1.2 The Method of Substitution

Student Text Pages
20–28

Suggested Timing
60–80 min

Technology Tools
- TI-89 graphing calculator

Related Resources
- T–7 The Computer Algebra System (CAS) on the TI-89 Calculator
- BLM 1–4 Section 1.2 Practice Master
- BLM 1–5 Section 1.2 Achievement Check Rubric
- A–6 Knowledge/Understanding General Scoring Rubric
- A–9 Communication General Scoring Rubric

TI-Navigator™

Go to **www.mcgrawhill.ca/books/principles10** and follow the links to the file for this section.

Teaching Suggestions

- Begin this section by reading aloud to the students the introductory paragraphs. Ask them if they agree with the comment, or if they think all linear system questions can be answered using graphing. (2 min)

Investigate

- This section allows students to see how to substitute one expression for a value. Encourage students to circle the expression they are substituting, and cross out the item they are replacing. Using colour can often help, so suggest that students use coloured pencils when working on substitution. (10 min)
- Demonstrate the method of substitution by using algebra tiles, where you have both x- and y-tiles. Show the process of substitution by replacing an x- or y-tile in one equation with what it equals in the other—students actually see the substitution. Use transparent tiles placed on the overhead.
- Use a map of Europe to show students the position of Switzerland and Austria. The marginal Did You Know? may promote discussion. You could speak to the Geography teacher to see if there are any cross-curricular activities you might do with the students.

Examples

- Discuss the **Examples** as a class. (20 min)
- **Example 1** provides a good example of when to use substitution. Soon students will have a variety of methods at their disposal, and will need to decide which method is best in a given situation. Point out that one of the equations is already set up for substitution. Stress the check at the end of the example.
- **Example 2** is not set up nicely for substitution, so students have to rearrange. Draw students back to this example after doing the elimination method.
- **Example 3** shows two methods, one by hand and the other with a CAS. The CAS method models the students' algebraic steps. Have students try the example by hand first and then do it on the CAS. This allows them to verify that the answers are the same, or it may help them to find their mistake (if they made one). Use **T–7 The Computer Algebra System (CAS) on the TI-89 Calculator** to support this activity.
- A common error often occurs with the type of question given in **Example 4**. Many students will incorrectly interpret the question by writing $S + 5 = B$ (Stephanie has five more fish than Brett)
  Be sure to help students to see the difference between $S + 5 = B$ and $S = 5 + B$. Use concrete examples to show the students.
- Review the vocabulary term (method of substitution).

Communicate Your Understanding

- Assign question C2 or C4 as a journal entry item. (10 min)
- Use **A–6 Knowledge/Understanding General Scoring Rubric** when assessing students for this section.
- Use **BLM 1–4 Section 1.2 Practice Master** for remediation or extra practice.

Common Errors

- Some students may have difficulty rearranging the equations for a particular variable.

R_x Have students use colour and arrows to help with their initial work, to become more familiar with the conventions.

Accommodations

Gifted and Enrichment—Challenge students to research the different costs of renting cars and create questions for their classmates to solve.

Visual—Encourage students to highlight the variables in the formulas in the linear systems in different colours.

Perceptual—Allow students to use colour-coding when substituting numbers into linear equations to evaluate variables.

Language—Let students work with a reading buddy who will read the questions to them.

Memory—Encourage students to review the steps required to simplify algebraic expressions.

ESL—Let students work with a partner or in groups.

Investigate Answers (pages 20–21)

1. a) S represents the number of cantons in Switzerland.

b) S represents the number of cantons in Switzerland.

c) the same value

2. a) $3A - 4 + A = 32$ **b)** $A = 9$

c) The number of states in Austria is 9.

d) Substitute $A = 9$ into equation ① and then solve for S.

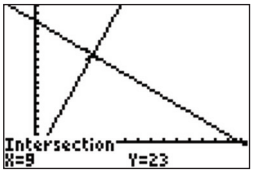
e) $S = 23$

f) The expression for S from the second equation, $3A - 4$, is substituted in place of S in the first equation. This makes an equation with just one variable, A. Solve this equation for A. Substitute the answer for A into the first equation to find what the value of S must be.

3. a) $A = 32 - S$ **b)** $3(32 - S) - 4 = S$

c) $S = 23$ **d)** yes

4. a) yes



b) There are 9 states in Austria and 23 cantons in Switzerland.

Communicate Your Understanding Responses (page 26)

C1. Answers may vary. For example: Substitute the expression for y from equation ① into equation ②. Solve for x. Substitute the value of x into equation ① to find the corresponding value of y. Check your answer.

C2. Answers may vary. For example: Solving by substitution is trying to find the value of x and y that make both equations true. Look for the simpler equation, from which you can obtain an expression for one of the variables. Substitute that expression into the other equation and solve for the one variable remaining. Once you have the value of one variable, substitute back into one of the original equations to find the corresponding value of the other variable.

C3. Answers may vary. For example: The methods are similar because you are still looking for the point that makes both equations true. The methods are different because solving by substitution is algebraic rather than visual.

C4. Answers may vary. For example: It is more advantageous to solve by substitution when the equations are difficult to graph or the answers are not "nice" numbers.

Practise

- Have students work in pairs to check each other's answers in this section. If CAS is available, have students use it to check their answers.
- **Question 6** explicitly asks students to state how they will assign the variables.
- For **questions 7** through **11**, students should start off by using statements telling how they are assigning their variables. It is implicit in a word problem that a declaration should be made at the opening to indicate what the variables represent. Have students try to solve by graphing, just to see how the two methods compare.
- For **questions 11** and **12**, use **A–9 Communication General Scoring Rubric** when assessing students.
- **Question 15** may lead to a discussion of a variety of sports activities in which points are gained when you win, lose, or tie.
- **Question 16** refers to the Chapter Problem. Students can answer this question here or wait until the Chapter Problem Wrap-Up.
- The Achievement Check in **question 17** provides an opportunity to assess whether the students are able to use the two methods used so far in the chapter.
- **Question 19** is an extension in which students can look at the graphical depiction as well as the algebraic situation.

Student Success

Use Think-Pair-Share to have students describe the steps in solving a linear system by substitution.

Given a solution (e.g., $x = 2$, $y = -3$), have students work backwards to invent a system of equations that has this solution.

Refer to the introduction of this Teacher's Resource for more information about how to use a Think-Pair-Share strategy.

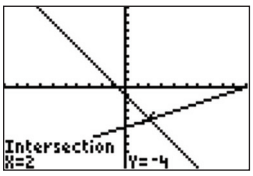
Achievement Check Sample Solution, question 17, page 28

Provide students with **BLM 1–5 Section 1.2 Achievement Check Rubric** to help them understand what is expected.

17. a) Substitute $y = -\frac{3}{2}x - 1$ into the first equation. The solution is $x = 2$ and $y = -4$.

b) Graph the lines by hand or use a graphing calculator.

$y = \frac{x}{2} - 5$ and $y = -\frac{3}{2}x - 1$



c) Let x represent the number of years of growth for the trees.
Let y represent height, in centimetres.
For the blue spruce: $y = 15x + 120$ ①
For the eastern hemlock: $y = 10x + 180$ ②
Solve by substitution.
The trees will be the same height 12 years after planting. At that time their heights will be 300 cm, or 3 m.

Literacy Connections

Whenever students are dealing with word problems, stress that they should state explicitly what their variables represent. Sometimes particular letters regularly represent certain things—for example, in grade 9, m represented the slope and b the y-intercept in the equation of a line. These letters are accepted to represent these things and everyone looking at lines knows this. Students may use the letters m and b if they wish, as long as they state explicitly in the opening of their answer what the m and b represent.

Add the new term in this section to the Word Wall, as well as any words students have difficulty with.

Mathematical Processes Integration

The table shows questions that provide good opportunities for students to use the mathematical processes.

Process Expectations	Selected Questions
Problem Solving	15, 21–23
Reasoning and Proving	3, 12–14
Reflecting	16, 19
Selecting Tools and Computational Strategies	3, 14, 15, 21–23
Connecting	7, 8, 10, 11, 14–16, 18, 19
Representing	6–11, 15, 16, 18, 19
Communicating	3, 12–14, 16, 19

Ongoing Assessment

- Use Achievement Check question 17 to monitor student success. See Achievement Check Answers and **BLM 1–5 Section 1.2 Achievement Check Rubric**.
- Chapter Problem question 16 can also be used as an assessment tool.
- Communicate Your Understanding questions can be used as quizzes to assess students' communication skills.