

SOLVING ALGEBRAIC EQUATIONS

Volume 15

Developed with Kristin Ulrich
Grades 5-8



Time

30-55 minutes

Content

Solve algebraic equations with one variable using a balance scale model.

Objectives

Students will be able to ...

- Solve a variety of linear equations using a balance scale model.
- Explain the process of solving a linear equation.
- Build concrete models to represent abstract algebraic equations.

Materials

- 302-Piece DECI-BLOCKS™ Set (TB24799)
- Number cards (attached with lesson plan download)
- Worksheet and answer key (attached with lesson plan download)
- Additional intervention and extension problems with answers (attached with lesson plan download)

Common Core State Standards

- CCSS.Math.Content.6.EE.A.2** — Write, read, and evaluate expressions in which letters stand for numbers.
- CCSS.Math.Content.7.EE.A.1** — Apply properties of operations as strategies to add, subtract, factor, and expand linear expressions with rational coefficients.
- CCSS.Math.Content.8.EE.C.7** — Solve linear equations in one variable.

Teacher Notes

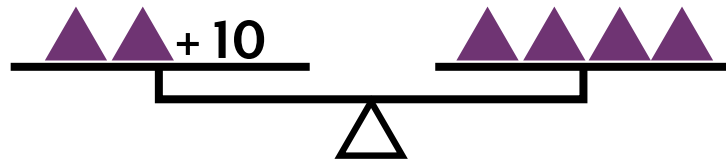
This lesson is meant to introduce or reinforce the concept of how to solve algebraic equations with one variable. The DECI-BLOCKSTM allow students to visualize and make an abstract concept much more concrete. The lesson provides an activity that guides the entire class through several examples. The worksheet works well with students in groups of 3-4, but it may also be completed individually. The lesson also includes eight problems that reinforce the skill as well as eight problems for extending the skill. Both sets of problems work well in a small group setting.

Introduction

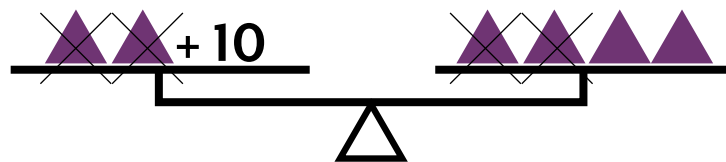
1. In this lesson, students will be solving equations using the balance scale model. To introduce the idea, draw or have students visualize a balance scale with two apples on one side of it, then ask them how many apples would need to be put on the other side of the balance scale to make it of equal value, i.e. to put the scale into balance (*two apples are needed*).
2. Continue by asking students how many pink trapezoid DECI-BLOCKS™ they would need for the scale to have equal value (to balance) if seven pink trapezoid DECI-BLOCKS™ are on one side already (*seven for the other side*). Ask what would happen if only six pink trapezoid blocks were placed on the other side (*the balance scale wouldn't be equal*).
3. Tell students that this idea is true when solving algebraic equations. The equal sign indicates that everything on the left side of the equal sign must be exactly the same value as everything on the right side of the equal sign. They just need to figure out what makes that value the same.

Activity

1. Begin with $2x + 10 = 4x$. Students should be able to tell that this is an algebraic equation because there is a variable (x) and an equal sign. It is also a linear equation because none of the numbers contains an exponent.
2. The DECI-BLOCKS™ will be used to represent the variable. Students should put two purple triangles on the left side of their “balance scale” and four purple triangles on the right side of the “balance scale.” See if students know why they are doing this (*there is a 2 in front of the variable on the left side and a 4 in front of the variable on the right side of the equation*). Next, have students add the addition card and the 10 number card to the left side of their “balance scale.” Draw a picture of what this would look like on the board to help students better visualize.

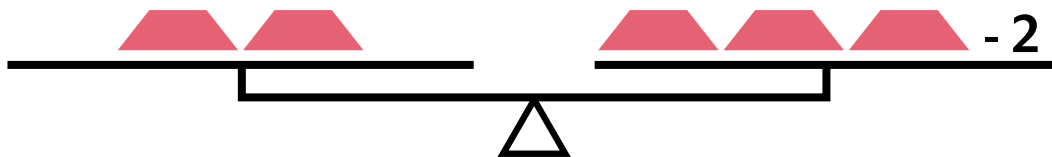


3. The next step is to cancel out pairs of purple triangles. A pair of triangles is made up of a triangle from each side of the “balance.” Pairs should be removed until there are no more pairs that can be removed. Students should be able to remove two pairs. The “balance scale” should now look like this:

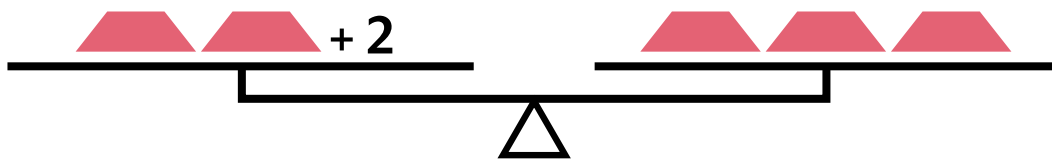


4. Students are now left with the number 10 on one side of the equation and two purple triangles on the other side of the equation. If two purple triangles equal 10, then students should be able to figure out that one purple triangle equals 5.
5. Now it's time to check and make sure that this is the correct answer. Have students replace the x 's in the original equation with 5.
 $2(5) + 10 = 4(5)$ $10 + 10 = 20$ $20 = 20$
 Since the number is the same on both sides of the equation and they “balance,” the solution is correct.

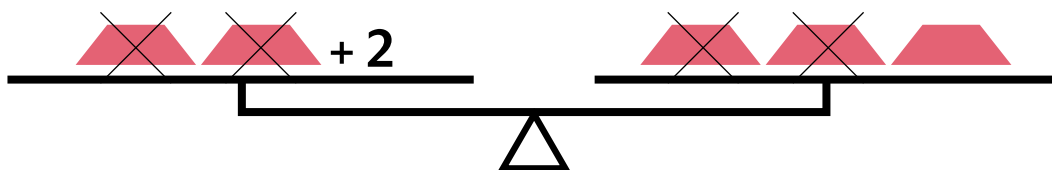
6. Move on to a linear algebraic equation that features subtraction, $2y = 3y - 2$. This time, students should use the pink trapezoid DECI-BLOCKS™ to represent the variable of y . Let students determine how many pink trapezoids need to go on each side of the “balance” (two on the left side and three on the right side). This time, students will need to place the subtraction card and the number card of 2 to the right side of their “balance,” since those items are on the right side of the actual equation. As before, you should draw a picture of what this would look like on the board to help students better visualize.



7. First, students need to deal with the -2 on the right side of the equation. Ask students what the opposite of subtracting 2 is (*adding 2*). When 2 is added to the right side of the equal sign, the -2 cancels out, since $2 - 2 = 0$. However, anything that is done to the right side of the equation also has to be done to the left, so 2 now needs to be added to the left side of the equation. The “balance scale” should now look like this:



8. The next step is to cancel out any pairs of pink trapezoids. Students should remove trapezoid pairs until all the pairs are removed. Two pairs can be removed. Make sure that their pairs consist of a piece from each side of the “balance.” The “balance scale” should now look like this:



9. Once the pairs are removed, students are left with a 2 on the left side of the equation and a pink trapezoid on the right side, which can also be read as $2 = y$. Students should replace the y 's in the equation with 2 to make sure this answer is the correct one.
 $2(2) = 3(2) - 2$ $4 = 6 - 2$ $4 = 4$
 The equation is fully balanced, so it is correct.

Practice

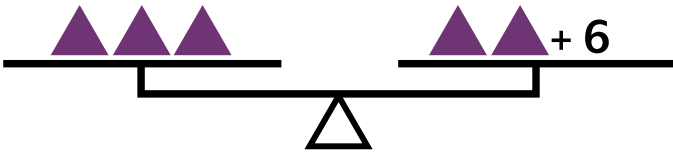
Hand out the worksheet. Students should complete problems 1 and 2 either independently or in small groups.

Check for Understanding

After students have completed problems 1 and 2, check for understanding by using the following line of questioning:

Problem 1

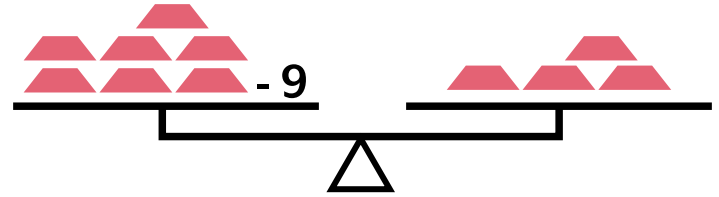
1. How many green triangles are needed on the left side of the “balance scale”? (3)
2. How do you know? (*The left side of the equal sign has a 3 before the variable, which is k.*)
3. How many green triangles are needed on the right side of the “balance scale”? (2)
4. How do you know? (*The right side of the equal sign has a 2 before the variable, which is k.*)
5. What operation is being performed in the equation? (*Addition*)
6. What number card needs to also be added to the right side of the equation? (6)
7. Ask a student to draw the “balance scale” that they or their group drew. It should look like the one below.



8. How many pairs of green triangles can be removed from the “balance scale”? (2)
9. What does that leave us with? ($k = 6$)
10. Ask a student to show you the work they or their group did to prove that k does equal 6. It should be similar to this:
 $3(6) = 2(6) + 6$ $18 = 12 + 6$ $18 = 18$

Problem 2

1. How many black trapezoids are needed on the left side of the “balance scale”? (7)
2. How do you know? (*The left side of the equal sign has a 7 before the variable, which is j.*)
3. How many black trapezoids are needed on the right side of the “balance scale”? (4)
4. How do you know? (*The right side of the equal sign has a 4 before the variable, which is j.*)
5. What operation is being performed in this problem? (*Subtraction*)
6. What number is being subtracted? (9)
7. Ask a student to draw the “balance scale” that they or their group drew. It should look like the one below.



8. What do we need to remember to do with the -9 ? (*Add 9 to both sides of the “balance,” so that it is now an addition problem.*)
9. What is the new equation? ($7j = 4j + 9$)
10. What do we need to do next? (*Remove the trapezoid pairs.*)
11. How many pairs can we remove from the “balance”? (4 pairs)
12. What does that leave us with? ($3j = 9$)
13. If three black trapezoids equal 9, how much would one black trapezoid equal? (3)
14. What does j equal? (3)
15. Ask a student to show you the work they or their group did to prove that j does equal 3. It should be similar to this:
 $7(3) - 9 = 4(3)$ $21 - 9 = 12$ $12 = 12$

Intervention

1. Give students the intervention problems to reinforce the skills and standards addressed in the lesson. All eight problems are addition problems.

Extension

1. Ask students to create their own equations using the balance scale model.
2. Problems 7 and 8 of the worksheet are enrichment problems because they require students to add another step to the process that was not explicitly taught in the lesson.
3. Give students the extension problems to further extend the skills and standards addressed in this lesson. All eight problems require students to combine like terms.

Additional Algebraic Equations and Answers

Intervention Problems and Answers

1. $7p + 6 = 8p$ $p = 6$

2. $4r = r + 9$ $r = 3$

3. $3z + 8 = 5z$ $z = 4$

4. $10z = z + 9$ $z = 1$

5. $2h + 5 = 3h$ $h = 5$

6. $2m = m + 7$ $m = 7$

7. $5f + 3 + f = 7f$ $f = 3$

8. $4r = r + 5 + r + 1$ $r = 3$

Extension Problems and Answers

1. $4y + 2 - y = 5y - 4 + y$ $y = 2$

2. $3r - 5 = 4r - 20$ $r = 15$

3. $7y - 5y + 3 = 8y - 4y + 3$ $y = 0$

4. $7n + 2 - 4n = 4n - 1$ $n = 3$

5. $6t - 18 = 3t - 10 + 2t$ $t = 8$

6. $3b - 8 + b = 4b - 12 + b - 1$ $b = 5$

7. $4 + 8n - 20 = 3n + 12 + 3n - 6$ $n = 11$

8. $7g + 11 = 4g + 19 + g$ $g = 4$

Number Cards

1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
+	-		

Name: _____

Solving Algebraic Equations Worksheet

Directions: Use the specified DECI-BLOCKS™ to build the balance scales for each of the following algebraic equations. Solve for the variable based on your work on the balance scale.

1. $3k = 2k + 6$ DECI-BLOCKS™ needed: green triangles

Draw the balance scale that you created below.

How many pairs of green triangles can you remove? _____

$k =$ _____

Check your work here.

2. $7j - 9 = 4j$

DECI-BLOCKS™ needed: black trapezoids

Draw the balance scale that you created below.

What do you need to do with the (-9)? _____

What is your new equation? _____

How many pairs of black trapezoids can you remove? _____

$j =$ _____

Check your work here.

3. $6p = 2p + 12$

DECI-BLOCKS™ needed: pink trapezoids

Draw the balance scale that you created below.

How many pairs of pink trapezoids can you remove? _____

$p =$ _____

Check your work here.

4. $3m - 8 = m$

DECI-BLOCKS™ needed: purple triangles

Draw the balance scale that you created below.

What do you need to do with the (-8)? _____

What is your new equation? _____

How many pairs of purple triangles can you remove? _____

$m =$ _____

Check your work here.

Solving Algebraic Equations Worksheet (continued)

5. $4s = 6s - 20$ DECI-BLOCKS™ needed: green triangles

Draw the balance scale that you created below.

What do you need to do with the (-20) ? _____

What is your new equation? _____

How many pairs of green triangles can you remove? _____

$s =$ _____

Check your work here.

6. $t + 16 = 3t$ DECI-BLOCKS™ needed: pink trapezoids

Draw the balance scale that you created below.

How many pairs of pink trapezoids can you remove? _____

$t =$ _____

Check your work here.

7. $3s + 4 + s = 5s$ DECI-BLOCKS™ needed: purple triangles

Draw the balance scale that you created below.

What do you need to do with the like terms? _____

What is your new equation? _____

How many pairs of purple triangles can you remove? _____

$s =$ _____

Check your work here.

8. $5n + 3 - 2n = 4n - 2$ DECI-BLOCKS™ needed: black trapezoids

Draw the balance scale that you created below.

What do you need to do with the like terms? _____

What is your new equation? _____

How many pairs of black trapezoids can you remove? _____

$n =$ _____

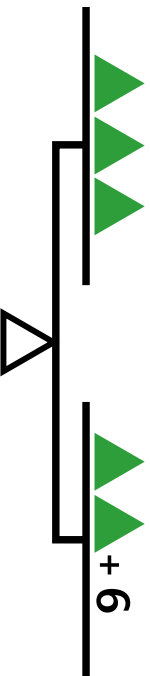
Check your work here.

Solving Algebraic Equations Worksheet Answer Key

Directions: Use the specified DECI-BLOCKS™ to build the balance scales for each of the following algebraic equations. Solve for the variable based on your work on the balance scale.

1. $3k = 2k + 6$ DECI-BLOCKS™ needed: green triangles

Draw the balance scale that you created below.



How many pairs of green triangles can you remove? 2

$$k = \underline{6}$$

Check your work here.

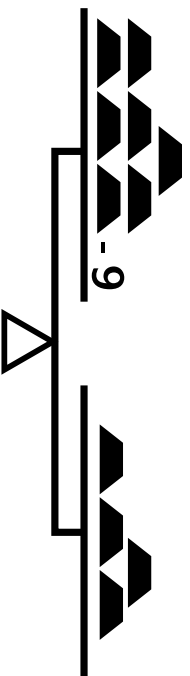
$$3(6) = 2(6) + 6$$

$$18 = 12 + 6$$

$$18 = 18$$

2. $7j - 9 = 4j$ DECI-BLOCKS™ needed: black trapezoids

Draw the balance scale that you created below.



What do you need to do with the (-9)? add 9 to both sides

What is your new equation? $7j = 4j + 9$

How many pairs of black trapezoids can you remove? 4

$$j = \underline{3}$$

Check your work here.

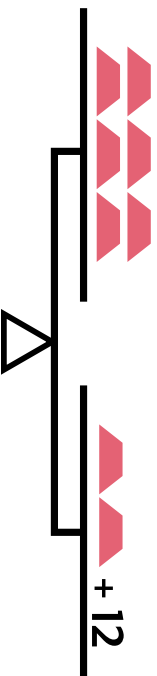
$$7(3) - 9 = 4(3)$$

$$21 - 9 = 12$$

$$12 = 12$$

3. $6p = 2p + 12$ DECI-BLOCKS™ needed: pink trapezoids

Draw the balance scale that you created below.



How many pairs of pink trapezoids can you remove? 2

$$p = \underline{3}$$

Check your work here.

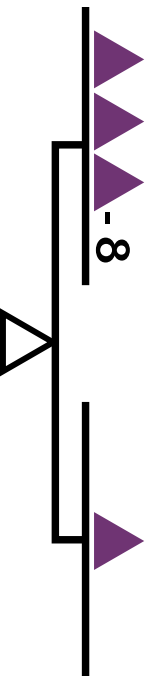
$$6(3) = 2(3) + 12$$

$$18 = 6 + 12$$

$$18 = 18$$

4. $3m - 8 = m$ DECI-BLOCKS™ needed: purple triangles

Draw the balance scale that you created below.



What do you need to do with the (-8)? add 8 to both sides

What is your new equation? $3m = m + 8$

How many pairs of purple triangles can you remove? 1

$$m = \underline{4}$$

Check your work here.

$$3(4) - 8 = 4$$

$$12 - 8 = 4$$

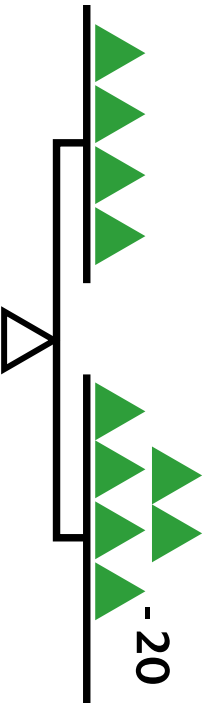
$$4 = 4$$

Solving Algebraic Equations Worksheet Answer Key Continued

5. $4s = 6s - 20$

DECI-BLOCKSTM needed: green triangles

Draw the balance scale that you created below.



What do you need to do with the (-20)? add 20 to both sides

What is your new equation? $4s + 20 = 6s$

How many pairs of green triangles can you remove? 4

$s = \underline{10}$

Check your work here. $4(10) = 6(10) - 20$

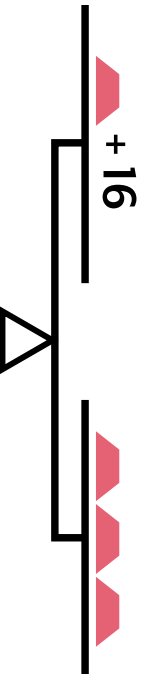
$40 = 60 - 20$

$40 = 40$

6. $t + 16 = 3t$

DECI-BLOCKSTM needed: pink trapezoids

Draw the balance scale that you created below.



How many pairs of pink trapezoids can you remove? 1

$t = \underline{8}$

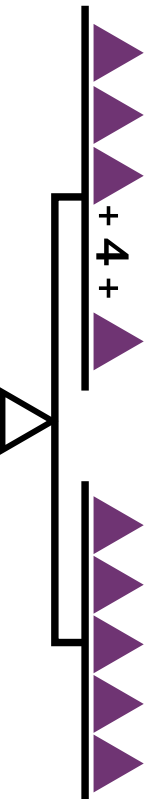
Check your work here. $8 + 16 = 3(8)$

$24 = 24$

7. $3s + 4 + s = 5s$

DECI-BLOCKSTM needed: purple triangles

Draw the balance scale that you created below.



What do you need to do with the like terms? add them

What is your new equation? $4s + 4 = 5s$

How many pairs of purple triangles can you remove? 4

$s = \underline{4}$

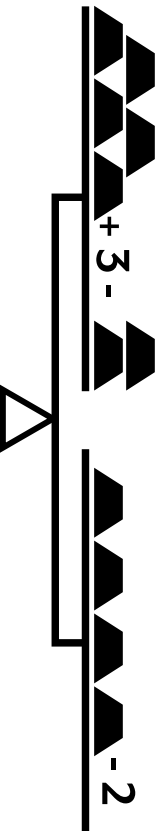
Check your work here. $3(4) + 4 + 4 = 5(4)$ $12 + 8 = 20$

$12 + 4 + 4 = 20$ $20 = 20$

8. $5n + 3 - 2n = 4n - 2$

DECI-BLOCKSTM needed: black trapezoids

Draw the balance scale that you created below.



What do you need to do with the like terms? subtract them

What is your new equation? $3n + 3 = 4n - 2$

How many pairs of black trapezoids can you remove? 3

$n = \underline{5}$

Check your work here. $5(5) + 3 - 2(5) = 4(5) - 2$ $28 - 10 = 18$

$25 + 3 - 10 = 20 - 2$

$18 = 18$