



Lesson 26: One-Step Equations—Addition and Subtraction

Student Outcomes

- Students solve one-step equations by relating an equation to a diagram.
- Students check to determine if their solution makes the equation true.

Lesson Notes

This lesson serves as a means for students to solve one-step equations through the use of tape diagrams. Through the construction of tape diagrams, students create algebraic equations and solve for one variable. In this lesson, students continue their study of the properties of operations and identity and develop intuition of the properties of equality. This lesson continues the informal study of the properties of equality students have practiced since Grade 1 and also serves as a springboard to the formal study, use, and application of the properties of equality seen in Grade 7. While students will intuitively use the properties of equality, understand that diagrams are driving the meaning behind the content of this lesson. This lesson purposefully omits focus on the actual properties of equality, which is reserved for Grade 7. Students will relate an equation directly to diagrams and verbalize what they do with diagrams to construct and solve algebraic equations.

Classwork

Opening (3 minutes)

In order for students to learn how to solve multi-step equations (in future grades), they must first learn how to solve basic equations. Although a majority of students have the ability to find the solutions to the equations using mental math, it is crucial that they understand the importance of knowing and understanding the process for solving equations so they can apply it to more complex equations in the future.

Mathematical Modeling Exercise (8 minutes)

Model the example to show students how to use tape diagrams to calculate solutions to one-step equations.

Calculate the solution: $a + 2 = 8$

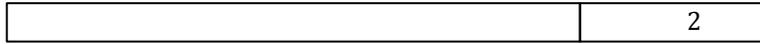
- Draw two tape diagrams that are the same length.

- Label the first tape diagram 8.

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- Represent 2 on the second tape diagram. What must the remaining section of the tape diagram represent? How do you know?

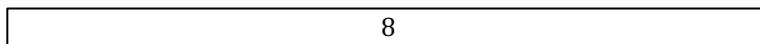


- The remaining part of the tape diagram represents 6 because the entire tape diagram is 8, and we know one section is 2. Therefore, we can compute the difference, $8 - 2$, to determine the remaining part.*

- Label your tape diagram.



- Draw another set of tape diagrams to represent the given equation: $a + 2 = 8$.



- Because both of the following tape diagrams represent the same value, what would the value of a be? Explain.



- Since both of the tape diagrams represent the same value, both parts that have a and 6 must represent the same value. Therefore, a must have a value of 6.*

- Using this knowledge, try to show or explain how to solve equations without tape diagrams. What actually happened when constructing the tape diagrams?

Guide and promote this discussion with students:

- The first set of tape diagrams shows that the quantity of $6 + 2$ is equal to 8. To write this algebraically, we can use the equal sign. $6 + 2 = 8$.*
- The second set of tape diagrams shows two things: first, that $a + 2$ is equal to 8 and also that $a + 2 = 8$ is equal to $6 + 2 = 8$.*
- We found that the only number that a can represent in the equation is 6. Therefore, when $a + 2 = 8$, the only solution for a is 6.*
- In previous lessons, we discussed identity properties. How can we explain why $a + 2 - 2 = a$ using the identity properties?
 - We know that when we add a number and then subtract the same number, the result is the original number. Previously, we demonstrated this identity with $a + b - b = a$.*
- How can we check our answer?
 - Substitute 6 in for a to determine if the number sentence is true. $6 + 2 = 8$ is a true number sentence because $6 + 2 - 2 = 8 - 2$, resulting in $6 = 6$. So, our answer is correct.*

Exercise 1 (8 minutes)

Students work with partners to complete the following problems. They will show how to solve each equation using tape diagrams and algebraically. Then, students will use substitution to check their answers after each problem.

Exercise 1
 Solve each equation. Use both tape diagrams and algebraic methods for each problem. Use substitution to check your answers.

a. $b + 9 = 15$

Algebraically:

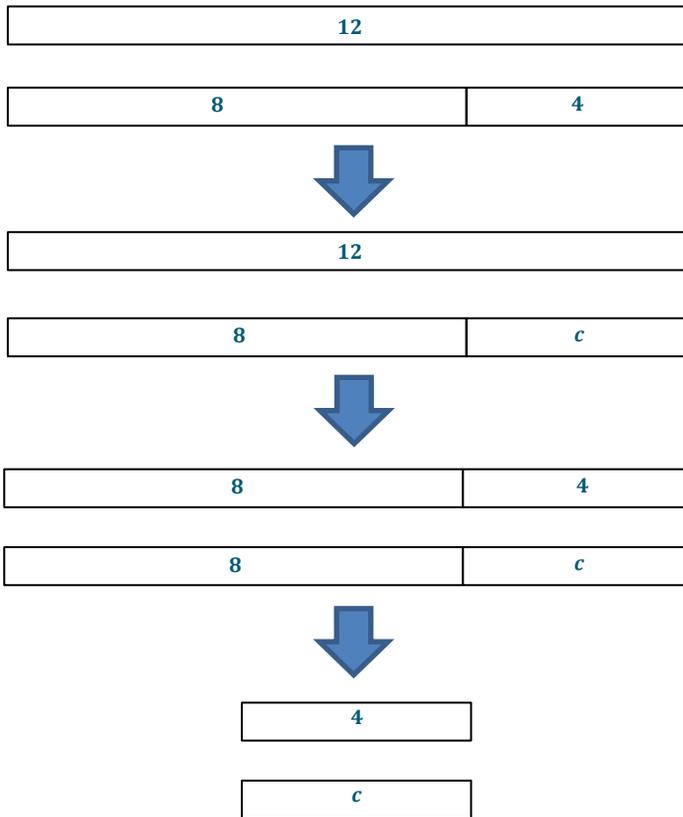
$$b + 9 = 15$$

$$b + 9 - 9 = 15 - 9$$

$$b = 6$$

Check: $6 + 9 - 9 = 15 - 9$; $6 = 6$. This is a true number sentence, so 6 is the correct solution.

b. $12 = 8 + c$



Algebraically:

$$12 = 8 + c$$

$$12 - 8 = 8 + c - 8$$

$$4 = c$$

Check: $12 - 8 = 8 + 4 - 8$; $4 = 4$. This is a true number sentence, so 4 is the correct solution.

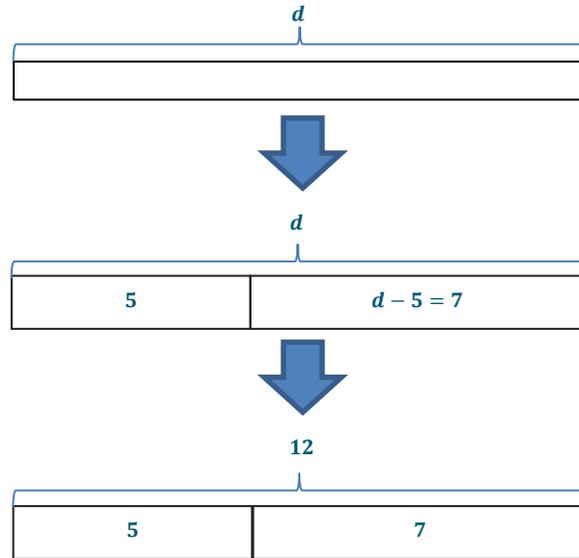
Exercise 2 (8 minutes)

Students use the knowledge gained in the first part of the lesson to determine how to solve an equation with subtraction.

Exercise 2

Given the equation $d - 5 = 7$:

- a. Demonstrate how to solve the equation using tape diagrams.



- b. Demonstrate how to solve the equation algebraically.

$$\begin{aligned} d - 5 &= 7 \\ d - 5 + 5 &= 7 + 5 \\ d &= 12 \end{aligned}$$

- c. Check your answer.

$12 - 5 + 5 = 7 + 5$; $12 = 12$. *This is a true number sentence, so our solution is correct.*

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Provide students time to work and then provide some examples that show how to solve the equations using both methods. At this time, remind students of the identity with subtraction to explain why $d - 5 + 5 = d$.

Exercise 3 (8 minutes)

Students solve each problem using the method of their choice, but they must show their work. Have students check their answers.

Exercise 3

Solve each problem, and show your work. You may choose which method (tape diagrams or algebraically) you prefer. Check your answers after solving each problem.

a. $e + 12 = 20$

| | |
|----|----|
| 20 | |
| 8 | 12 |

↓

| | |
|-----|----|
| 20 | |
| e | 12 |

↓

| | |
|-----|----|
| 8 | 12 |
| e | 12 |

↓

| |
|-----|
| 8 |
| e |

Algebraically:

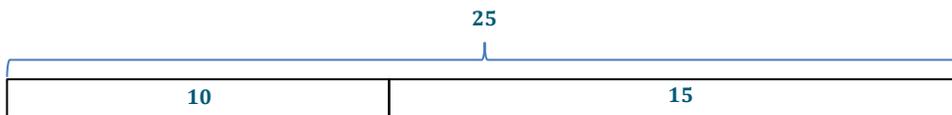
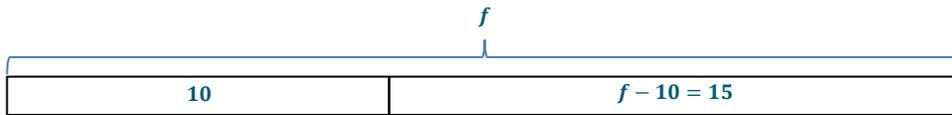
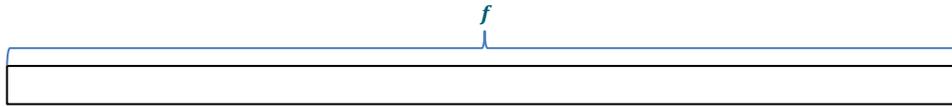
$$e + 12 = 20$$

$$e + 12 - 12 = 20 - 12$$

$$e = 8$$

Check: $8 + 12 - 12 = 20 - 12$; $8 = 8$. *This is a true number sentence, so our answer is correct.*

b. $f - 10 = 15$

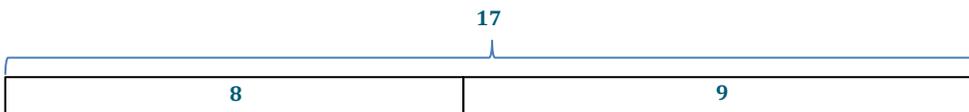
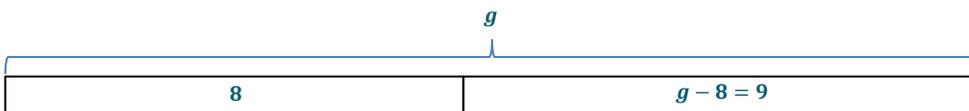


Algebraically:

$$\begin{aligned} f - 10 &= 15 \\ f - 10 + 10 &= 15 + 10 \\ f &= 25 \end{aligned}$$

Check: $25 - 10 + 10 = 15 + 10$; $25 = 25$. This is a true number sentence, so our solution is correct.

c. $g - 8 = 9$



Algebraically:

$$\begin{aligned} g - 8 &= 9 \\ g - 8 + 8 &= 9 + 8 \\ g &= 17 \end{aligned}$$

Check: $17 - 8 + 8 = 9 + 8$; $17 = 17$. This number sentence is true, so our solution is correct.

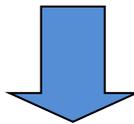
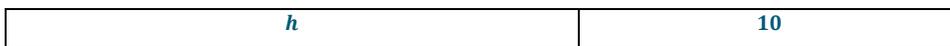
Closing (5 minutes)

- John checked his answer and found that it was incorrect. John’s work is below. What did he do incorrectly?

$$\begin{aligned}
 h + 10 &= 25 \\
 h + 10 + 10 &= 25 + 10 \\
 h &= 35
 \end{aligned}$$

- John should have subtracted 10 on each side of the equation instead of adding because $h + 10 + 10 \neq h$.

- Use a tape diagram to show why John’s method does not lead to the correct answer.



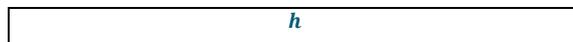
- When John added 10 to both sides of the equation, the equation would change to $h + 20 = 35$. Therefore, the value of h cannot equal 35.

- Why do you do the inverse operation to calculate the solution of the equation? Include a tape diagram as part of your explanation.

- When you do the inverse operation, the result is zero. Using the identity property, we know any number added to zero is the original number.



- This tape diagram demonstrates $h + 10$; however, we want to know the value of just h . Therefore, we would subtract 10 from this tape diagram.



- Therefore, $h + 10 - 10 = h$.

Exit Ticket (5 minutes)

Name _____

Date _____

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Exit Ticket

1. If you know the answer, state it. Then use a tape diagram to demonstrate why this is the correct answer. If you do not know the answer, find the solution using a tape diagram.

$$j + 12 = 25$$

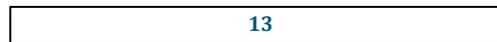
2. Find the solution to the equation algebraically. Check your answer.

$$k - 16 = 4$$

Exit Ticket Sample Solutions

1. If you know the answer, state it. Then use a tape diagram to demonstrate why this is the correct answer. If you do not know the answer, find the solution using a tape diagram.

$$j + 12 = 25$$



j is equal to 13; j = 13.

Check: 13 + 12 = 25; 25 = 25. This is a true number sentence, so the solution is correct.

2. Find the solution to the equation algebraically. Check your answer.

$$k - 16 = 4$$

$$k - 16 + 16 = 4 + 16$$

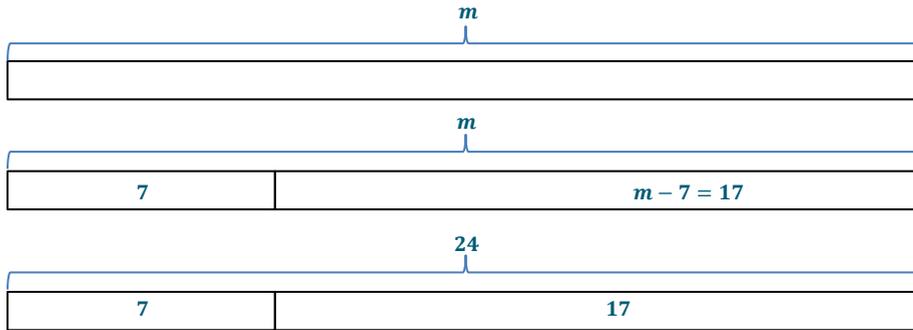
$$k = 20$$

Check: 20 - 16 = 4; 4 = 4. This is a true number sentence, so the solution is correct.

Problem Set Sample Solutions

1. Find the solution to the equation below using tape diagrams. Check your answer.

$$m - 7 = 17$$



m is equal to 24; m = 24.

Check: 24 - 7 = 17; 17 = 17. This number sentence is true, so the solution is correct.

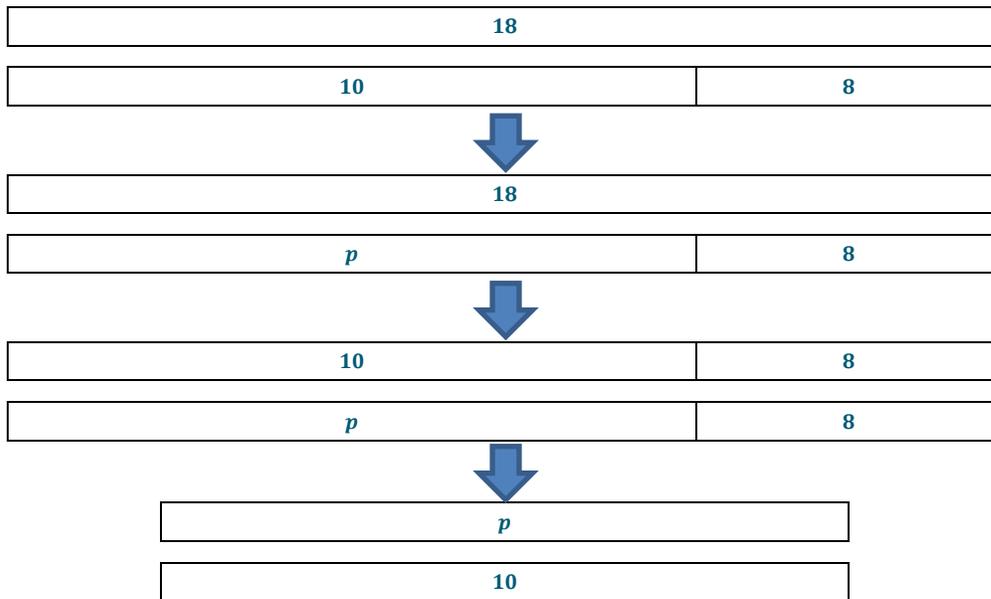
2. Find the solution of the equation below algebraically. Check your answer.

$$\begin{aligned} n + 14 &= 25 \\ n + 14 - 14 &= 25 - 14 \\ n &= 11 \end{aligned}$$

Check: 11 + 14 = 25; 25 = 25. This number sentence is true, so the solution is correct.

3. Find the solution of the equation below using tape diagrams. Check your answer.

$$p + 8 = 18 \qquad p = 10$$



Check: 10 + 8 = 18; 18 = 18. This number sentence is true, so the solution is correct.

4. Find the solution to the equation algebraically. Check your answer.

$$g - 62 = 14$$

$$g - 62 + 62 = 14 + 62$$

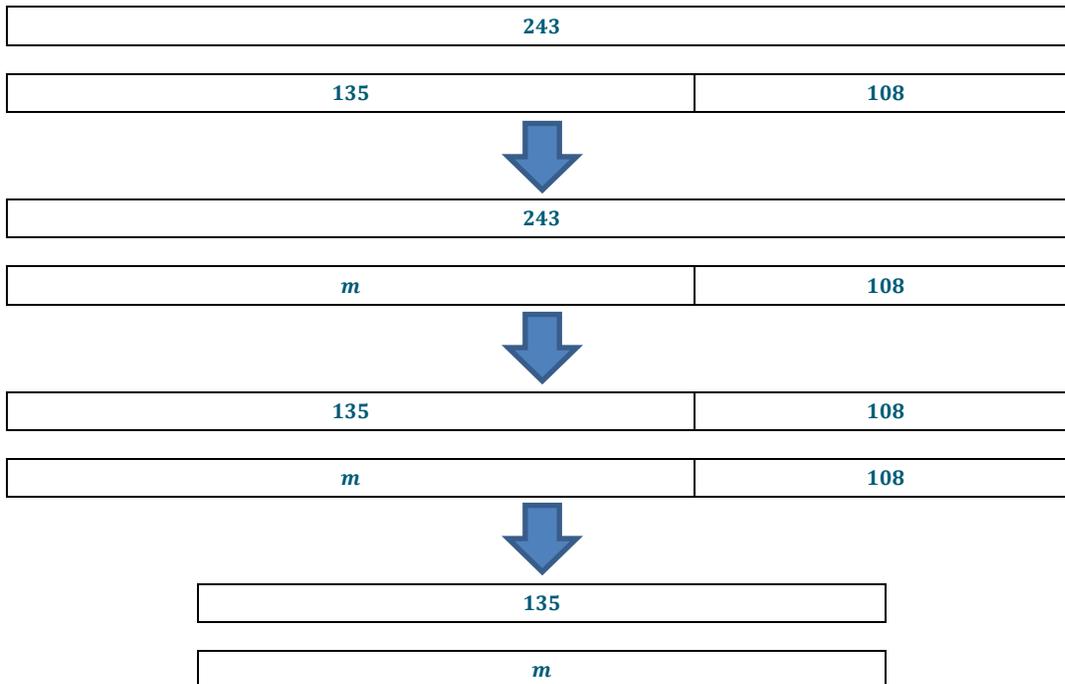
$$g = 76$$

Check: $76 - 62 = 14$; $14 = 14$. This number sentence is true, so the solution is correct.

5. Find the solution to the equation using the method of your choice. Check your answer.

$$m + 108 = 243$$

Tape Diagrams:



Algebraically:

$$m + 108 = 243$$

$$m + 108 - 108 = 243 - 108$$

$$m = 135$$

Check: $135 + 108 = 243$; $243 = 243$. This number sentence is true, so the solution is correct.

6. Identify the mistake in the problem below. Then, correct the mistake.

$$p - 21 = 34$$

$$p - 21 - 21 = 34 - 21$$

$$p = 13$$

The mistake is subtracting rather than adding 21. This is incorrect because $p - 21 - 21$ would not equal p .

$$p - 21 = 34$$

$$p - 21 + 21 = 34 + 21$$

$$p = 55$$

7. Identify the mistake in the problem below. Then, correct the mistake.

$$q + 18 = 22$$

$$q + 18 - 18 = 22 + 18$$

$$q = 40$$

The mistake is adding 18 on the right side of the equation instead of subtracting it from both sides.

$$q + 18 = 22$$

$$q + 18 - 18 = 22 - 18$$

$$q = 4$$

8. Match the equation with the correct solution on the right.

| | | |
|---------------|------------------|----------|
| $r + 10 = 22$ | _____ | $r = 10$ |
| $r - 15 = 5$ | _____ | $r = 20$ |
| $r - 18 = 14$ | _____ | $r = 12$ |
| $r + 5 = 15$ | _____ | $r = 32$ |