Solve Multi-Step Linear Equations

Student Text Pages
163–173

Suggested Timing
80–160 min

Tools
- algebra tiles
- chart paper
- Computer Algebra System (CAS)

Related Resources
BLM 4.2.1 Practice: Solve
  Multi-Step Linear Equations
BLM 4.CO.1 Literacy Link: Concept
  Circle
BLM A4 Application General
  Scoring Rubric
BLM T2 The Computer Algebra
  System (CAS) on the TI-89
  Calculator

Specific Expectations
Manipulating and Solving Algebraic Equations
In this section, students will
ML1.02 determine the value of a variable in the first degree, using a formula (i.e., by isolating the variable and then substituting known values; by substituting known values and then solving for the variable) (e.g., in analytic geometry, in measurement)

Link to Get Ready
Students will solve more complicated equations in this section. This section requires similar skills to the content in Section 4.1. These skills are reviewed in questions 3, 5, and 6 of the Get Ready.

Warm-Up
1. Solve each linear equation.
   a) $3x - 2 = 4$ **b)** $2x - 5 = 0$

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

2. Joseph does not understand how to solve $20 = 3x + 2$ for x, even though he knows that the answer is $x = 6$. Explain to him the concept of opposite operations and how they are used to find x.

Warm-Up Answers

1. a) $x = 2$ **b)** $x = \frac{5}{2}$ **c)** $x = 14$

2. Opposite operations undo operations. To undo the addition of 2, Joseph needs to subtract 2 from both sides. Now Joseph has $18 = 3x$. To undo the multiplication by 3, he needs to divide both sides by 3. Then, he finds that $x = 6$.

Teaching Suggestions
Warm-Up
- Write the Warm-Up questions on the board or on an overhead. Split the class into three groups and assign one part of question 1 to each group. Have students draw a flow diagram on chart paper and post it on the wall. Have each group present the diagram to the class. Discuss the solution to question 2 as a class. (5–10 min)

Section Opener

- Discuss with the class how an air traffic controller ensures that planes fly a safe distance apart and how linear equations may be used to describe the motion of planes.
- Have students research and report back to the class how a biologist can model a population of animals and predict population changes using linear equations.

Investigate

- Have students work in small groups for the Investigate.
- As an alternative activity, you could split the class into small groups. Have each group write on strips of paper a series of steps for tasks such as making a sandwich, building and painting a birdhouse, or mowing a lawn and bagging clippings. Have groups exchange strips and tape them in order onto chart paper. Ask each group to present the ordered steps to the class.
- This Investigate may be done as a class by putting the steps on strips of acetate for the overhead and having students put the steps in order.
- This is a good section to introduce the Computer Algebra System (CAS) to help students with solving equations. This system enables students to master the concept without the interference of simple arithmetic mistakes. You may wish to use **BLM T2 The Computer Algebra System (CAS) on the TI-89 Calculator** for this activity.
- Consolidate students' understanding by discussing the results. Guide students to make the connection between doing a step out of order and not reaching the desired outcome in both the Investigate and when solving a multi-step linear equation.
- Use **BLM 4.2.1 Practice: Solve Multi-Step Linear Equations** for extra practice or remediation.

Investigate Answers (pages 163–164)

Part A
1. Fill the kettle with cold water.
2. Plug in the kettle.
3. Warm the teapot by filling it with hot water.
4. Pour the hot water out of the teapot.
5. Put two tea bags in the teapot.
6. When the kettle boils, pour the boiling water over the teabags.
7. Let the tea steep for four minutes.
8. Remove the teabags.
9. Serve the tea.

Part B
1. Remove the drill bit from the drill.
2. Put the drill bit back in the case.
3. Remove the battery from the cordless drill.
4. Put the battery into the battery charger.
5. Put the drill back into the case.

Examples

- Have students work through the Examples as a class before proceeding to Discuss the Concepts. Alternatively, have students complete the Examples independently or in small groups before reviewing them as a class.
- For Example 1, spend time on part a) where students are asked to describe in words the meaning of the question. If students can do this, solving the equation is much easier.

- Before students begin work on Example 2, have them read the Key Terms in the margin.
- For Example 3, a quick review of the distributive property may help students as they get started on the solution to the example.
- For Example 4 Method 1, some students may need help working with the LCM. You might demonstrate another way to solve the problem:

$$\frac{x + 3}{8} + \frac{x + 1}{3} = 3$$

$$\frac{3(x + 3)}{24} + \frac{8(x + 1)}{24} = 3$$

$$\frac{3x + 9 + 8x + 8}{24} = 3$$

$$\frac{11x + 17}{24} = 3$$

$$11x + 17 = 3 \times 24$$

$$11x = 72 - 17$$

$$11x = 55$$

$$x = \frac{55}{11}$$

$$x = 5$$

- For Example 4 Method 2, you will need to have access to a CAS to follow this method. You may wish to use **BLM T2 The Computer Algebra System (CAS) on the TI-89 Calculator** for this activity. If no such system is available, have students substitute the solution into the original question to verify the solution.

Key Concepts
- Ensure that students are comfortable using opposite operations, algebra tiles, and a CAS. In addition, ensure students are able to identify the least common multiples of denominators.

Discuss the Concepts
- Have students read the questions and record their solutions before starting a class discussion.

Discuss the Concepts Suggested Answers (page 169)

D1. a) Multiply to eliminate the brackets: $5x - 15 + 4 = 2x + 6 + 1$
　　Collect like terms: $5x - 2x = 6 + 1 + 15 - 4$; $3x = 18$
　　Divide by the coefficient of x: $x = 6$

　　b) Multiply both sides by 5: $3m + 1 = -20$
　　Collect like terms: $3m = -21$
　　Divide by the coefficient of m: $m = -7$

D2. Answers will vary. Possible answer: You can move the variable terms to either side, but care must be taken when determining the sign of the resulting coefficient of x.

Practise the Concepts (A)
- Encourage students to refer back to the Examples before asking for assistance.
- Encourage students to keep **BLM 4.CO.1 Literacy Link: Concept Circle** handy for reference.

Apply the Concepts (B)

- Question 7 is a Literacy Connect. As a class, discuss some student responses. Literacy Connect questions offer the opportunity to explore literacy issues in the mathematics classroom and within the context of mathematics. This supports general Think Literacy strategies. For more information visit http://www.edu.gov.on.ca/eng/studentsuccess/thinkliteracy.
- For question 9, outline to students that they have been given an equation that, once solved, will solve the problem.
- Have students read the MathConnect before or after completing question 9. You may wish to have interested students follow the link for more information and report their findings back to the class.
- For question 10, you might wish to have students solve the problem by using fractions first and then by using their decimal equivalents.
- Question 10b) can be done even if students were unable to do part a), because the equation that needs to be solved has been provided.
- Question 14 links to the Chapter Problem. Remind students to keep the solution to this question handy as the methods they used may help them with the Chapter Problem Wrap-Up.

Extend the Concepts (C)

- Assign the Extend the Concepts questions to students who are not being challenged by questions in Apply the Concepts.
- Extend the Concepts questions can be used as a diagnostic assessment for those students considering a university-level course in grade 11.
- Mention to students that they may have seen and used the equation in question 15 in the study of motion in physics class.
- Have students doing the Extend the Concepts questions read the MathConnect before they do question 16. You may wish to have students use the formula in question 16 to measure their cardiorespiratory fitness index in their physical education class.