3.4 Subtracting Vectors

Study Guide and Exercise Book Pages
54 to 56

Tools
- grid paper
- ruler
- protractor
- computer with dynamic geometry software
- grid poster paper

Related Resources
- G–1 Grid Paper
- T–2 *The Geometer's Sketchpad®* 4
- T3–5 How to Do Section 3.4 #14 Using *The Geometer's Sketchpad®*

Teaching Suggestions

Key Concepts

- The **Key Concepts** in this section are very closely related to those in section 3.3. You may want to have students work in groups to revisit the **Key Concepts**, and to "teach" these concepts to one another.
- Use a large, clear grid to draw diagrams of vectors.
- Have students add the rule along with a diagram to their chapter reference sheets.

Example

- Subtracting vectors is similar to subtracting scalars: add the opposite of $\vec{v}$ to $\vec{u}$. You might want to begin the class by revisiting this concept algebraically.
- Consider introducing the lesson by showing the effect of subtracting two vectors with various orientations. First subtract two vectors that have the same direction, and then subtract two vectors that have opposite directions. Then, show what happens when two vectors that have opposite direction and equal magnitude are subtracted. Finally, subtract two vectors that are not parallel.
- You may wish to have students make up their own pair of vectors. They could then present their solutions to the class or exchange their vectors with a partner.
- Have students subtract the vectors using both the triangle and the parallelogram methods. Ask them to explain which method they prefer and why.

Questions

- Review vector notation with students to help them understand the concept of a vector.
- Remind students that vectors in different locations are equivalent if they have the same magnitude and direction.
- It may be helpful to have students work with physical representations of vectors that have been cut out of paper, or made from sticks or pipe cleaners of different lengths.
- Encourage students to use the head-to-tail (triangle) method and the tail-to-tail (parallelogram) method when completing the questions.
- Give students plenty of time and opportunities to practise subtracting two vectors.
- Revisit subtracting polynomial expressions, particularly with students who are having difficulty conceptualizing and understanding subtraction of vectors.
- To help students understand the concept of subtracting vectors, encourage them to draw diagrams of the vector representations when they are doing their homework.
- Some students may not know how to start **question 2a**). They may not know which vector to express as a difference of the other two. Suggest students try the question in a few different ways.

Common Errors
- The concept of subtracting vectors may seem confusing to students simply because of the amount of new notation in this chapter.

R_x Check students' work to ensure that they are using new notation correctly. Have students work in groups to create diagrams on grid poster paper that visually prove **Key Concepts** from the chapter.

Differentiated Instruction

- Have students work in groups so that they have the opportunity to communicate their questions and solutions using terminology that is new to them.
- Have students work in **cooperative task groups** to draw diagrams of any two vectors on grid poster paper. Have them add and subtract the vectors. Use **think aloud** and have one student in each group lead the class through their example.
- As a class, discuss the differences between adding and subtracting vectors.
- It may be helpful for students who are having difficulty understanding the concept of vectors to work with a peer tutor.
- If students are having difficulty drawing vectors, encourage them to work with scale models or to work with *The Geometer's Sketchpad*® to create the vectors.
- It may be helpful to have students work as partners or in small groups to give them an opportunity to practise the concepts and ideas in this section in the classroom, rather than working alone at home.

Ongoing Assessment

- Consider using **question 6** to assess students' understanding of subtracting vectors.
- Consider using **question 13** to assess students' reflecting, connecting, and representing skills.
- Use the following question to assess students' understanding:
  - Suppose $\vec{u}$, $\vec{v}$, and $\vec{w}$ represent the three sides of an equilateral triangle, such that $\vec{u}+\vec{v}+\vec{w}=\vec{0}$. Write an expression for $\vec{u}+\vec{v}-\vec{w}$ and $\vec{u}-\vec{v}-\vec{w}$.

- Review with students that vectors may be named by a single lower-case letter, such as the notation $\vec{u}$ in **question 4**, or using two upper-case letters, such as $\overrightarrow{AB}$.
- For **question 4a**), have students draw the resultant vector for $\vec{u}-\vec{v}$ before drawing $\vec{u}-\vec{v}-\vec{w}$.
- For **question 5**, review types of polygons, especially octagons. Help students recognize that answers may vary for this question.
- For **question 8**, review types of polygons, especially hexagons.
- Some students will find **question 9** challenging because of the three-dimensional diagram.
- For **question 11**, encourage students to be creative when naming the vector in more than one way. You may also want to discuss the definition of *collinear* with students.
- Assign **question 14** to challenge students. You may suggest to students that they test for when the expression is true for scalars, before attempting the question with vectors.

Technology Suggestions

- Consider letting students use the dynamic nature of *The Geometer's Sketchpad*® as an aid in explaining their method in **question 3**.
- You can use *The Geometer's Sketchpad*® to draw the three vectors in **question 4**. You can then dynamically manipulate each vector separately, moving them to illustrate the vector combinations needed in the question. The non-commutative nature of vector subtraction becomes obvious when this is done.
- Use *The Geometer's Sketchpad*® to dynamically illustrate the relationship in **question 13**.
- Use a prepared sketch from *The Geometer's Sketchpad*® to illustrate the concept in **question 16**. See **BLM T3–5 How to Do Section 3.4 #14 Using *The Geometer's Sketchpad*®**.

Mathematical Process Expectations

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

Process Expectation	Selected Questions
Problem Solving	13, 14
Reasoning and Proving	3, 13, 14
Reflecting	4, 8, 14
Selecting Tools and Computational Strategies	3, 13, 14
Connecting	4, 9, 11, 13, 14
Representing	13, 14
Communicating	3, 14