6.5 Solve Problems With Given Constraints

Student Text Pages
335–345

Suggested Timing
80–160 min

Tools
- square dot paper
- isometric dot paper
- computers
- *The Geometer's Sketchpad®*

Related Resources
BLM 6-14 Section 6.5 Solve Problems With Given Constraints
BLM 6-15 Section 6.5 Achievement Check Rubric
BLM G-4 Square Dot Paper
BLM G-5 Isometric Dot Paper
BLM T-2 *The Geometer's Sketchpad®* 3
BLM T-3 *The Geometer's Sketchpad®* 4

Link to Prerequisite Skills

Students should complete all the Prerequisite Skills questions before proceeding with this section.

Warm-Up

1. Liquid waste from a factory is to be stored in a square pond with side length 20 m. The pond must hold 2400 m^3 of waste. How deep must the pond be?
2. The roof of a house measures 21 ft across the base. The roof is 20 ft high. What is the slant height of the roof?
3. A cylindrical silo has an inner diameter of 6 m, outer diameter of 7 m, and height of 20 m. How many cubic metres of concrete are required to form the wall of the silo? Round your answer to the nearest cubic metre.

Warm-Up Answers

1. 6 m **2.** 29 ft **3.** 102 m^3

Teaching Suggestions

Warm-Up

- Write the Warm-Up questions on the board or on an overhead. Have students complete the questions independently. Then, discuss the solutions as a class.

Section Opener

- Some people like to design their own houses. Have students consider building a house on a lot measuring 50 ft by 75 ft. What are some of the constraints they must deal with when designing their house? Constraints may include: minimum distances from the edges of the lot; height of the house; thickness of the walls for insulation purposes; minimum spacing of framing studs and roofing rafters; windows placement for natural lighting; access to utilities such as sewers, electricity, and water; and overall appearance.

Examples

- Have students work through the Examples as a class before proceeding to the Discuss the Concepts. Alternatively, have students complete the Examples independently or in small groups before reviewing them as a class.
- The nets shown in Example 1 are more complicated than any previously used. Calculations must be done first to determine unknown lengths. Students may find it helpful to draw a rough diagram of the net on ordinary paper before drawing the net on dot paper or using *The Geometer's Sketchpad®*.

- You can demonstrate the containment situation described in Example 2 using a cylindrical jar and a square pan. Fill the jar with water, and ask students whether the pan can hold all the water if the jar leaks. Pour the water into the pan to test the prediction.
- As a follow-up, ask students how a berm could be constructed, leading to a reason for the square shape. Berms are usually made by piling up earth, stabilizing the earth with wire screens, and lining the interior with liquid-proof material such as thick plastic sheeting. In the case of toxic waste, there may be a layer of concrete above and below the plastic.

Technology

- You may wish to use the Use Technology section on pages 344–345 at this point. The section gives instructions on how to use *The Geometer's Sketchpad®* to create tessellations using rotations. Supply students with **BLM 6-13 Section 6.4 Use the Transform Menu in *The Geometer's Sketchpad®*** if they have not already received instructions on using this software function.

Key Concepts

- Cost is often an important constraint when designing a structure or product. In many third-world countries, housing is in short supply, but inhabitants cannot afford to buy the kinds of building materials commonly used in Canada. In a dry climate, mud is a viable construction material. It is readily available, and forms a strong material when mixed with straw, and baked in the sun. It will even withstand the occasional rainstorm.

Discuss the Concepts

- Have students work with a partner. Discuss the answers as a class.

Discuss the Concepts Suggested Answers (page 340)

D1. The frames should be strong enough to withstand rough handling or exposure to weather. The lenses must not shatter if broken. The glasses must block strong sunlight, including ultraviolet rays. The glasses should be light, and comfortable to wear for a long period of time. The parts must be easy to manufacture to keep costs low and to maximize profits.

D2. All materials for the huts and the tools to assemble them must be carried in by climbers. Everything should be light, or in parts that can be reassembled. The huts must withstand strong winds and continual use. The materials should be as inexpensive as possible, and available locally so building and repairs can be done quickly.

Practise (A)

- Encourage students to refer to the Examples before asking for assistance.
- You may wish to have copies of **BLM G-4 Square Dot Paper** and **BLM G-5 Isometric Dot Paper** available.
- For **question 1**, students should realize that a cuboidal box provides a maximum volume for a given surface area. This keeps costs down. You may wish to extend this question by asking students why all packaging boxes are not cuboidal.
- In **question 3**, students should discuss the pros and cons of each type of box. A square box is easier to make and fold, but contains more air that cools the pizza during delivery. An octagonal box uses less material, and better insulates the pizza to keep it hot, as well as being a more distinctive package. However, the net is more complex, and requires more time to fold properly.

Apply (B)

- **Questions 5** to **8** provide fertile grounds for extensions, if you are looking for ideas for a summative assessment.
- You may wish to have students extend **question 6** by researching spill containment products and the effects of oil spills on the environment. Go to the McGraw-Hill Ryerson Web-site at *www.mcgrawhill.ca/books/foundations11* and follow the links.
- Report covers work well for the construction in **question 7**.
- In **question 8**, students use drinking straws to build a bridge. Some of these bridges are surprisingly strong. You can make testing weights using plastic drink bottles of various sizes, filled with water. One millilitre of water has a mass of 1 g. A 500-mL bottle of water has a mass of about 0.5 kg.
- **Question 10** links to the Chapter Problem. The containment building for a nuclear reactor is often connected to a vacuum building. In the event of a leak of reactor steam or other vapours, the line to the vacuum building is automatically opened, and the spill is removed. For details on the system used in the Canadian CANDU system, go to the McGraw-Hill Ryerson Web-site at *www.mcgrawhill.ca/books/foundations11* and follow the links. Remind students to keep the solution to this question handy as the methods they used may help them with the Chapter Problem Wrap-Up.
- **Question 11** is an Achievement Check question. It can be used as a diagnostic or formative assessment, or assigned as a small summative assessment piece. You may wish to use **BLM 6-15 Section 6.5 Achievement Check Rubric** to assist you in assessing your students.

Extend (C)

- Assign the Extend questions to students who are not being challenged by the questions in Apply.
- For **question 12**, the typical pressure inside a fully-filled scuba tank is over 200 times normal atmospheric pressure. A 1-ft^3 tank can hold over 200 ft^3 of air when compressed. A tank like this would be used for commercial diving. A tank used for sport diving is smaller, usually holding about 80 ft^3 of compressed air.

Achievement Check Answers (page 343)

11. Yes. From Example 2, the square berm is 40 m by 40 m by 5 m and can hold 6283 m^3 of oil. The perimeter of the berm is 160 m.

A circular berm that could hold the same amount of oil would be a cylinder with height 5 m and diameter 40 m. The circumference is approximately 125.7 m. The circular berm would cover a smaller area.

Common Errors

- Some students may become confused when drawing a complicated net.

R_x Have students work in pairs or small groups and check each other's work. Encourage students to sketch rough diagrams to catch errors before time is invested in drawing the net on dot paper or using geometry software.

- Some students have difficulty visualizing conservation of volume. They do not believe their berm will hold the oil from the tank, despite having made the calculations.

R_x For many students, a physical demonstration is more convincing than a mathematical argument. Use the tank models. Fill the tank with a fine, but dry, "fluid" such as navy beans, rice, or oatmeal to minimize mess. Pour the "fluid" into the berm to show that it does indeed contain the spill.

Accommodations

Visual—prepare a handout with numbered steps and diagrams for construction problems

Spatial—provide additional scaffolding for problems with unfamiliar contexts

Gifted and Enrichment—encourage students to research tessellations and to create an original tessellation

Mathematical Process Expectations

Process Expectation	Questions
Problem Solving	6, 7, 8, 10–13
Reasoning and Proving	3, 4, 11
Reflecting	3, 4, 11
Selecting Tools and Computational Strategies	1, 2, 6, 9–12
Connecting	1, 7, 9, 10, 12
Representing	5, 7–10, 12–14
Communicating	3, 4, 7, 8, 11

Extra Practice

- You may wish to use **BLM 6-14 Section 6.5 Solve Problems With Given Constraints** for remediation or extra practice.