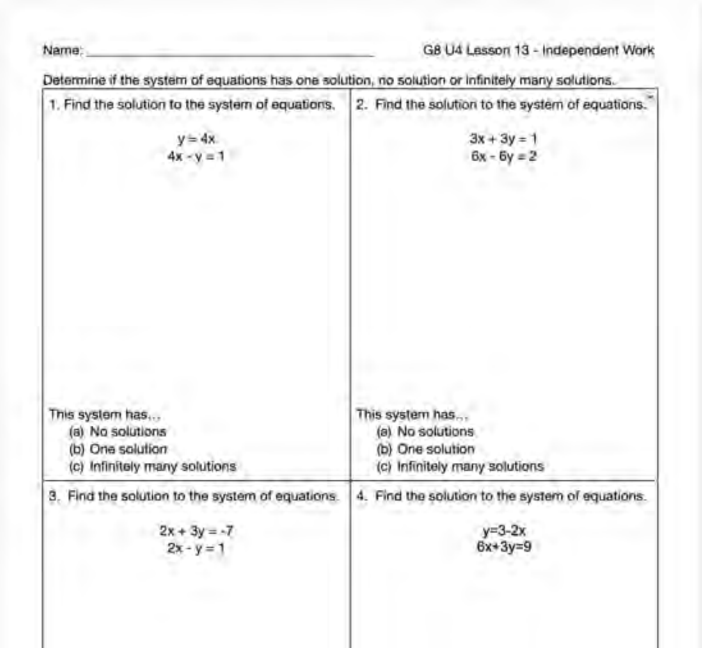
Determine if the system of equations has one solution, no solution or infinitely many solutions.

$$\begin{aligned} 4x + 2y &= 8 \\ y &= -2x + 4 \end{aligned}$$

5. Decide if you are going to use substitution or elimination. Begin solving.

On your Own:

Now it’s time for you to do it on your own!



Name: ______________________ G8 U4 Lesson 13 - Independent Work

Determine if the system of equations has one solution, no solution or infinitely many solutions.

1. Find the solution to the system of equations.

$y = 4x$
$4x - y = 1$

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

2. Find the solution to the system of equations.

$3x + 3y = 1$
$6x - 6y = 2$

This system has…
(a) No solutions
(b) One solution
(c) Infinitely many solutions

3. Find the solution to the system of equations.

$2x + 3y = -7$
$2x - y = 1$

4. Find the solution to the system of equations.

$y=3-2x$
$6x+3y=9$

Use the equations to fill in the sentences.

7 = 7 -3 = -3 1 = 1

1. Equations like the ones below are _____________ true which means there is _________ solution.

2. In these cases, we say there are ________________ solution(s).

2 = 6 2 = -2 0 = 1

3. Equations like the ones below are _____________ true which means there is _________ solution.

4. In these cases, we say there are ________________ solution(s).

Determine if the system of equations has one solution, no solution or infinitely many solutions.

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

5. Decide if you are going to use substitution or elimination. Begin solving.

This system has…
- (a) No solutions
- (b) One solution
- (c) Infinitely many solutions

Determine if the system of equations has one solution, no solution or infinitely many solutions.

$$2x + y = -4$$
$$3x - 2y = -6$$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

Name: ____

G8 U4 Lesson 13 - Independent Work

Determine if the system of equations has one solution, no solution or infinitely many solutions.

1. Find the solution to the system of equations.

$$y = 4x$$
$$4x - y = 1$$

This system has…
  (a) No solutions
  (b) One solution
  (c) Infinitely many solutions

2. Find the solution to the system of equations.

$$3x + 3y = 1$$
$$-6x - 6y = -2$$

This system has…
  (a) No solutions
  (b) One solution
  (c) Infinitely many solutions

3. Find the solution to the system of equations.

$$2x + 3y = -7$$
$$2x - y = 1$$

This system has…
  (a) No solutions
  (b) One solution
  (c) Infinitely many solutions

4. Find the solution to the system of equations.

$$y=3-2x$$
$$6x+3y=9$$

This system has…
  (a) No solutions
  (b) One solution
  (c) Infinitely many solutions

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

$$y = 3x$$
$$6x - 2y = 0$$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

6. Find the solution to the system of equations.

$$4x+2y=6$$
$$6x+3y=9$$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

7. Find the solution to the system of equations.

$$-6x + 3y = -7$$
$$y = 2x - 1$$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

8. Find the solution to the system of equations.

$$3x - 9y = -27$$
$$2x + 7y = 8$$

This system has…

(a) No solutions
(b) One solution
(c) Infinitely many solutions

Name: ANSWER KEY

G8 U4 Lesson 13 - Let's Try It

Use the equations to fill in the sentences.

$7 = 7$ $-3 = -3$ $1 = 1$

1. Equations like the ones below are always true which means there is always solution.

2. In these cases, we say there are infinitely many solution(s).

$2 = 6$ $2 = -2$ $0 = 1$

3. Equations like the ones below are never true which means there is never a solution.

4. In these cases, we say there are no solution(s).

Determine if the system of equations has one solution, no solution or infinitely many solutions.

$$\begin{aligned} 4x + 2y &= 8 \\ y &= -2x + 4 \end{aligned}$$

5. Decide if you are going to use [✓ substitution] or elimination. Begin solving.

$$4x + 2(-2x + 4) = 8$$
$$4x - 4x + 8 = 8$$
$$0 + 8 = 8$$
$$8 = 8$$

always

This system has…
- (a) No solutions
- (b) One solution
- [✓ (c)] Infinitely many solutions

Determine if the system of equations has one solution, no solution or infinitely many solutions.

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

$3x - 2y = -6$

$$\begin{aligned} 4x + 2y &= -8 \\ 3x - 2y &= -6 \\ \hline \frac{7x}{7} &= \frac{-14}{7} \end{aligned}$$

$$\boxed{x = -2}$$

$3x - 2y = -6$

$3(-2) - 2y = -6$

$-6 - 2y = -6$

$+6 \qquad +6$

$\frac{-2y}{-2} = \frac{0}{-2}$

$$\boxed{y = 0}$$

This system has…

(a) No solutions

[✓ (b)] One solution

(c) Infinitely many solutions

Name: ANSWER KEY

G8 U4 Lesson 13 - Independent Work

Determine if the system of equations has one solution, no solution or infinitely many solutions.

1. Find the solution to the system of equations.

$$y = 4x$$
$$4x - y = 1$$

$$4x - 4x = 1$$
$$0 = 1$$

never

This system has…

[✓ (a) No solutions]
(b) One solution
(c) Infinitely many solutions

2. Find the solution to the system of equations.

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

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

$$0 = 0$$

always

This system has…

[✓ (a) No solutions]
(b) One solution
(c) Infinitely many solutions

3. Find the solution to the system of equations.

$$2x + 3y = -7$$
$$3(2x - y) = 1(3)$$

$$2x + 3y = -7$$
$$6x - 3y = 3$$

$$\frac{8x}{8} = \frac{-4}{8}$$
$$\boxed{x = -\tfrac{1}{2}}$$

$$2x + 3y = -7$$
$$2(-\tfrac{1}{2}) + 3y = -7$$
$$-1 + 3y = -7$$
$$+1 \qquad +1$$
$$\frac{3y}{3} = \frac{-6}{3} \quad \boxed{y = -2}$$

This system has…

(a) No solutions
[✓ (b) One solution]
(c) Infinitely many solutions

4. Find the solution to the system of equations.

$$y = 3 - 2x$$
$$6x + 3y = 9$$

$$6x + 3(3 - 2x) = 9$$
$$6x + 9 - 6x = 9$$
$$0 + 9 = 9$$

always

This system has…

(a) No solutions
(b) One solution
[✓ (c) Infinitely many solutions]

Determine if the coordinates are a solution to the system of equations given.

5. Find the solution to the system of equations.

$$y = 3x$$
$$6x - 2y = 0$$

$$6x-2(3x)=0$$
$$6x-6x=0$$
$$0=0$$
always

This system has...

(a) No solutions
(b) One solution
[✓ (c) Infinitely many solutions]

6. Find the solution to the system of equations.

$$-3(4x+2y)=6(-3)$$
$$2(6x+3y)=9(2)$$

$$-12x-6y=-18$$
$$12x+6y=18$$
$$0=0$$

This system has...

(a) No solutions
(b) One solution
[✓ (c) Infinitely many solutions]

7. Find the solution to the system of equations.

$$-6x + 3y = -7$$
$$y = 2x - 1$$

$$-6x+3(2x-1)=-7$$
$$-6x+6x-3=-7$$
$$-3=-7$$
never

This system has...

[✓ (a) No solutions]
(b) One solution
(c) Infinitely many solutions

8. Find the solution to the system of equations.

$$-2(3x - 9y)= -27(-2)$$
$$3(2x + 7y)= 8(3)$$

$$-6x+18y=54$$
$$6x+21y=24$$

$$\frac{39y}{39}=\frac{78}{39}$$
$$\boxed{y=2}$$

$$3x-9y=-27$$
$$3x-9(2)=-27$$
$$3x-18=-27$$
$$+18 \quad +18$$
$$\frac{3x}{3}=\frac{-9}{3}$$
$$\boxed{x=-3}$$

This system has...

(a) No solutions
[✓ (b) One solution]
(c) Infinitely many solutions