Grade 8 Mathematics
Algebra: Lesson 2

Read aloud to the students the material that is printed in **boldface type** inside the boxes. Information in regular type inside the boxes and all information outside the boxes should **not** be read to students. Possible student responses are included in parentheses after the questions.

NOTE: The directions read to students may depend on the available materials. Read only those parts of the lesson that apply to the materials you are using.

Any directions that ask you to do something, such as to turn to a page or to hand out materials to students, will have an arrow symbol (⇨) by them.

Purpose of Lesson 2:

- In this lesson, the tutor and the students will
  - ✓ use various methods to solve equations; and
  - ✓ solve equations involving addition, subtraction, multiplication, or division.

Equipment/Materials Needed:

- Student Sheet 17
- Paper and pencils
- A pan balance scale (Optional)
- 10 small objects of any kind, blocks, paper clips, etc. If you use the actual balance, the objects must weigh the same. If not, they just have to be the same size.
- A few small pieces of paper with *x* written on them

Preparations before beginning Lesson 2:

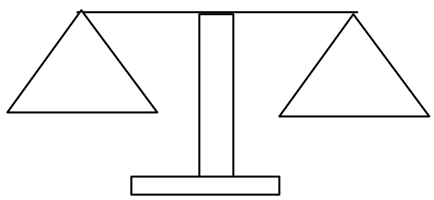
- Run off one (1) copy of Student Sheet 17 for each student.
- Have paper and pencils available.
- Have the objects and the pieces of paper available.
- Find a pan balance scale if you are going to use one.

Lesson 2: Algebra

Say:

In the previous lesson, we wrote expressions and equations for word problems. Today we are going to solve equations. Remember that an equation says that two expressions are equal. To make an equation true, we must find the value or values that make these two expressions equal. Sometimes it helps to think of an equation as a balance scale.

⇨ Use a copy of Student Sheet 17 yourself and give a copy to each student.



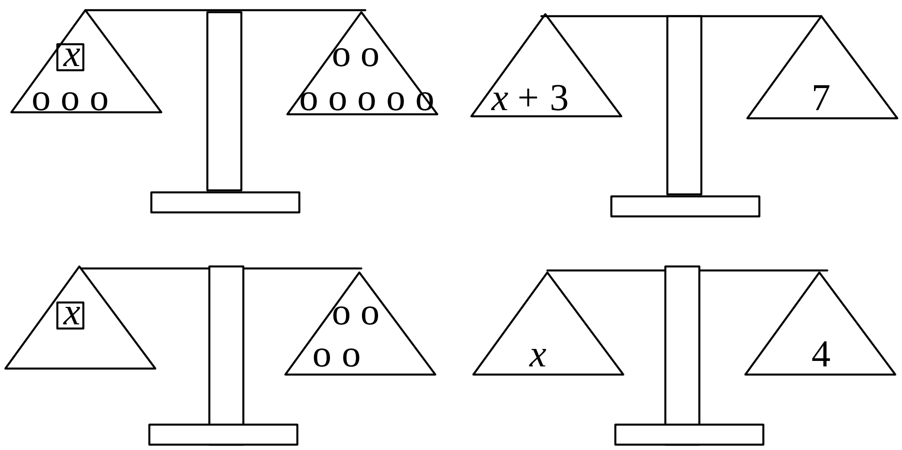
Say:

How does a balance scale work? If you have a scale, use it. If not, use the objects and Student Sheet 17. Place 4 objects (same size) on one side of the balance scale and 4 objects (same size) on the other side. **If I put 4 objects on one side of the scale and 4 objects on the other side, does the scale balance?** (Yes.) **If I add one object to the right side, is the scale balanced?** (No. The right side has more and would become heavier. The right side would drop down.) **What could I do to balance the scale?** (I could add one object to the left side.) **Is the scale balanced now?** (Yes.) **How many objects are on each side?** (5) **What if I removed 2 objects from the left side? Is the scale balanced?** (No.) **What could I do to balance the scale?** (remove 2 objects from the right side) **Is the scale balanced now?** (Yes.) **How many objects are on each side?** (3) **What if I doubled the amount of objects on the right side? How many objects would I have on the right side?** (6) **Is the scale balanced?** (No.) **What could I do to balance the scale?** (double the objects on the left side)
You have just discovered an important rule in solving equations. In order to balance an equation, must make the 2 sides be equal. Whatever you do to one side, you must do to the other.

Say:

Let's see how a balance scale can be used to represent an equation. Let's look at the equation $x + 3 = 7$. This equation says that the expression $x + 3$ equals the expression 7.

If I put *x* + 3 in one pan of the balance scale and 7 in the other, the scale should be balanced. Use the top scale on Sheet 17. In the left pan, draw a box for *x* and 3 circles for the 3. In the right pan, draw 7 circles. (You do the same on your sheet.) **When I solve an equation, I want to get *x* alone. What could I do?** (remove 3 circles) **If I remove 3 circles, the scale will not be balanced. What could I do to keep the scale balanced?** (remove 3 circles from both sides) **How many circles are left on the right side of the scale?** (4) **This procedure shows that *x* equals 4.**



Say:

What happens if I start with 0, add 3, and then subtract 3? (I get back to zero.) **What happens if I start with 10, subtract 3, and then add 3?** (I get right back to 10.) **To find the value of *x* in an equation, we can use inverse operations. Addition and subtraction are *inverse operations.* They undo each other; so to solve $x + 3 = 7$, I subtracted 3 from both sides of the equation.**

⇨ Write this problem on the board or on a piece of paper.

$x + 3 = 7$

$x + 3 - 3 = 7 - 3$

$x = 4$

Say:

Remember that to solve an equation, you must keep the equation balanced: whatever you do to one side, you must do to the other.

⇨ Write this equation on the board: $x - 6 = 10$

Say:

I want to get the *x* alone on one side of the equation, so I think; "How is the 6 related to the *x*?" (It is subtracted.) **What could I do to solve this equation?** (add 6 to both sides) **Why would I add 6?** (because that operation is the opposite operation and to get *x* alone) **Why add 6 to both sides?** (to keep the equation balanced)

⇨ Write these equations on the board.

1. $x + 14 = 15$ 2. $6.1 + x = 9.3$ 3. $x - 8043 = 9628$
4. $¼ = x + ¼$ 5. $5.8 = x - 3.4$

Have the students work the problems one at a time. See the comments below.

Say:

What operation would I use to solve the equation? What number would I add or subtract? What is my solution?

Answers:

1) Subtract 14; the answer is 1. 2) Subtract 6.1; the answer is 3.2.
3) Add 8043; the answer is 17,671. 4) Subtract ¼; the answer is 0.
5) Add 3.4; the answer is 9.2.

You should always check your answer or solution to make sure that you did not make any careless mistakes. To check a solution, replace *x* with the value that you found. If the two sides of the equation are equal, your solution is correct. I'll do the first one for you.

⇨ Write $x + 14 = 15$ on the board.

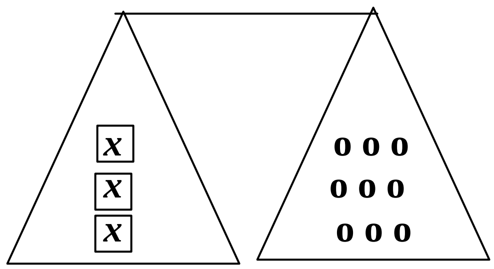
Say:

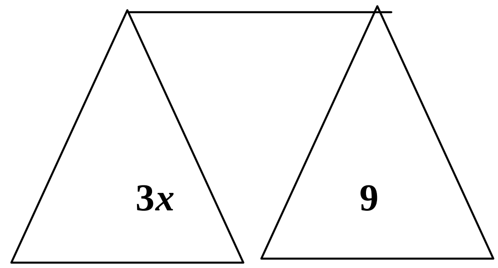
We found the solution to be one (1), so in place of *x*, I will write a one (1). I have 1 + 14 = 15. Is this equation true? (Yes.) **Then my answer is correct. Check the other 4 equations.** Answers:

2) 6.1 + 3.2 = 9.3; 9.3 = 9.3 3) 17,671 – 8043 = 9628; 9628 = 9628
4) ¼ = 0 + ¼; ¼ = ¼ 5) 5.8 = 9.2 – 3.4; 5.8 = 5.8

Say:

We are going to use the balance scale on the bottom of Sheet 17 to look at another kind of equation. Suppose we had the equation *3x = 9*. What would you draw or write in the left pan? (3*x* or draw 3 boxes with *x*'s on them.) **What would you put on the right side of the pan?** (*9* or draw 9 circles.)





This time we have the x's on one side of the equation, but we want to find out what one x will equal. If you look at the way I have drawn my balance scale, you can see that $3x$'s = 9, so $1x$ would equal 3; or we could think about those inverse operations again. In the equation $3x = 9$, how are the 3 and the x related? (multiplication) **How do we undo multiplication?** (division) **Multiplication and division are inverse operations. If I start with the number one, multiply by 3, and then divide by 3, I am right back to 1; or if I start with 24, divide by 6, and then multiply by 6, I am right back to 24. So to solve $3x = 9$, I would divide both sides by 3. Therefore, $x = 3$.**

⇨ Write this problem on the board or on a piece of paper.

$$3x = 9$$

$$\frac{3x}{3} = \frac{9}{3}$$

$$x = 3$$

Say:

Remember that to solve an equation, we must keep it balanced – whatever we do to one side, we must do to the other. To check this equation, we would replace the x with 3. $3x = 9$; $3(3) = 9$; $9 = 9$.

⇨ Write this equation on the board: $\frac{x}{10} = 4$

Say:

How are the x and the *10* related? (x is divided by 10.) **What could you do to solve this equation?** (multiply both sides by 10) **Why would you multiply?** (because that is the opposite operation) **Why would you multiply by 10?** (to get x alone) **Why would you multiply both sides?** (to keep the equation balanced) **What is the answer or solution?** (40)

⇨ Write these equations on the board.

1. $\frac{x}{6} = 15$ 2. $6.1x = 18.3$

3. $804 = \frac{x}{2}$ 4. $202x = 202$

Have the students work the problems one at a time. Discuss each one as you go along.

Say:

What operation would I use to solve the equation? What number would I add or subtract? What is my solution?

Answers:

1) Multiply by 6; the answer is 90. 2) Divide by 6.1; the answer is 3.

3) Multiply by 2; the answer is 1608. 4) Divide by 202; the answer is 1.

You should always check your answer or solution to make sure that you did not make any careless mistakes. To check a solution, replace *x* with the value that you found. If the two sides of the equation are equal, your solution is correct. I'll do the first one for you.

⇨ Write $\frac{x}{6} = 15$ on the board.

Say:

We found the solution to be 90, so in place of *x*, I will write 90. I have $\frac{90}{6} = 15$. Is this equation true? (Yes.) **Then my answer is correct. Check the other 3 equations.**

Answers:

2) $6.1(3) = 18.3$; $18.3 = 18.3$ 3) $804 = \frac{1608}{2}$; $804 = 804$

4. $202(1) = 202$; $202 = 202$

Say:

Sometimes we have equations that contain more than one operation. We still use the same ideas to solve these equations: inverse operations and performing the same operation to both sides of the equation.

⇨ Write this equation on the board or on a piece of paper.

$3x + 6 = 12$

Say:

$3x + 6 = 12$. What operations are involved in this equation? (multiplication and addition) **We have to decide which operation we will do first. When we solve an equation, we are "undoing" operations or "unbuilding" the equation. When we build an equation, we multiply or divide first, and then we add and subtract. To "unbuild" the equation, we add or subtract first, then multiply and divide.**
On this equation, we will work on the addition part first. What is the inverse operation? (Subtraction.) **What should I subtract?** (6)

$3x + 6 - 6 = 12 - 6$ **What am I left with?**

$3x = 6$ **How should I get x alone now.** (Divide by 3.)

$\frac{3x}{3} = \frac{6}{3}$ **What am I left with?** ($x = 2$)

$x = 2$

To check the equation, replace x with 2.
$3(2) + 6 = 12$,
$6 + 6 = 12$; $12 = 12$

⇨ Write these equations on the board or on a piece of paper.

1. $12 + 8x = 68$
2. $\frac{x}{6} - 8 = 4$
3. $6x - 1.4 = 16.6$
4. $100 = \frac{x}{2} - 100$

Have the students work the equations one at a time; then have the students check each one.

Say:

What operation will you do first in each equation? Which inverse operations will you use?
Answers:
1. Subtract 12, divide by 8; the answer is 7.
2. Add 8, multiply by 6; the answer is 72.
3. Add 1.4, divide by 6; the answer is 3.
4. Add 100, multiply by 2; the answer is 400.

⇨ Have one student summarize today's lesson. You want the students to discuss what it means to balance an equation.

Student Sheet 17 (Algebra: Lesson 2)