9.1 Investigate Measurement Concepts

Strand:
Measurement and Geometry

Student Text Pages
478 to 483

Suggested Timing
80 to 160

Tools
- geoboard
- toothpicks
- elastic bands
- grid paper

Technology Tools
- *The Geometer's Sketchpad®*
- Corel® *Quattro Pro®*
- Microsoft® *Excel*
- computers

Related Resources
BLM G10 Grid Paper
BLM 9.1.1 Rectangle Data Recording Table
BLM T4 *The Geometer's Sketchpad®* 3
BLM T5 *The Geometer's Sketchpad®* 4
BLM T1 Corel® *Quattro Pro®* 8
BLM T2 Corel® *Quattro Pro®* 10
BLM T3 Microsoft® *Excel*
BLM 9.1.2 Practice: Investigate Measurement Concepts
BLM A11 Group Work Assessment Recording Sheet
BLM A17 Teamwork Self Assessment
BLM A3 Portfolio Checklist

Mathematical Process Expectations Emphasis

- ☑ Problem Solving
- ☑ Reasoning and Proving
- ☑ Reflecting
- ☑ Selecting Tools and Computational Strategies
- ☑ Connecting
- ☑ Representing
- ☑ Communicating

Specific Expectations

Investigating the Optimal Value of Measurements

MG1.01 determine the maximum area of a rectangle with a given perimeter by constructing a variety of rectangles, using a variety of tools (e.g., geoboards, graph paper, toothpicks, a pre-made dynamic geometry sketch), and by examining various values of the area as the side lengths change and the perimeter remains constant;

MG1.02 determine the minimum perimeter of a rectangle with a given area by constructing a variety of rectangles, using a variety of tools (e.g., geoboards, graph paper, a premade dynamic geometry sketch), and by examining various values of the side lengths and the perimeter as the area stays constant;

MG1.05 pose and solve problems involving maximization and minimization of measurements of geometric shapes and figures (e.g., determine the dimensions of the rectangular field with the maximum area that can be enclosed by a fixed amount of fencing, if the fencing is required on only three sides).

Link to Get Ready

This section requires skills with perimeter and area of two-dimensional figures. Assign questions 1 and 2.

Warm-Up

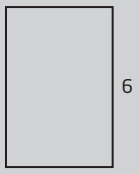
1. a) On grid paper, draw different rectangles that have a perimeter of 20 units.

b) Calculate the area of each rectangle in part a).

Warm-Up Answers

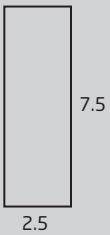
1. a) Answers will vary. Possible answers include:

i)



ii)

iii)



b) i) 24 **ii)** 21 **iii)** 18.75

Teaching Suggestions

- You may wish to use **BLM G10 Grid Paper** for the Warm-Up.
- Introduce the Investigate. Ensure that students understand that the perimeter is fixed. Have students complete the Investigate A, Method 1: Use a Geoboard.
- You may wish to have some students share their results with the class. Use an overhead geoboard to have students illustrate the different rectangles that are possible. (5–10 min)

Common Errors

- Some students may consider the conclusion to an investigation more important than the process.

R_x Stress the importance of the investigation itself. Value the process, not just the conclusion in all class discussions. Encourage students to keep clear records of the results of an investigation (e.g., tables, diagrams, computer sketches, etc.). Treat the investigations like an experiment in a science class. Encourage students to keep their investigations organized so that they may be referred to later. For example, instruct students to keep all of their investigations in a portfolio, and collect and assess their work at the end of the chapter. You may wish to use **BLM A3 Portfolio Checklist** to assist you in assessing student portfolios.

Ongoing Assessment

Communicate Your Understanding questions can be used as quizzes to assess students' Communication skills.

- You may wish to use **BLM 9.1.1 Rectangle Data Recording Table** for Investigate A and B.
- As an alternate strategy to Investigate A, have students use toothpicks instead of a geoboard.
- If the class has access to computers, you may wish to use Method 2: Use *The Geometer's Sketchpad*®. You may wish to use **BLM T4 *The Geometer's Sketchpad*® 3** or **BLM T5 *The Geometer's Sketchpad*® 4** to support this activity. Have students work with a partner. (10 min)
- For another approach, use an overhead geoboard to introduce the Investigate. Have students form different rectangles with an elastic on the overhead geoboard and then discuss the areas of the rectangles. After some discussion, students could complete *The Geometer's Sketchpad*® Method 2. (15–20 min)
- Follow this Investigate with a class discussion. The play area should be square to result in the largest area.
- The OSAPAC Committee (Ontario Software Acquisition Program Advisory Committee) has licensed the student edition of *The Geometer's Sketchpad*® for students' home use. Make students aware of this opportunity.
- Investigate B involves finding the perimeter of rectangles with a fixed area. This can be done on grid paper using a paper and pencil technique. Use **BLM G10 Grid Paper** for this activity.
- Alternatively, if there is computer access, have students use a spreadsheet program. You may wish to use **BLM T1 Corel® *Quattro Pro*® 8**, **BLM T2 Corel® *Quattro Pro*® 10**, or **BLM T3 Microsoft® *Excel*** to support this activity.
- Follow up with a class discussion. The pet exercise area should be square to use the least amount of fencing.
- The Investigate skills are the focus of this section. Encourage students to use any manipulatives that might suit an Investigate. Have geoboards and elastics, toothpicks, grid paper, interlocking cubes, etc., readily available in the classroom. Where possible, provide access to computers so that students can use spreadsheets or *The Geometer's Sketchpad*® to complete the Investigates.
- You may wish to use **BLM 9.1.1 Practice: Investigate Measurement Concepts** for remediation or extra practice.

Investigate Answers (page 478)

A: Method 1

1. b)

Rectangle	Width (m)	Length (m)	Perimeter (m)	Area (m)
1	1	5	12	5
2	2	4	12	8
3	3	3	12	9

c) 3 rectangles

2. a) Rectangle 1 has the least area; its dimensions are 1×5; its shape is a narrow rectangle.

b) Rectangle 3 has the greatest area; its dimensions are 3×3; its shape is a square.

3. Answers will vary. Sample answer: I would choose rectangle 3 (a square) because for a given length of rope, 12 m, greatest area can be enclosed.

Method 2

8. Use *The Geometer's Sketchpad*® to draw graphs.

15. Answers will vary. Sample answer: I would choose rectangle 3 (a square) because for a given length of rope, 12 m, greatest area can be enclosed.

Accommodations

Gifted and Enrichment—Challenge students to use toothpicks to build enclosures with the greatest area using other types of quadrilaterals and other shapes.

Visual—Provide verbal instructions for the steps for students to use *The Geometer's Sketchpad*® to complete the Investigate.

Motor—Provide students with enlarged photocopies of the tables in this section for them to fill in the results of the Investigate. If students complete the Investigate using *The Geometer's Sketchpad*®, they should work together with a partner, or in groups.

Language—Let students give an oral report of the findings of the Investigate rather than a written report.

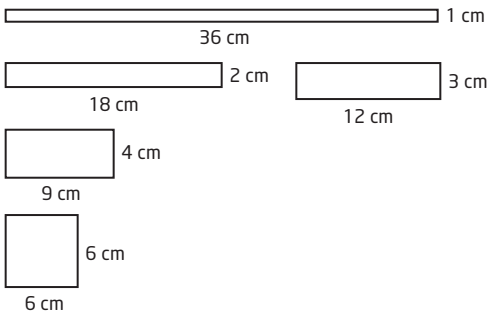
Memory—Review with the students the steps required to use a spreadsheet to complete the Investigate.

Student Success

Use **jigsaw** to have students learn and teach the investigations in this section using multiple methods (pencil and paper, spreadsheet, manipulatives, graphing calculators).

B:

1. a)



b) Answers will vary. The values in the Width (m) and the Length (m) columns can be interchanged.

Rectangle	Width (m)	Length (m)	Perimeter (m)	Area (m^2)
1	1	36	74	36
2	2	18	40	36
3	3	12	30	36
4	4	9	26	36
5	6	6	24	36

2. a) 6 m × 6 m **b)** 1 m × 36 m

3. As can be seen from the table above, all five rectangles enclose 36 m^2 of land but require different lengths of fencing. I would use Rectangle 5 (a square: 6 m × 6 m) for the pet exercise area as it requires the least amount of fencing to enclose the same area.

Communicate Your Understanding Responses (page 482)

C1. Answers will vary. Let each square on the grid paper represent 1 unit and draw different rectangles with a perimeter of 40 units. Once the rectangles have been drawn, measure the dimensions of each rectangle and record them. Then, use the formula for the area of a rectangle (Area = length × width) to determine and compare the areas of various rectangles with a perimeter of 40 units.

C2. Answers will vary. Let the space between 2 pins equal 1 unit and use an elastic band to make different rectangles with a perimeter of 15 units.

Practise

Questions 1 and 2 are similar to Investigate A and use grid paper (question 1) and toothpicks (question 2). Use **BLM G10 Grid Paper** for question 1.

Question 3 is similar to Investigate B, but uses a geoboard.

Connect and Apply

Question 4 has a fixed area and a geoboard is used.

Question 5 has a fixed perimeter and uses *The Geometer's Sketchpad*®. Use **BLM T4 *The Geometer's Sketchpad*® 3** or **BLM T5 *The Geometer's Sketchpad*® 4** for question 5.

Question 6 has a fixed perimeter and uses either grid paper or a spreadsheet. Use **BLM G10 Grid Paper or BLM T1 Corel® *Quattro Pro*® 8**, **BLM T2 Corel® *Quattro Pro*® 10**, or **BLM T3 Microsoft® *Excel*** for question 6.

Give students opportunities to use a variety of strategies and tools for conducting investigations. The strategies for the questions can be interchanged.

Extend

Have students work in small groups for question 7. Have each group submit a brief report. You may wish to use **BLM A11 Group Work Assessment Recording Sheet** to assist you in assessing your students. Or, use **BLM A17 Teamwork Self Assessment** as a self-assessment. Students will handle the circular enclosure in a variety of ways. Some may use a circumference of 36, solve for the radius, and then calculate the area. Others may try to calculate the area of the 36-sided regular polygon! Any appropriate technique would be acceptable. Follow with a class discussion. The circular enclosure would have the largest area and student answers should illustrate this trend.

The Math Contest question is a variation on the fixed perimeter scenario. The fact that the three fields are adjoined will mean that a square is not the optimal shape. Again, students should be encouraged to use different manipulatives to conduct this investigation.

Exercise Guide

Category	Question Number
Minimum	1–4
Typical	1–6
Extension	7