McGRAW-HILL RYERSON

MATHEMATICS 7

MAKING CONNECTIONS

Authors

Elizabeth Ainslie
Hon. B.Sc., B.Ed.
Toronto District School Board

Wayne Erdman
B.Math., B.Ed.
Toronto District School Board

Dan Gilfoy
B.Sc. (Agr.), B.Ed.
Halifax Regional School Board

Honi Huyck
B.Sc., B.Ed.
Belle River, Ontario

Stacey Lax
B.A., B.Ed., M.Ed.
York Region District School Board

Brian McCudden
M.A., M.Ed., Ph.D.
Toronto, Ontario

Kelly Ryan
Hon. B.Sc., B.Ed.
Toronto District School Board

Jacob Speijer
B.Eng., M.Sc.Ed., P.Eng.
District School Board of Niagara

Sandy Szeto
B.Sc., B.Ed.
Toronto District School Board

Michael Webb
B.Sc., M.Sc., Ph.D.
Toronto, Ontario

Assessment/Pedagogy Consultants

Elizabeth Ainslie
Toronto District School Board

Brian McCudden
Toronto, Ontario

Combined Grades Consultant

Jonathan Dean
Hamilton-Wentworth District School Board

Special Education Consultants

Pauline Creighton
District School Board of Niagara

Deirdre Gordon
Hastings and Prince Edward District School Board

Technology Consultant

Honi Huyck
Belle River, Ontario

Mental Mathematics Consultant

Joan Manuel
District 10, St. Stephen, New Brunswick

Literacy Consultant

Anne Burnham MacLeod
District 18, Fredericton, New Brunswick

English as a Second Language Consultant

Jane E. Sims
Toronto, Ontario

Advisors

Chris Dearling
OISE - University of Toronto

Catherine Little
Toronto District School Board

Shelley McCurdy
Simcoe Muskoka Catholic District School Board

Tess Miller
Durham District School Board

Troy Parkhouse
District School Board of Niagara

Debbie Price
Greater Essex County District School Board

Mary E. O'Neill
The Halifax Regional School Board, Nova Scotia

McGraw-Hill Ryerson

Toronto Montréal Boston Burr Ridge, IL Dubuque, IA Madison, WI New York
San Francisco St. Louis Bangkok Bogotá Caracas Kuala Lumpur Lisbon London
Madrid Mexico City Milan New Delhi Santiago Seoul Singapore Sydney Taipei

COPIES OF THIS BOOK MAY BE OBTAINED BY CONTACTING:

McGraw-Hill Ryerson Ltd.

WEB SITE:
http://www.mcgrawhill.ca

E-MAIL:
orders@mcgrawhill.ca

TOLL-FREE FAX:
1-800-463-5885

TOLL-FREE CALL:
1-800-565-5758

OR BY MAILING YOUR ORDER TO:
McGraw-Hill Ryerson
Order Department
300 Water Street
Whitby, ON L1N 9B6

Please quote the ISBN and title when placing your order.

Student Text ISBN:
0-07-0909S0-4

McGraw-Hill
Ryerson Limited
A Subsidiary of The McGraw-Hill Companies

McGraw-Hill Ryerson
Mathematics 7: Making Connections

ISBN 0-07-090950-4

http://www.mcgrawhill.ca

3 4 5 6 7 8 9 10 **TRI** 0 9 8 7 6 5

Printed and bound in Canada

The Geometer's Sketchpad®, Key Curriculum Press, 1150 65th Street, Emeryville, CA 94608, 1-800-995-MATH.

National Library of Canada Cataloging in Publication Data

Mathematics 7 : making connections / authors, Elizabeth Ainslie ... [et al.].

Includes index.
ISBN 0-07-090950-4

1. Mathematics—Textbooks. I. Ainslie, Elizabeth
II. Title: Mathematics seven.

QA107.2.M39 2004 510 C2004-901442-0

PUBLISHER: Diane Wyman
PROJECT MANAGER: Helen Mason
DEVELOPMENTAL EDITORS: Maggie Cheverie, Jean Ford, Tom Gamblin, Jacqueline Lacoursiere
MANAGER, EDITORIAL SERVICES: Linda Allison
SUPERVISING EDITOR: Crystal Shortt
COPY EDITOR: Julia Cochrane
PERMISSIONS EDITOR: Paula Joiner
JUNIOR EDITORS: Scott Rostrop, Darren Scanlan
EDITORIAL ASSISTANT: Erin Hartley
MANAGER, PRODUCTION SERVICES: Yolanda Pigden
PRODUCTION CO-ORDINATOR: Janie Deneau
COVER AND INTERIOR DESIGN: Pronk & Associates
ART DIRECTION: Tom Dart/First Folio Resource Group, Inc.
ELECTRONIC PAGE MAKE-UP: Tom Dart, Greg Duhaney, Claire Milne, Adam Wood of First Folio Resource Group, Inc.
COVER IMAGE: David Brooks/CORBIS/MAGMA

Acknowledgements

Reviewers

The authors and editors of McGraw-Hill Ryerson Mathematics 7: Making Connections, *wish to thank the following educators for their thoughtful comments and creative suggestions about what would work best in grade 7 classrooms. Their input has been invaluable in making sure that the text and its related Teacher's Resource meet the needs of students and teachers of Ontario.*

Rahat Ahmed
Toronto District School Board

Chris Aikman
Hastings and Prince Edward District School Board

Jennifer Anderson
Ottawa-Carleton District School Board

Mary Anderson
York Region District School Board

Dan Antflyck
Toronto District School Board

Vijaya Balchandani
Toronto District School Board

Sarah Barclay
Upper Canada College

Tracey Bates
Ottawa-Carleton Catholic District School Board

Wayne Bechard
St. Clair Catholic District School Board

Matthew Bernstein
York Region District School Board

Michael Blackburn
Limestone District School Board

Andrew Canham
Ottawa-Carleton District School Board

Dennis Caron
Toronto Catholic District School Board

Richard Chaplinsky
Ottawa-Carleton Catholic District School Board

Adam Conacher
Ottawa-Carleton District School Board

Gordon Cooke
Upper Canada District School Board

Paul Cornies
Greater Essex County District School Board

Darlene Davison
Kawartha Pine Ridge District School Board

Charmaine Donnelly
Halifax Regional School Board

Angela Esau
District School Board of Niagara

George Fawcett
Hamilton Wentworth District School Board

Jodee Anne Ferdinand
Renfrew County District School Board

Maria Fotias Ginis
Toronto District School Board

Joanne Harris
Halton District School Board

Cheri Heslop
Upper Grand District School Board

Todd Horn
Sudbury Catholic District School Board

Stephen Hua
Hamilton-Wentworth District School

Iwan Jugley
District School Board of Niagara

Marion Kline
Grand Erie District School Board

Sylvia Constancio Kwan
Toronto District School Board

Heather Leonard
York Region District School Board

Dianne Lloyd
St. Clair Catholic District School Board

Stephen MacEachern
Durham Catholic District School Board

Patricia Macey
Peterborough Victoria Northumberland and Clarington Catholic District School Board

Jim Markovski
The Durham District School Board

Sean Marks
Halton District School Board

Christina Maschas-Hammond
Peterborough Victoria Northumberland and Clarington Catholic District School Board

Chester Makischuk
York Catholic District School Board

Mykola Matviyenko
Toronto District School Board

Cindy Terrade Moffat
Ottawa-Carleton District School Board

Suzanne Morrison
Upper Canada District School Board

Stephen Nevills
Durham District School Board

Jeremy Nowiski
Ottawa-Carleton District School Board

Megan Nowiski
Ottawa-Carleton District School Board

Dennis Paré
Ottawa-Carleton District School Board

Christopher Perry
Hamilton Wentworth District School Board

Kenneth Stanley Peterson
Kawartha Pine Ridge District School Board

Marilyn Price
Lower Sackville, Nova Scotia

Anna Przybylo
Durham Catholic District School Board

Lydia Rabenko-Javor
Toronto District School Board

Chad Richard
Toronto District School Board

Sherry St. Denis
Toronto District School Board

William Searle
Ottawa-Carleton District School Board

Jessica Silver
Limestone District School Board

Wuchow Than
Hamilton-Wentworth District School Board

Peter Thompson
Appleby College

Lisa True
Durham Catholic District School Board

Kathy Valiquette
Peterborough Victoria Northumberland and Clarington Catholic District School Board

Theresa Varney
District School Board of Niagara

Cara White
Kawartha Pine Ridge District School Board

Alan Wickens
Toronto District School Board

Field-Test Teachers

The authors and editors of McGraw-Hill Ryerson Mathematics 7: Making Connections, *wish to thank these teachers for their thoughtful comments and suggestions about what worked best in their classrooms. Their input has been invaluable in making sure that the text activities, explanations, Tasks, and teacher's resource support meet the needs of students and teachers.*

Melanie Allport
Limestone District School Board

Greg Arkwright
Trillium Lakelands District School Board

Andrew Austin
Peterborough Victoria Northumberland and Clarington Catholic District School Board

Wayne Bechard
St. Clair Catholic District School Board

Yolanda Calquhoun
Thames Valley District School Board

Richard Chaplinsky
Ottawa-Carleton Catholic District School Board

Pete Cobb
Lambton Kent District School Board

Patrizia DiFabio
Simcoe Muskoka Catholic District School Board

Angela Esau
District School Board of Niagara

Pegita Ghasemi
Toronto District School Board

Maria Fotias Ginis
Toronto District School Board

Gordana Grmuša
Greater Essex County District School Board

Todd Hayward
Lambton Kent District School Board

Cheri Heslop
Upper Grand District School Board

Michael Hill
Simcoe County District School Board

Dana Hopkins
Greater Essex County District School Board

Jan Kidd
Greater Essex County District School Board

Athina Lakoseljac
Toronto District School Board

Gloria Lasovich
Waterloo Catholic District School Board

Cyril Lewin
Toronto District School Board

Chris MacDonald
Toronto District School Board

Mike MacDonald
Dufferin-Peel Catholic District School Board

Stephen MacEachern
Durham Catholic District School Board

Christina Maschas Hammond
Peterborough Victoria Northumberland and Clarington Catholic District School Board

Michael Masse
York Region District School Board

Frank Mercuri
Niagara Catholic District School Board

Cindy Terrade Moffat
Ottawa-Carleton District School Board

Suzanne Morrison
Upper Canada District School Board

Kevin Reid
Durham District School Board

Cathy Renda
Waterloo Catholic District School Board

Elaine Roberts
Algonquin Lakeshore Catholic District School Board

Alex Sikkema
Emmanuel Christian School

Jiiva Somerville
Peel District School Board

Beth Vallance
Avon-Maitland District School Board

Wes Vickers
Greater Essex County District School Board

Rachel Wallage
Brant Haldimand-Norfolk Catholic District School Board

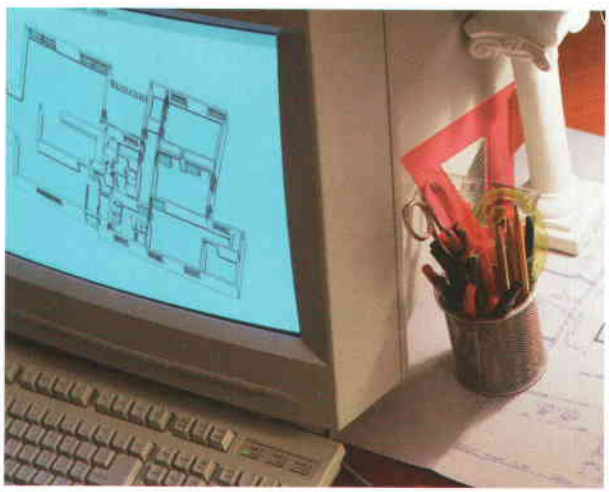
Dawna Wastesicoot
Durham District School Board

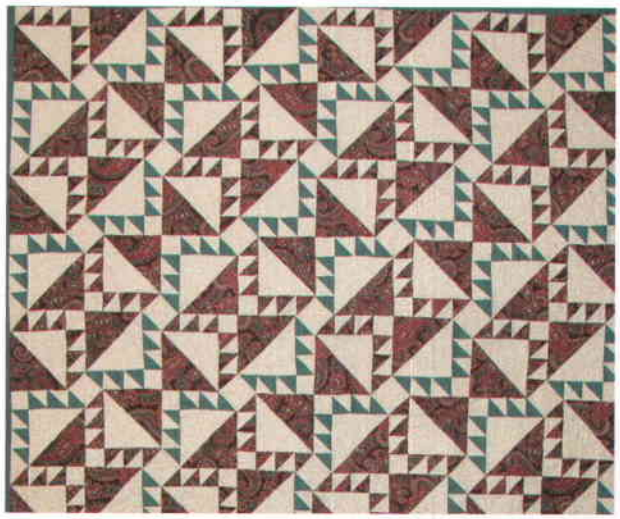
Jackie Watson
Niagara Catholic District School Board

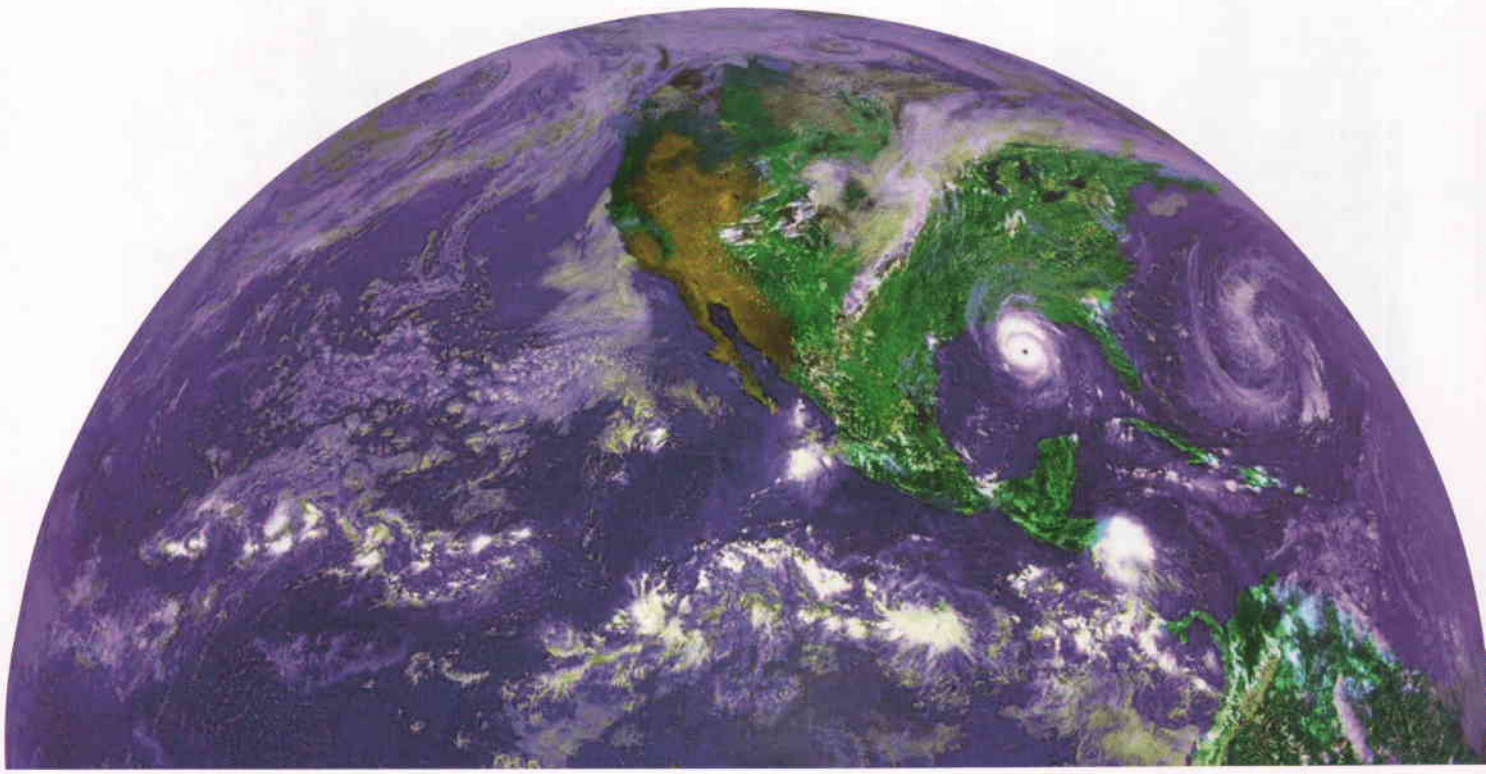
Vickie Williams
Hastings and Prince Edward District School Board

Margarita Ziroldo
Ottawa-Carleton Catholic District School Board

Contents







CHAPTER 12

CHAPTER 13

A Tour of Your Textbook

How is *Mathematics 7: Making Connections* set up?

Each chapter starts off with a **Chapter Problem** that connects math and your world. You will be able to solve the problem using the math skills that you learn in the chapter.

www.mcgrawhill.ca/links/math7 and follow the links to find out more about wind chill.

Chapter Problem

The thermometer reads −10°C. The wind is from the northwest at 25 km/h. The radio weather forecaster says that this gives a wind chill of −19. This means it feels as cold as it would on a calm day with a temperature of −19°C.

What patterns or trends can you see in the wind chill chart? Start by looking down the −10°C temperature column and across the 25 km/h wind speed row.

You are asked to answer questions related to the problem throughout the chapter.

Chapter Problem

14. Traditionally, patchwork quilts were made by sewing together square or rectangular pieces of fabric. Modern designs use many different shapes.

a) List all the geometric shapes that you can find in the patchwork quilt shown.
b) Design your own patchwork quilt containing at least 20 patches. Include at least two different types of quadrilaterals. Draw the design in your notebook.

The **Chapter Problem Wrap-Up** is at the end of the chapter, on the second Practice Test page.

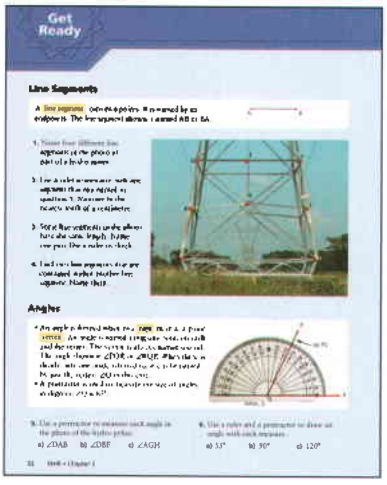
Chapter Problem Wrap-Up

Patterns that use a variety of shapes are more interesting. Design a pattern for the front of your binder, or for another similar purpose. You may draw it on paper, and then create it using pieces of coloured tissue paper, fabric, wood, or other materials you choose.

Your pattern block should include
- two different quadrilaterals
- two different triangles
- some congruent figures
- some similar figures

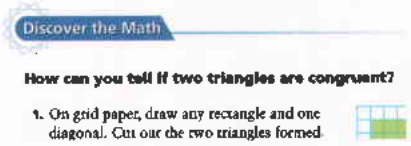
Write an e-mail to a friend giving a brief description of your design. List its geometric properties.

The **Get Ready** pages provide a brief review of skills from previous grades that are important for success with this chapter.



The **numbered sections** often start with a photo to connect the topic to a real setting. The purpose of this introduction is to help you make connections between the math in the section and the real world, or to make connections to previous knowledge.

A three-part lesson follows.

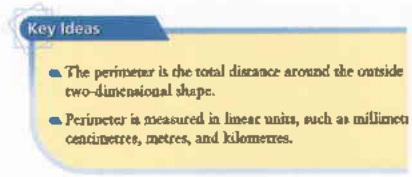

Discover the Math

How can you tell if two triangles are congruent?

1. On grid paper, draw any rectangle and one diagonal. Cut out the two triangles formed.

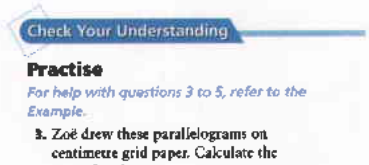
The first part helps you find answers to the key question.

- An activity is designed to help you build your own understanding of the new concept and lead toward answers to the key question.
- **Examples** and **Solutions** demonstrate how to use the concept.


Key Ideas

- The perimeter is the total distance around the outside two-dimensional shape.
- Perimeter is measured in linear units, such as millimetres, centimetres, metres, and kilometres.

- A summary of the main new concepts is given in the **Key Ideas** box.
- Questions in the **Communicate the Ideas** section let you talk or write about the concepts and assess whether you understand the ideas.

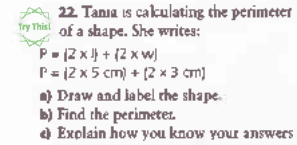

Check Your Understanding

Practise

For help with questions 3 to 5, refer to the Example.

3. Zoë drew these parallelograms on centimetre grid paper. Calculate the area of each one.

- **Practise:** these are straightforward questions to check your knowledge and understanding of what you have learned.
- **Apply:** in these questions, you need to apply what you have learned to solve problems.
- **Extend:** these questions may be a little more challenging and may make connections to other lessons.


Try This!

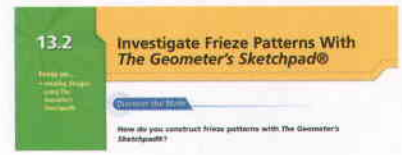
22. Tania is calculating the perimeter of a shape. She writes:

$P = (2 \times l) + (2 \times w)$

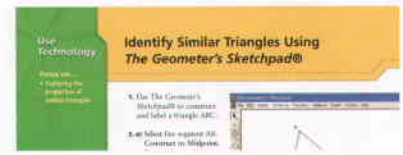
$P = (2 \times 5\text{ cm}) + (2 \times 3\text{ cm})$

a) Draw and label the shape.
b) Find the perimeter.
c) Explain how you know your answers

The last Apply question in each set of questions is designed to assess your level of success with the section. Everyone should be able to respond to at least some part of each Try This! question.


13.2 Investigate Frieze Patterns With *The Geometer's Sketchpad®*

Numbered sections that have a green tab are based on the use of technology such as scientific calculators, spreadsheets, or *The Geometer's Sketchpad®*.

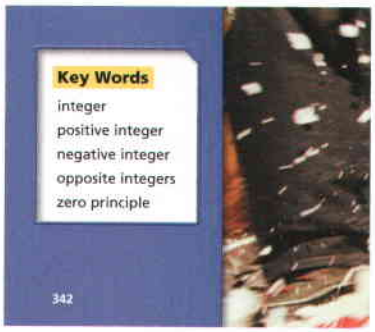

Use Technology: Identify Similar Triangles Using *The Geometer's Sketchpad®*

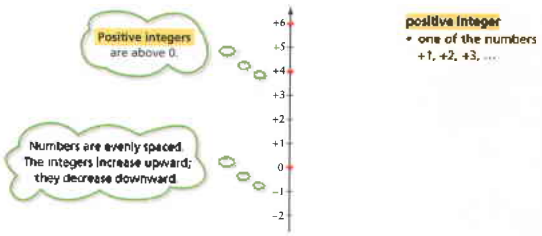
Some numbered sections are followed by a Use Technology feature. This means some or part of the preceding section may be done using the technology shown.

How does *Mathematics 7: Making Connections* help you learn?

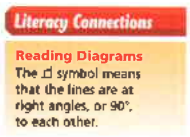
Understanding Vocabulary

Key words are listed on the Chapter Opener. Perhaps you already know the meaning of some of them. Great! If not, watch for these terms highlighted the first time they are used in the chapter. The meaning is given close by in the margin.



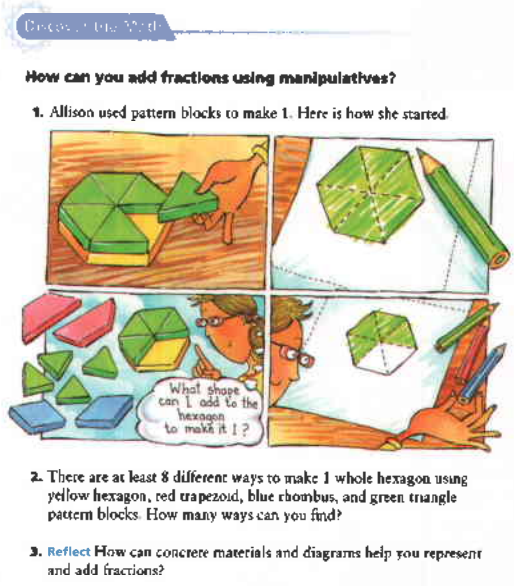


Literacy Connections provide tips to help you read and interpret items in math. These tips will help you in other subjects as well.



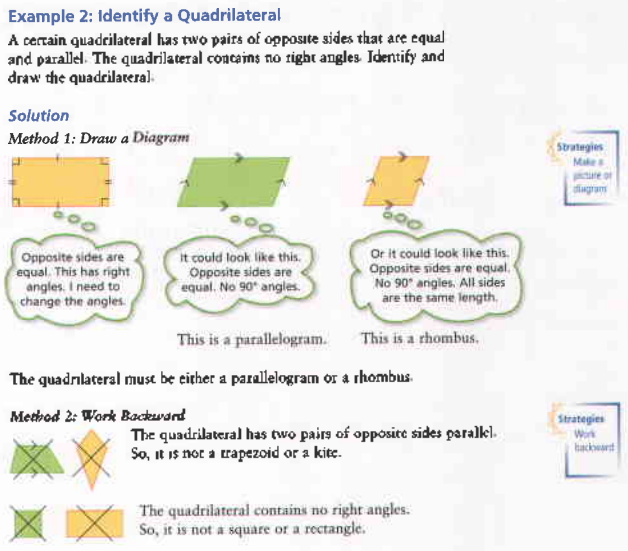
Understanding Concepts

The Discover the Math activity is designed to help you construct your own understanding of new concepts. The key question tells you what the activity is about. Short steps, with illustrations, lead you to be able to make some conclusions in the last step, the **Reflect** question.



The **Examples** and their worked **Solutions** include several tools to help you understand the work.

- Notes in a thought or speech bubble help you think through the steps.
- Sometimes different methods of solving the same problem are shown. One way may make more sense to you than the other.
- **Problem Solving Strategies** are pointed out.
- Calculator key press sequences are shown where appropriate.



Example 2: Identify a Quadrilateral

A certain quadrilateral has two pairs of opposite sides that are equal and parallel. The quadrilateral contains no right angles. Identify and draw the quadrilateral.

Solution

Method 1: Draw a Diagram

Strategies: Make a picture or diagram

Opposite sides are equal. This has right angles. I need to change the angles.

It could look like this. Opposite sides are equal. No 90° angles.

Or it could look like this. Opposite sides are equal. No 90° angles. All sides are the same length.

This is a parallelogram. This is a rhombus.

The quadrilateral must be either a parallelogram or a rhombus.

Method 2: Work Backward

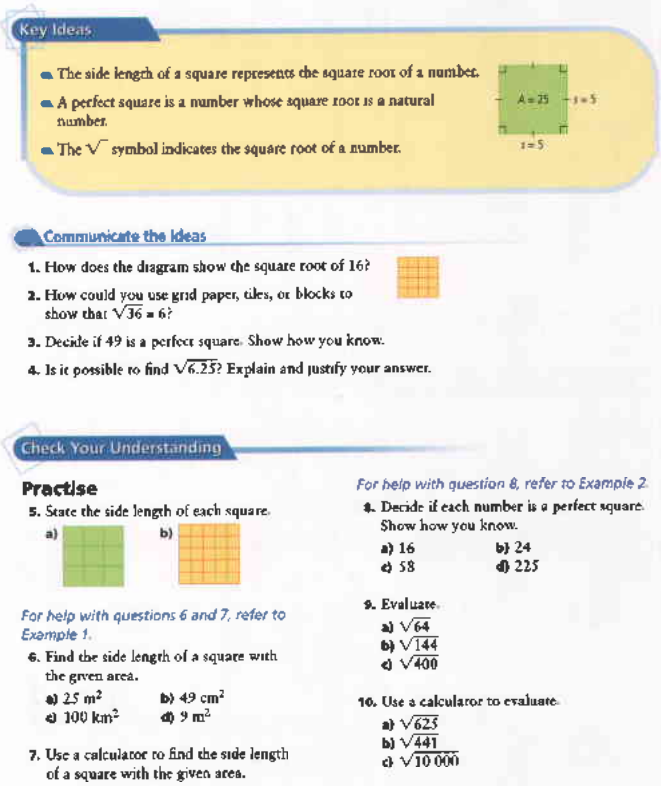
Strategies: Work backward

The quadrilateral has two pairs of opposite sides parallel. So, it is not a trapezoid or a kite.

The quadrilateral contains no right angles. So, it is not a square or a rectangle.

The exercises begin with **Communicate the Ideas.** These two or three short questions focus your thinking on the **Key Ideas** you learned in the section. By discussing these questions in a group, or doing the action called for, you can see whether you understand the main points and are ready to start the exercises.

The first few questions in **Check Your Understanding** can often be done by following one of the worked Examples.



Key Ideas

- The side length of a square represents the square root of a number.
- A perfect square is a number whose square root is a natural number.
- The $\sqrt{\ }$ symbol indicates the square root of a number.

A = 25, s = 5, s = 5

Communicate the Ideas

1. How does the diagram show the square root of 16?
2. How could you use grid paper, tiles, or blocks to show that $\sqrt{36} = 6$?
3. Decide if 49 is a perfect square. Show how you know.
4. Is it possible to find $\sqrt{6.25}$? Explain and justify your answer.

Check Your Understanding

Practise

5. State the side length of each square.

a) b)

For help with questions 6 and 7, refer to Example 1.

6. Find the side length of a square with the given area.
   a) 25 m^2 b) 49 cm^2
   c) 100 km^2 d) 9 m^2
7. Use a calculator to find the side length of a square with the given area.

For help with question 8, refer to Example 2.

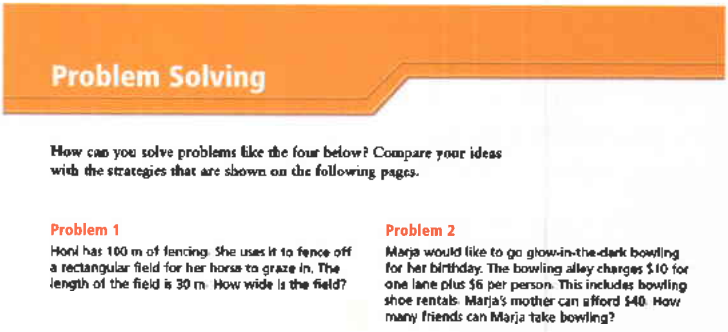
8. Decide if each number is a perfect square. Show how you know.
   a) 16 b) 24
   c) 58 d) 225
9. Evaluate.
   a) $\sqrt{64}$
   b) $\sqrt{144}$
   c) $\sqrt{400}$
10. Use a calculator to evaluate.
    a) $\sqrt{625}$
    b) $\sqrt{441}$
    c) $\sqrt{10\,000}$

What else will you find in *Mathematics 7: Making Connections*?

Two special sections at the beginning of the book will help you to be successful with the grade 7 course.

Problem Solving

This is an overview of the four steps you can use to approach solving problems. Samples of 12 problem solving strategies are shown. You can refer back to this section if you need help choosing a strategy to solve a problem. You are also encouraged to use your own strategies.



Problem Solving

How can you solve problems like the four below? Compare your ideas with the strategies that are shown on the following pages.

Problem 1

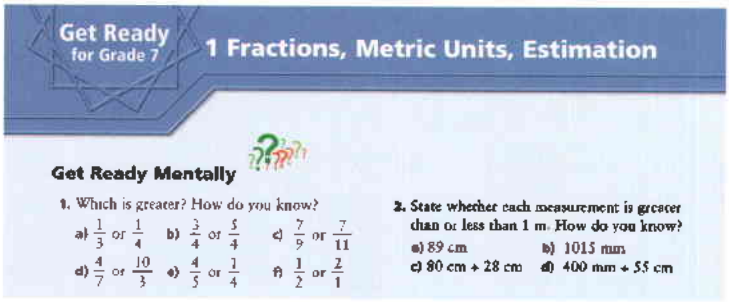
Honi has 100 m of fencing. She uses it to fence off a rectangular field for her horse to graze in. The length of the field is 30 m. How wide is the field?

Problem 2

Marja would like to go glow-in-the-dark bowling for her birthday. The bowling alley charges $10 for one lane plus $6 per person. This includes bowling shoe rentals. Marja's mother can afford $40. How many friends can Marja take bowling?

Get Ready for Grade 7

These six pages present a brief review of basic concepts from earlier grades and ways of thinking about the concepts.



Get Ready for Grade 7 — 1 Fractions, Metric Units, Estimation

Get Ready Mentally

1. Which is greater? How do you know?
   a) $\frac{1}{3}$ or $\frac{1}{4}$ b) $\frac{3}{4}$ or $\frac{5}{4}$ c) $\frac{7}{9}$ or $\frac{7}{11}$
   d) $\frac{4}{7}$ or $\frac{10}{3}$ e) $\frac{4}{5}$ or $\frac{1}{4}$ f) $\frac{1}{2}$ or $\frac{2}{1}$

2. State whether each measurement is greater than or less than 1 m. How do you know?
   a) 89 cm b) 1015 mm
   c) 80 cm + 28 cm d) 400 mm + 55 cm

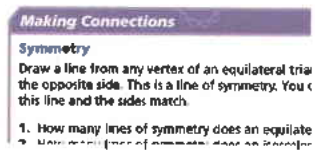
Other Special Features

Did You Know?

Mers Kutt invented the world's first personal computer in Ontario in 1973. It was called the MCM-70 Microcomputer. It had only 2 to 8 kilobytes of random access memory (RAM) and 14 kilobytes of read-only memory (ROM).

Did You Know?

These are interesting facts related to math topics you are learning.



Making Connections

Symmetry

Draw a line from any vertex of an equilateral tria the opposite side. This is a line of symmetry. You c this line and the sides match.

1. How many lines of symmetry does an equilate

Making Connections

These activities link the current topic to careers, games, or to another subject.

b) Draw two other designs for paper airplanes. What types of triangles do they involve? Go to www.mcgrawhill.ca/links/math7 and follow the links if you need some suggestions.

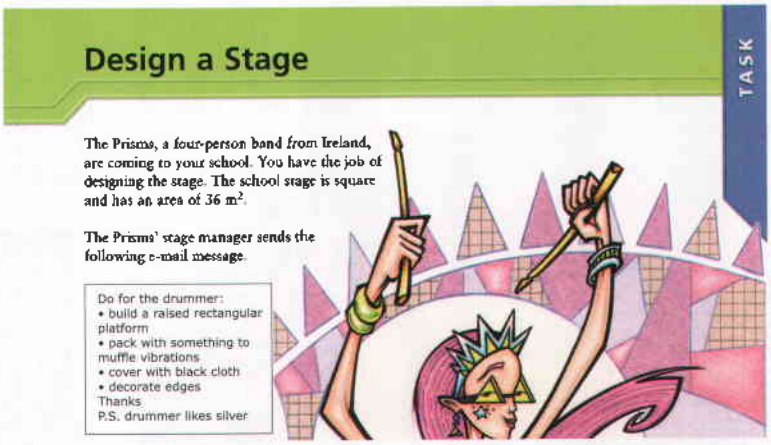
Internet Connect

You can find extra information related to some questions on the Internet. Log on to www.mcgrawhill.ca/links/math7 and you will be able to link to recommended Web sites.

Each chapter ends with a **Chapter Review** and a **Practice Test**. The chapter review is organized by section number so you can look back if you need help with a question. The test includes the different types of questions that you will find on provincial tests: multiple choice, short answer, and extended response.

Task

These projects follow each pair of chapters. To provide a solution, you may need to combine skills from multiple chapters and your own creativity.



Reviews of the previous four chapters can be found following Chapters 4, 8, and 12.

Answers

Answers are provided to the odd-numbered Practise, Apply, and Extend questions, as well as, Reviews and Practice Tests. Sample answers are given for questions that have a variety of possible answers or that involve communication. If you need help, read the sample and then try to give an alternative response.

Answers are omitted for the Try This and the Chapter Problem questions because teachers may use these questions to assess your progress.

Glossary

Refer to the illustrated Glossary at the back of the text if you need to check the exact meaning of mathematical terms.

Problem Solving

How can you solve problems like the four below? Compare your ideas with the strategies that are shown on the following pages.

Problem 1

Honi has 100 m of fencing. She uses it to fence off a rectangular field for her horse to graze in. The length of the field is 30 m. How wide is the field?

Problem 2

Marja would like to go glow-in-the-dark bowling for her birthday. The bowling alley charges $10 for one lane plus $6 per person. This includes bowling shoe rentals. Marja's mother can afford $40. How many friends can Marja take bowling?

Problem 3

Rani is paid $7 per hour to baby-sit the neighbour's two children. Rani is saving for a new bike. How many hours does he need to baby-sit to earn enough money for the bike?

Problem 4

The corner store has five flavours of ice cream: chocolate, strawberry, bubble gum, rocky road, and orange fizz. How many different two-scoop cones are possible?

People solve mathematical problems at home, at work, and at play. There are many different ways to solve problems. In *Mathematics 7: Making Connections*, you are encouraged to try different methods and to use your own ideas. Your method may be different but it may also work.

A Problem Solving Model

Where do you begin with problem solving? It may help to use the following four-step process.

Understand

Read the problem carefully.

- Think about the problem. Express it in your own words.
- What information do you have?
- What further information do you need?
- What is the problem asking you to do?

Plan

Select a strategy for solving the problem. Sometimes you need more than one strategy.

- Consider other problems you have solved successfully. Is this problem like one of them? Can you use a similar strategy? Strategies that you might use include
  - Make a model
  - Make an assumption
  - Make a picture or diagram
  - Find needed information
  - Choose a formula
  - Solve a simpler problem
  - Act it out
  - Make an organized list
  - Work backward
  - Make a table or chart
  - Use systematic trial
  - Look for a pattern
- Decide whether any of the following might help. Plan how to use them.
  - tools such as a ruler or a calculator
  - materials such as graph paper or a number line

Do It!

Solve the problem by carrying out your plan.

- Use mental math to estimate a possible answer.
- Do the calculations.
- Record each step you are doing.
- Explain and justify your thinking.

Look Back

Examine your answer. Does it make sense?

- Is your answer close to your estimate?
- Does your answer fit the facts given in the problem?
- Is the answer reasonable? If not, make a new plan. Try a different strategy.
- Consider solving the problem a different way. Do you get the same answer?
- Compare your method with that of other students.

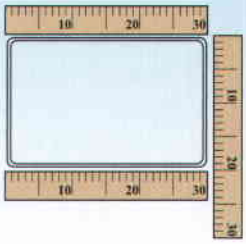
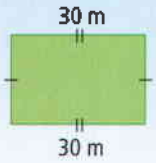
Problem Solving Strategies

Here are twelve strategies you can use to help solve problems. The chart shows you different ways to solve the four problems on page xvi. Your ideas on how to solve the problems might be different from any of these.

To see other examples of how to use these strategies, refer to the page references. These show where the strategy is used in other sections of *Mathematics 7: Making Connections*.

Problem 1

Honi has 100 m of fencing. She uses it to fence off a rectangular field for her horse to graze in. The length of the field is 30 m. How wide is the field?

Strategy	Example	Other Examples
Make a model	Use three 30-cm rulers and a piece of string 100 cm long. Assume that each centimetre represents 1 m. $30 + 30 + 20 + 20 = 100$ The width of the field is 20 m. 	pages 98, 122, 153, 248, 253
Make a picture or diagram	$30 + 30 = 60$ The two lengths are 60 m. $100 - 60 = 40$ The two widths add to 40 m. $20 + 20 = 40$ One width is 20 m. distance around is 100 m 	pages 41, 62, 105, 181, 411
Choose a formula	The formula for the perimeter, P, of a rectangle is $P = l + w + l + w$ Substitute $P = 100$ and $l = 30$. $100 = 30 + w + 30 + w$ Add these two numbers. $100 = 60 + w + w$ $100 = 60 + 40$ It is a rectangle. The widths are the same size. $20 + 20 = 40$ The width of the field is 20 m.	pages 13, 168, 254

Problem 2

Marja would like to go glow-in-the-dark bowling for her birthday. The bowling alley charges $10 for one lane plus $6 per person. This includes bowling shoe rentals. Marja's mother can afford $40. How many friends can Marja take bowling?

Strategy	Example	Other Examples
Act it out	 Here is $10 for the lane. Add $6 for 1 person. That's $16.  Four more piles of $6 give $40 altogether. I used $10 and then 5 times $6 to make $40. For $40, five people can go bowling. Marja is one of the people. She can take four friends.	pages 134, 400
Work backward	It costs $10 for the lane. $40 - 10 = 30$ This means $30 is left for the people. Each person costs $6. $\frac{30}{6} = 5$ $30 is enough for 5 people. One of these is Marja. She can take four friends.	pages 62, 411
Use systematic trial	The cost is $10 plus $6 per person. Try 3 people: $10 + 3 \times 6$ $= 10 + 18$ $= 28$ Too low. She can take more friends. Try 5 people: $10 + 5 \times 6$ $= 10 + 30$ $= 40$ Right on. For $40, five people can go bowling. Marja is one of the people. She can take four friends.	pages 215, 406

Problem 3 Rani is paid $7 per hour to baby-sit the neighbour's two children. Rani is saving for a new bike. How many hours does he need to baby-sit to earn enough money for the bike?

Strategy	Example	Other Examples
Make an assumption	 The problem does not say how much Rani's new bike costs. I will assume that he is saving for a racing bike that costs about $350 including taxes. Find the number of hours to earn $350. $\frac{350}{7} = 50$ Rani needs to baby-sit for 50 h to earn $350.	pages 167, 225
Find needed information	 The problem does not say how much Rani's new bike costs. I found the price of bikes in an advertising flyer. The one I like costs $210. Find the number of hours to earn $210. $\frac{210}{7} = 30$ Rani needs to baby-sit for 30 h to earn $210.	pages 171, 225

Problem 4

The corner store has five flavours of ice cream: chocolate, strawberry, bubble gum, rocky road, and orange fizz. How many different two-scoop cones are possible?

Strategy	Example	Other Examples

Solve a simpler problem

What if the only two choices were chocolate and strawberry?
There are only 3 possible two-scoop cones:
chocolate with strawberry, double chocolate, or double strawberry

OK, this gets me started. Now I will make an organized list of the possible pairs for five choices. I don't think the order of scoops of different flavours matters.

pages 126, 226

Make an organized list

I could also show this list in a tree diagram.

1. chocolate + strawberry
2. chocolate + bubble gum
3. chocolate + rocky road
4. chocolate + orange fizz
5. strawberry + bubble gum
6. strawberry + rocky road
7. strawberry + orange fizz
8. bubble gum + rocky road
9. bubble gum + orange fizz
10. rocky road + orange fizz

There are 10 different combinations of two scoops. A person might choose two scoops of the same flavour. That makes 5 more possibilities.
Fifteen different two-scoop cones are possible using the five flavours.

pages 127, 135

Make a table or chart

	chocolate	strawberry	bubble gum	rocky road	orange fizz
chocolate	x	x	x	x	x
strawberry		x	x	x	x
bubble gum			x	x	x
rocky road				x	x
orange fizz					x

Fifteen different two-scoop cones are possible using the five flavours.

pages 192, 399

Look for a pattern

loop means double

	Possibilities
1 flavour ⊂C	1 double = 1
2 flavours ⊂C—S⊃	1 mixed + 2 doubles = 3
3 flavours ⊂C—R⊃ (S)	3 mixed + 3 doubles = 6
4 flavours ⊂C—R⊃ (S, B)	6 mixed + 4 doubles = 10

From 1 to 3 is add 2, 3 to 6 is add 3, 6 to 10 is add 4. The increase between numbers is one more each time. The next number in the pattern is 10 + 5.

Look for a pattern: 1, 3, 6, 10, ...
Fifteen different two-scoop cones are possible using the five flavours.

pages 95, 105

1 Fractions, Metric Units, Estimation

Get Ready Mentally

1. Which is greater? How do you know?

a) $\frac{1}{3}$ or $\frac{1}{4}$ **b)** $\frac{3}{4}$ or $\frac{5}{4}$ **c)** $\frac{7}{9}$ or $\frac{7}{11}$

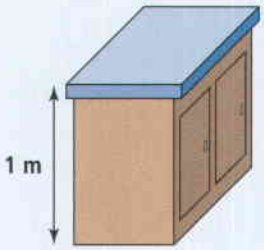
d) $\frac{4}{7}$ or $\frac{10}{3}$ **e)** $\frac{4}{5}$ or $\frac{1}{4}$ **f)** $\frac{1}{2}$ or $\frac{2}{1}$

2. State whether each measurement is greater than or less than 1 m. How do you know?

a) 89 cm **b)** 1015 mm

c) 80 cm + 28 cm **d)** 400 mm + 55 cm

Get Ready by Thinking



1 cm = 10 mm
1 m = 100 cm
1 g = 1000 mg
1 kg = 1000 g
1 L = 1000 mL

Choose the most reasonable estimate in questions 3 to 9. Share your estimates with a partner. Explain your thinking.

3. The length of a newly sharpened pencil is about

A 4 cm **B** 18 cm
C 74 mm **D** 18 mm

4. The mass of a calculator is about

A 25 g **B** 0.75 kg
C 40 g **D** 0.25 kg

5. The length of this textbook is about

A 8 cm **B** 120 cm
C 230 mm **D** 150 mm

6. The shaded portion is about

A $\frac{2}{3}$ **B** $\frac{2}{5}$
C $\frac{9}{10}$ **D** $\frac{3}{4}$

7. The volume is about

A 30 mL **B** 200 mL
C 0.5 L **D** 125 mL

8. The height of your classroom door is about

A 2.4 m **B** 360 cm
C 420 cm **D** 1.4 m

9. The total of this sale, before tax, is about

lined paper	$1.99
binder	$3.49
pens	$2.38
compasses set	$2.95
backpack	$9.97

Estimate to the nearest dollar.

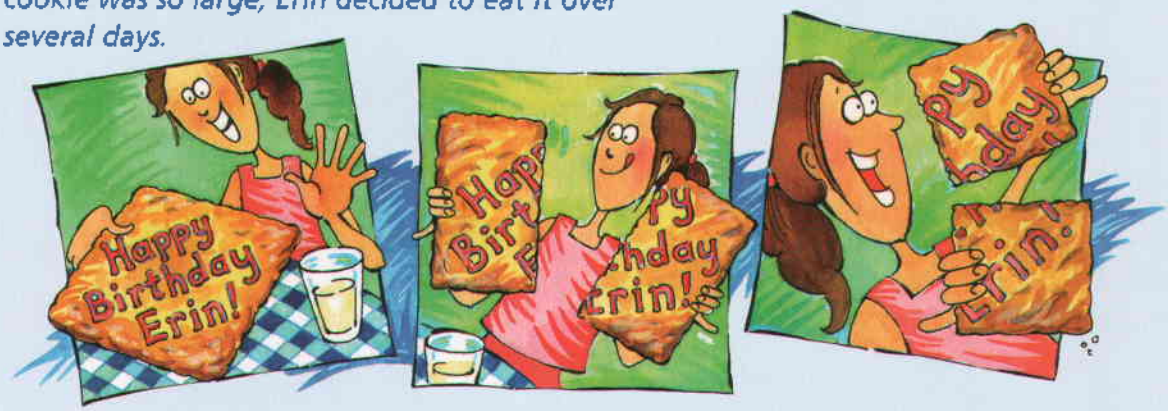
A $17 **B** $20
C $10 **D** $71

Get Ready by Exploring

Materials

- BLM Get Ready 7A Erin's Cookie

Erin's aunt baked a giant cookie for Erin's birthday. Because the cookie was so large, Erin decided to eat it over several days.



10. If Erin continues in this way, how much of the original cookie will she eat on the eighth day? How much will be left?

11. **a)** What patterns can you see as Erin eats her cookie?

b) Make a diagram of the different sizes of cookie pieces.

12. A regular cookie has a mass of about 12 g. On the eighth day, Erin's cookie was about the size of a regular cookie. Estimate the mass of Erin's original cookie. Describe how you estimated.

13. About how many regular cookies would make up Erin's cookie?

14. When will Erin finish eating her cookie? Explain using words, manipulatives, or pictures.

Get Ready by Reflecting

15. How would you describe a fraction? Use words or pictures to explain five things you know about fractions.

16. Use words or pictures to describe the relationship between the following units of measure.

a) millimetres, centimetres, metres, and kilometres

b) millilitres and litres

c) milligrams, grams, and kilograms

17. What do you consider to be a good estimate? What advice would you give a classmate who is having difficulty estimating?

2 Multiplying and Dividing Decimals, Estimation

Get Ready Mentally

1. Solve.

a) 32×10 **b)** 32×100
c) 32×0.1 **d)** 32×0.01

2. Solve.

a) $32 \div 10$ **b)** $32 \div 100$
c) $32 \div 0.1$ **d)** $32 \div 0.01$

3. Explain the rules you used in questions 1 and 2.

4. $32 \times 6 = 192$. Use this fact to find each product.

a) 32×60 **b)** 3.2×6
c) 32×0.6 **d)** 3.2×0.6

5. $3205 \div 5 = 641$. Use this fact to find each quotient.

a) $320.5 \div 5$ **b)** $3205 \div 50$
c) $32.05 \div 5$ **d)** $3205 \div 500$

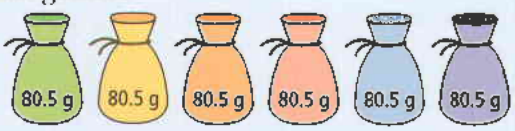
Get Ready by Thinking

Choose the most reasonable estimate for questions 6 to 12. Share your estimates with a partner. Explain your thinking.

6. About how many litres of paint are there altogether?

A 12 L **B** 13 L
C 12.5 L **D** 14.75 L

7. About how many grams of candy are there altogether?



A 600 g **B** 540 g
C 480 g **D** 48 g

8. A model train travels seven times around a 6.5-m track. About how many metres does the train travel?

A 43 m **B** 455 m
C 46 m **D** 42 m

9. About how many millilitres of juice are there altogether?

A 1600 mL **B** 1500 mL
C 1700 mL **D** 1650 mL

10. Heather divides 25 m of rope equally among four people. About how many metres of rope does each person get?

A 7 m **B** 6 m **C** 21 m **D** 6.3 m

11. Ali's teacher asks him to divide a bucket of centimetre cubes equally into nine plastic bags. There are 758 centimetre cubes. About how many will be in each bag?

A 80 **B** 90 **C** 85 **D** 7200

12. In a four-person relay, the finish time was 55.3 s. If each person ran for the same length of time, for about how long did each person run?

A 12 s **B** 13 s **C** 14 s **D** 15 s

Get Ready by Exploring

Coach Doyle held tryouts for the school cross-country team. Two students will make the team. To help decide which ones, Coach Doyle looked at the results from three special events.

Event 1: Students chose their favourite trail and ran as many complete laps as they could without stopping. Only complete laps counted.

- Carriff ran 3 laps of a 2.6-km trail.
- Jeremy ran 2 laps of a 3.2-km trail.
- Len ran 4 laps of a 1.8-km trail.
- Meghan ran 6 laps of a 1.3-km trail.
- Amy ran 3 laps of a 2.1-km trail.

Event 2: Students ran as much of a 1500-m course as they could without stopping and recorded the distance travelled.

- Carriff ran the entire course.
- Jeremy ran 0.75 of the course.
- Len ran 0.65 of the course.
- Meghan ran 0.9 of the course.
- Amy ran 0.8 of the course.

13. How far did each student run in Event 1?

14. How far did each student run in Event 2?

15. Organize the results in a way that would help Coach Doyle decide who should make the team.

16. Which two students would you recommend for the team? Explain your choices.

Get Ready by Reflecting

17. Describe the relationship between the number of decimal places in the numbers you are multiplying or dividing and the number of decimal places in the answer. Use words or diagrams.

18. How can estimation help you in your calculations with decimals?

19. What advice would you give a classmate who is having difficulty multiplying and dividing decimals?

3 Patterns With Natural Numbers, Fractions, and Decimals

Get Ready Mentally

1. Identify the next three numbers in each pattern.

a) 3, 5, 7, ■, ■, ■
b) 1, 4, 7, ■, ■, ■
c) 3, 13, 23, ■, ■, ■
d) 1, 4, 9, 16, ■, ■, ■
e) 2, 13, 24, ■, ■, ■
f) 2, 5, 11, 20, ■, ■, ■

2. Identify the next three numbers in each pattern.

a) $\frac{1}{4}, \frac{2}{4}, \frac{3}{4}$, ■, ■, ■
b) 2.7, 3.0, 3.3, ■, ■, ■
c) $1, \frac{1}{2}, \frac{1}{4}, \frac{1}{8}$, ■, ■, ■
d) $3.5, 4\frac{1}{2}, 5.5$, ■, ■, ■

Get Ready by Thinking

3. Explain what happens to the input number to get the output number.

a)

Input	Output
4	7
7	10
12	15

b)

Input	Output
3	9
5	13
7	17

c)

Input	Output
2	6
5	15
8	24

d)

Input	Output
4	9
10	21
3	7

Strategies
Look for a pattern

4. Create a pattern of your own and ask a classmate to describe the pattern.

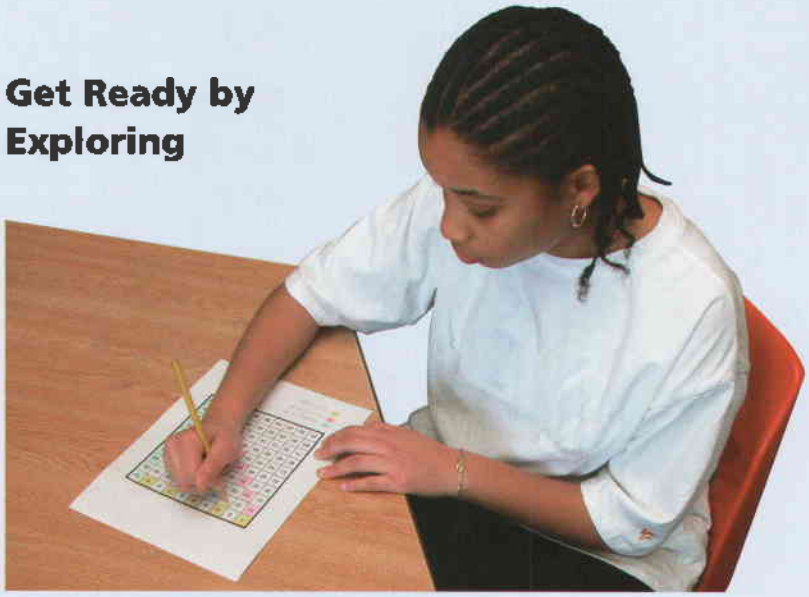
5. Look at the number line.

a) What number could each letter represent? Explain your reasoning.
b) Where might 130 be on the number line?
c) About how far apart are A and D?
d) Do you think C is greater than or less than 100? Why?

Literacy Connections

Using Problem Solving Strategies
To learn about different problem solving strategies, refer to the Problem Solving section on pages xvi to 1. The orange banner will help you find these pages. Refer to these pages whenever you need help deciding on a strategy to use to solve a problem.

Get Ready by Exploring



Materials

- pencil crayons
- BLM Get Ready 7B Hundred Chart

Sharon was asked to find number patterns on a hundred chart.

6. Describe a general pattern for each column.

7. Describe a diagonal pattern that you see on your hundred chart.

8. Sharon said that the number 48 belonged to only three different number patterns. Is Sharon correct? Explain.

9. How many patterns does the number 65 belong to?

10. Describe a pattern that 84 belongs to.

11. Describe a pattern that 5, 7, 17, and 43 belong to.

12. What do the numbers 8 and 12 have in common?

13. How many patterns could Sharon find containing the number 18? Describe them.

14. Use your own hundred chart to find five patterns. Use pencil crayons to show the numbers that belong to each pattern. Include a legend to identify the pattern for each colour.

15. Work with a partner. Ask each other questions about the patterns each of you found on your hundred charts.

Get Ready by Reflecting

16. Describe the most interesting pattern you found.

17. Describe the most interesting pattern your partner found.

18. What general statements can you make about the patterns you found on your hundred chart?

Measurement

- Estimate and calculate area and perimeter of 2-D shapes, including various trapezoids.
- Develop the formulas for area of a parallelogram, triangle, and trapezoid.
- Define and describe measurement concepts.
- Ask questions about linear measurement and area.
- Research and report on uses of measurement.

Number Sense and Numeration

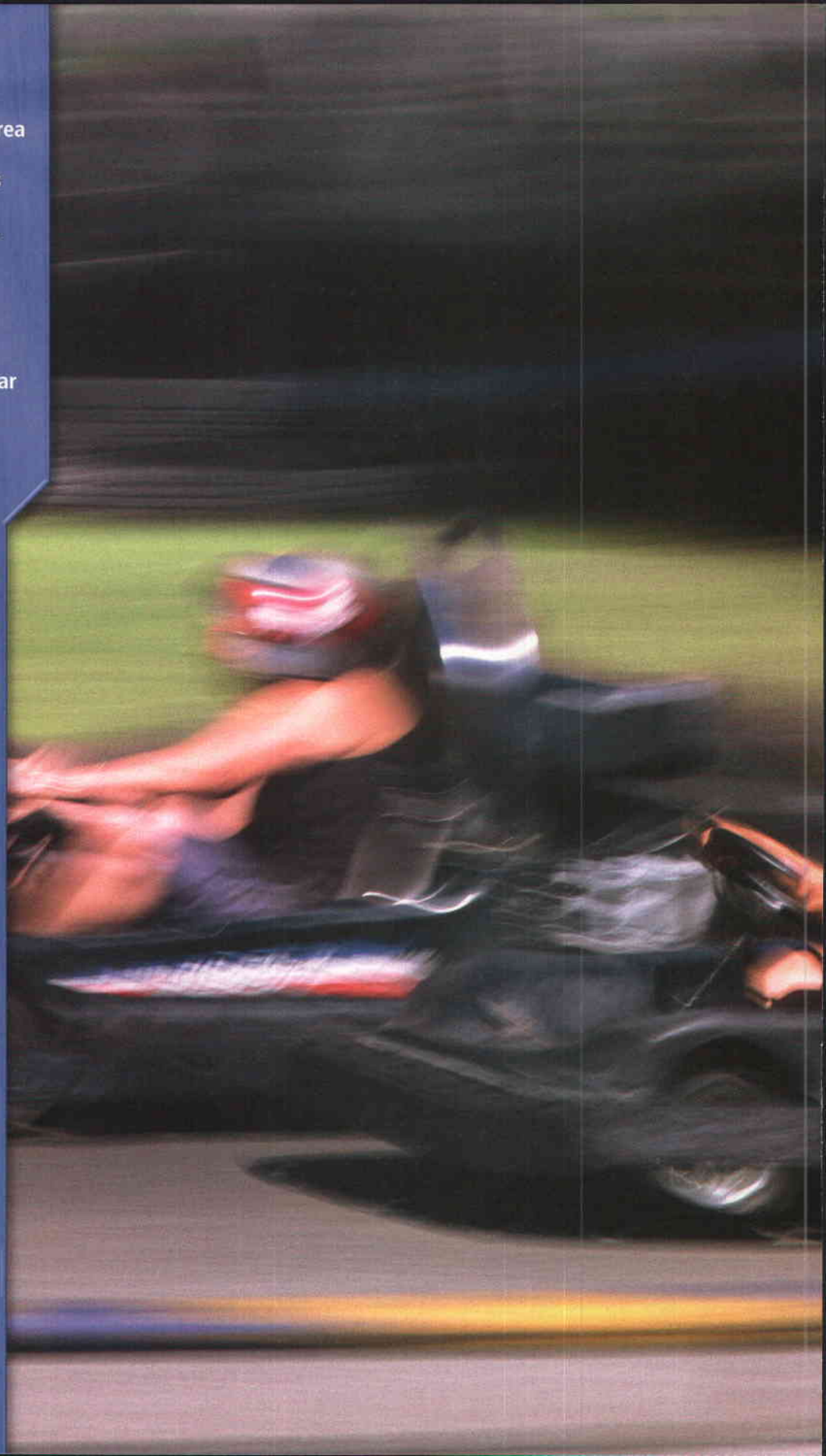
- Justify the choice of method for calculations.
- Solve problems, using calculators.
- Understand and apply the order of operations, including brackets.

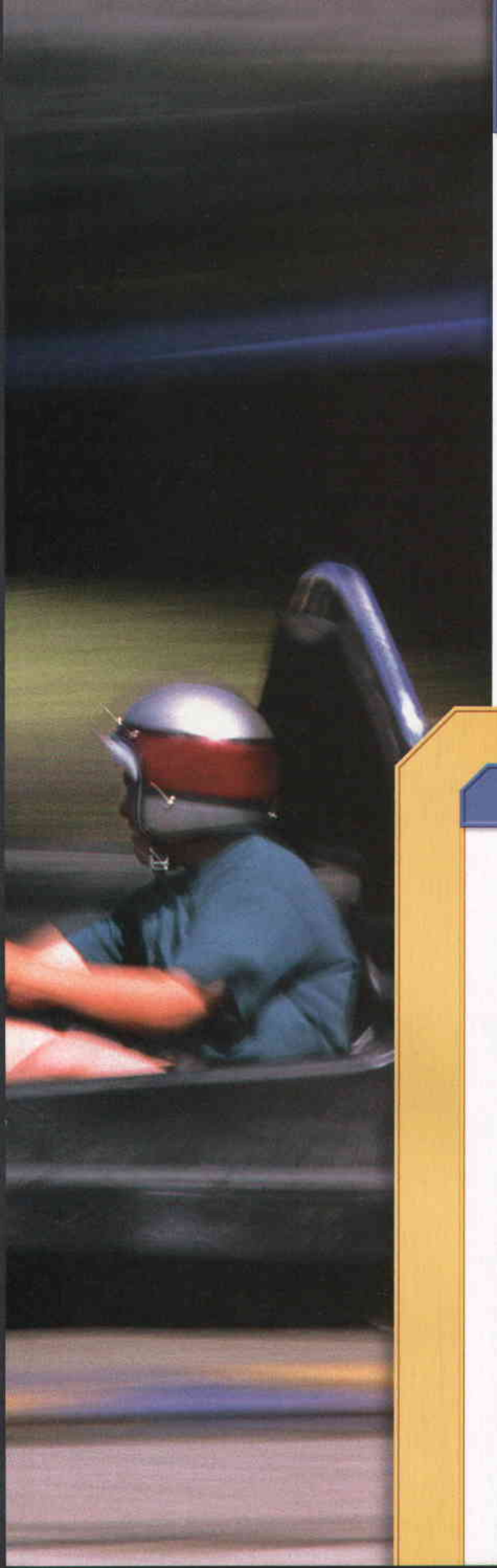
Geometry and Spatial Sense

- Identify and describe geometric figures.

Key Words

parallelogram
base
height
triangle
order of operations
trapezoid
vertex
composite shape





CHAPTER 1

Measurement and Number Sense

Have you ever driven a go-kart or watched go-kart racing?

Look at the go-karts in the picture. What geometric shapes do you recognize?

Participating in and watching go-kart racing can be lots of fun. Many go-karters like to design and build their own go-karts.

By the end of this chapter, you will be able to build your own go-kart model and go off to the races!

Chapter Problem

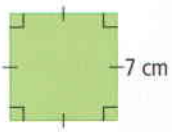
Think about various parts of the go-karts in the picture. How many pieces would you have to develop to design your own go-kart?

Perimeter

Perimeter is the distance around the outside of a two-dimensional shape or figure. It is measured in linear units.

Common linear units are millimetres (mm), centimetres (cm), metres (m), and kilometres (km).

What is the perimeter of this square?



The markings show which sides have equal lengths.

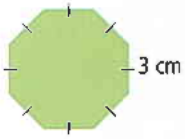
$P = 7 + 7 + 7 + 7$
$P = 28$

The perimeter of the square is 28 cm.

A **regular polygon** is a closed two-dimensional figure with all sides equal and all angles equal. To find the perimeter of this regular octagon, multiply the side length by 8.

$P = 8 \times 3$
$P = 24$

The perimeter is 24 cm.

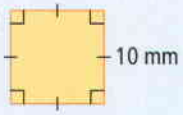


Literacy Connections

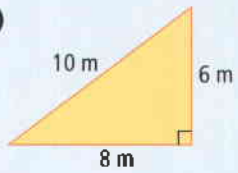
Reading Diagrams
Short marks across two or more identical sides of a figure show that these sides have equal length.

1. Find the perimeter of each shape.

a)

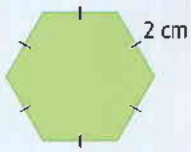


b)

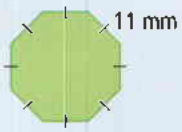


2. For each regular polygon, state the number of sides. Then, find the perimeter.

a)



b)



Convert Between Metric Units

To convert between metric units, use the relationships in the table.
For example,

$6000 \text{ m} = \frac{6000}{1000} \text{ km}$
$= 6 \text{ km}$

I am converting from metres to kilometres. I am converting to a larger unit, so I divide.

$3.4 \text{ m} = 3.4 \times 100 \text{ cm}$
$= 340 \text{ cm}$

I am converting to a smaller unit, so I multiply.

Metric Units
1 cm = 10 mm
1 m = 100 cm 1 m = 1000 mm
1 km = 1000 m

3. Convert each measure from metres to kilometres.

a) 9000 m **b)** 18 000 m
c) 1200 m **d)** 700 m

4. Convert each measure, as described.

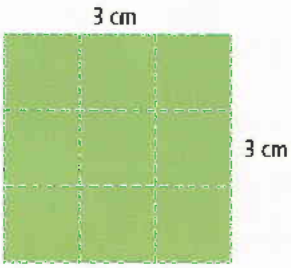
a) 9 m, to centimetres **b)** 12 km, to metres
c) 150 cm, to metres **d)** 0.5 km, to metres
e) 2.5 cm, to millimetres

Area

Area measures how much space a two-dimensional shape covers. It is measured in square units. Square units include square centimetres (cm^2), square metres (m^2), and square kilometres (km^2).

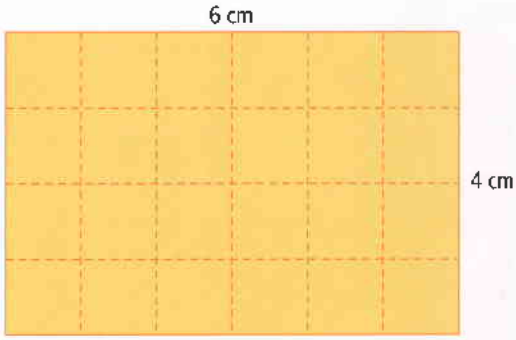
One way to measure area is to count the number of square units inside the shape.

This square contains nine square centimetres. The area is 9 cm^2.



$A = s \times s$
$A = 3 \times 3$
$A = 9$

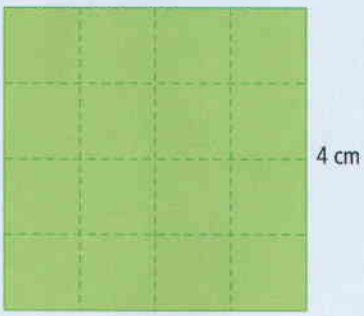
This rectangle contains 4 rows of six square centimetres. The area is 24 cm^2.



$A = l \times w$
$A = 6 \times 4$
$A = 24$

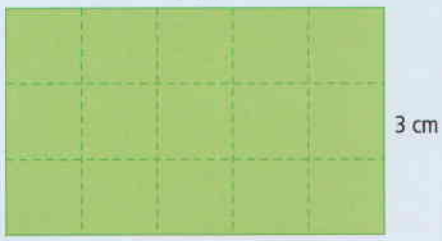
5. Find the area of each shape. Use two different methods.

a)



b)

c)



1.1 Perimeters of Two-Dimensional Shapes

Focus on...
- perimeter
- rectangles
- trapezoids
- regular polygons

Ice cream stands like this octagonal one are often found in tourist areas. If the length of each edge is 2 m, what is the distance around the ice cream stand?

Discover the Math

How do you find the perimeter of various shapes?

1. Look at the table. Match the shapes to the photographs. For example, shape 4 goes with photograph A.

Shape and Definition	
1. Quadrilateral	any four-sided figure
2. Parallelogram	a quadrilateral with opposite sides parallel
3. Trapezoid	a quadrilateral with just one pair of opposite sides parallel
4. Polygon	a figure with three or more sides
5. Regular polygon	a polygon with all sides equal and all angles equal
6. Regular hexagon	a regular polygon with 6 sides
7. Regular octagon	a regular polygon with 8 sides

Mystery Object
A 
B 
C 
D 

2. Which shapes do not match any photographs? Sketch real-life objects that have each of these shapes.

3. **Reflect** Describe how to calculate the perimeter of each type of shape. What information would you need? How would you use this information?

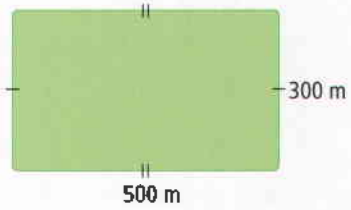
Example 1: Distance Around a Race Track

Sarah enjoys go-karting. She enters a go-kart race where the track is close to rectangular.

a) Determine the perimeter of the track.

b) How many kilometres must Sarah drive in a 10-lap race?

c) How can you check your answer?



Solution

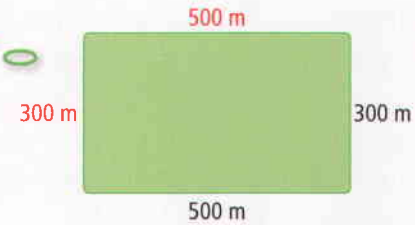
a) *Method 1: Add Side Lengths*

$P = 500 + 300 + 500 + 300$

$P = 1600$

The distance around the track is 1600 m.

I started by labelling the missing side lengths.



Method 2: Use a Formula

Use the formula for the perimeter of a rectangle.

$P = (2 \times l) + (2 \times w)$

$P = (2 \times 500) + (2 \times 300)$

$P = 1000 + 600$

$P = 1600$

The distance around the track is 1600 m. **Add proper units to the final answer.**

Strategies
Choose a formula

b) Find the total distance of a 10-lap race.

$1600 \text{ m} \times 10 = 16\,000 \text{ m}$

To convert to kilometres, remember that 1000 m = 1 km.

$16\,000 \text{ m} = \frac{16\,000}{1000} \text{ km} = 16 \text{ km}$

Sarah must drive 16 km to complete the race.

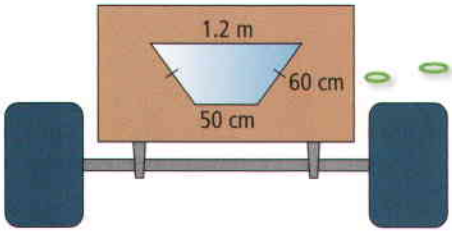
I am converting from metres to kilometres. I am converting to a larger unit, so I divide.

c) One kilometre is the distance between Amar's school and the arena. The race distance is 16 times that distance.

What is about 1 km from your school?

Example 2: Trapezoidal Window

Sarah wants to cut out a window in the shape of a trapezoid for the back of her go-kart. What total length of cut must she make?



One length is not given. The markings show that the missing side is 60 cm.

Solution

P = 1.2 m + 60 cm + 50 cm + 60 cm
P = 120 cm + 60 cm + 50 cm + 60 cm
P = 290 cm
Sarah must cut 290 cm to make the window.

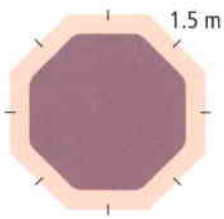
1.2 m = 1.2 × 100 cm
= 120 cm

Example 3: Cost of a Hot Tub

This hot tub is in the shape of a regular octagon. It needs new padding around its edge.

a) What length of padding is needed?

b) Padding costs $4.50 per metre. What is the total cost of padding the sides of the hot tub?



Solution

a) side length = 1.5 m
all sides are equal
number of sides = 8
P = 8 × 1.5
P = 12

The length of padding is 12 m.

Remember to include units.

Strategies
What other strategy might you use?

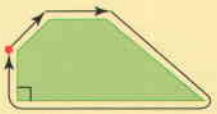
b) cost of padding: $4.50 per metre
length of padding: 12 m
4.50 × 12 = 54 **Multiply cost per metre by length.**

The padding around the hot tub costs $54.

The length of my driveway is 12 m. What does 12 m mean to you?

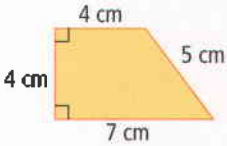
Key Ideas

- The perimeter is the total distance around the outside of a two-dimensional shape.
- Perimeter is measured in linear units, such as millimetres, centimetres, metres, and kilometres.



Communicate the Ideas

1. Write definitions in your own words for these terms: perimeter, distance, two-dimensional figure, linear units.
2. Matthew and Sonja calculated the perimeter of this figure. Matthew said the perimeter is 20 cm. Sonja said the perimeter is 20 cm^2. Who is right? How do you know?



3. $P = 6 \times 1.5$ m
   $P = 9$ m
   Draw and label this shape.

Literacy Connections

Reading Diagrams
The ⊿ symbol means that the lines are at right angles, or 90°, to each other.

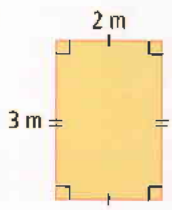
Check Your Understanding

Practise

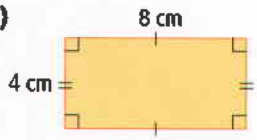
For help with questions 4 and 5, refer to Example 1.

4. Find the perimeter of each rectangle.

a)

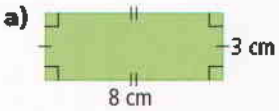


b)

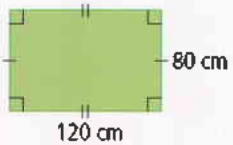


5. Find the perimeter of each rectangle.

a)



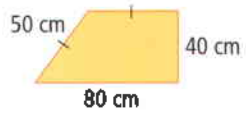
b)



For help with questions 6 to 8, refer to Example 2.

6. You want to cut out this window. What length of cut should you make?

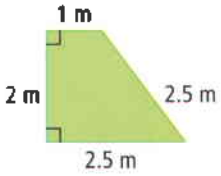
7. What length of cut is needed for this shape?



8. Find the perimeter of each trapezoid.

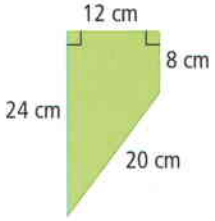
a)

b)



c)

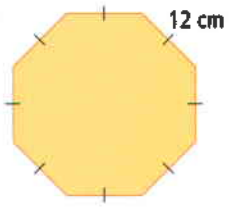
d)



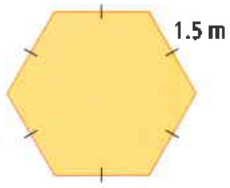
For help with questions 9 to 11, refer to Example 3.

9. Find the perimeter of each regular polygon.

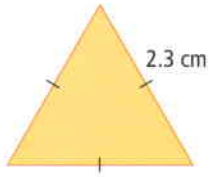
a)



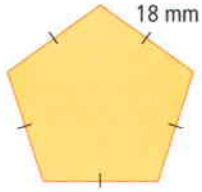
b)



c)

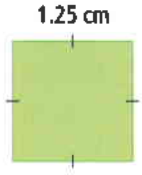


d)

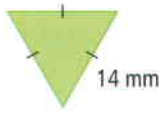


10. Find each perimeter.

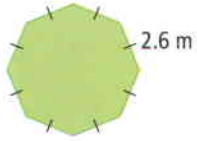
a)



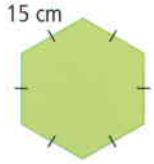
b)



c)



d)



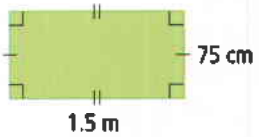
11. a) Look around the classroom, or your home. Sketch five different polygons. Identify where you found each one.

b) Measure the perimeter of each polygon. Choose the best measurement unit for each polygon.

12. What projects at home, at a workplace, or in the community might involve finding a perimeter?

Apply

13. You need to find the perimeter of this rectangle. What steps must you take before adding lengths?



14. Why is perimeter measured in linear units? Use a diagram to help you explain.

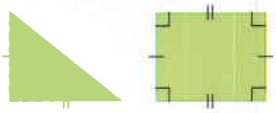
For help with question 15, refer to Example 1.

15. A rectangular go-kart track has length 450 m and width 150 m.

a) How long is one lap, in metres?

b) How long is a 20-lap race, in kilometres?

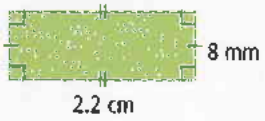
16. Describe any relationships you see between the right triangle and the rectangle.



Making Connections

You will learn more about right triangles in Chapter 2.

17. Anders found the perimeter of this rectangle. His friend Sasha says that his solution is wrong.

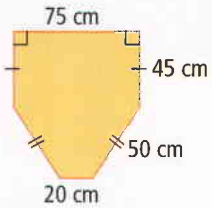


$P = (2 \times l) + (2 \times w)$
$P = (2 \times 2.2) + (2 \times 8)$
$P = 4.4 + 16$
$P = 20.4$

Who is right, Anders or Sasha?

Chapter Problem

18. Sarah wants to put glow-in-the-dark tape around the nose of her go-kart.



- Regular glow-in-the-dark tape costs $6.00 per metre.
- Sparkly purple tape costs $7.50 per metre.

Design a colour scheme for Sarah's go-kart tape. How much will the tape for your design cost? Explain your calculations

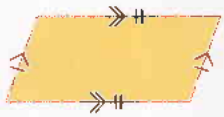
19. What kind of geometric shape is a loonie? Determine the perimeter of a loonie.

20. Leila skates around the perimeter of an ice rink.

a) How far does Leila skate on each lap?
b) How far does Leila skate in 8 laps?
c) How many laps should Leila skate to travel 3 km?

21. A parallelogram is a quadrilateral that has opposite sides parallel and opposite sides equal in length.

a) Measure the length of each side of this parallelogram.



b) Find the perimeter.
c) Describe another way to find the perimeter of a parallelogram.

Literacy Connections

Reading Diagrams
Arrows such as > or >> on two sides of a figure show that these sides are parallel.

Try This!

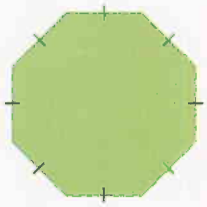
22. Tania is calculating the perimeter of a shape. She writes:

$P = (2 \times l) + (2 \times w)$
$P = (2 \times 5\text{ cm}) + (2 \times 3\text{ cm})$

a) Draw and label the shape.
b) Find the perimeter.
c) Explain how you know your answers to parts a) and b) are correct.

Extend

23. The gazebo shown in the plan has a perimeter of 18 m. Can you fit a 2.5-m bench along one side? Justify your answer mathematically.

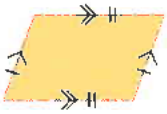


24. Heidi wants to use stones to surround a rectangular garden she is creating. How many different ways can she design her garden so that it has a perimeter of 26 m? Show each different design.

1.2 Area of a Parallelogram

Focus on...
- area
- parallelograms
- base and height

parallelogram
- four-sided figure with both pairs of opposite sides equal and parallel



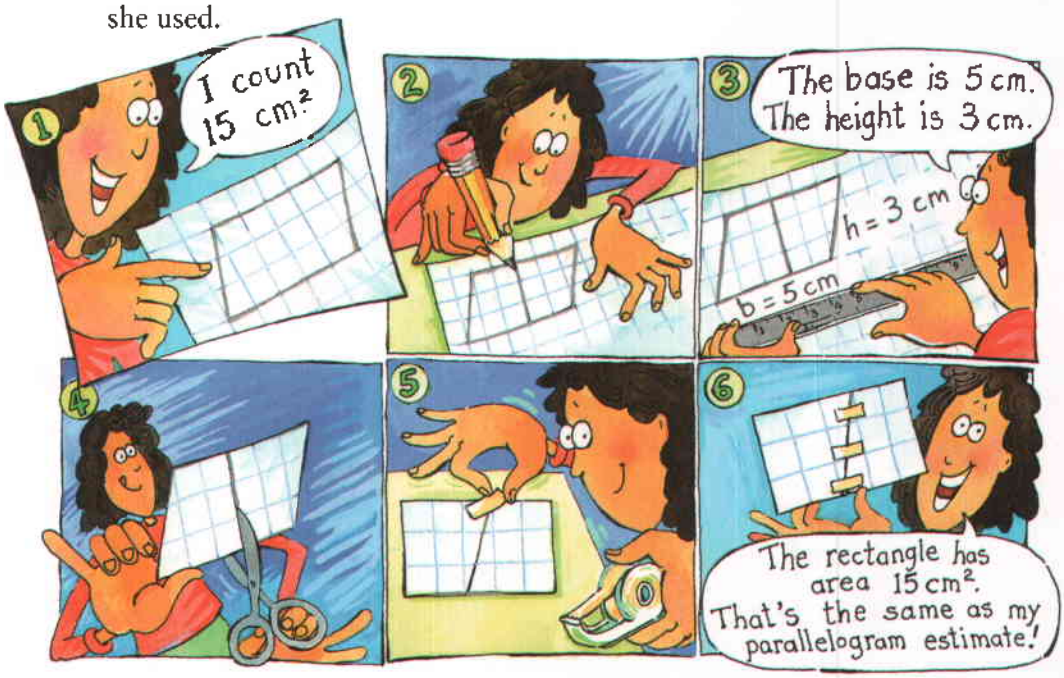
Look at this building. Which windows are **parallelograms**? The formula for the area of a rectangle is $A = l \times w$. Will this work for parallelograms?

Discover the Math

Materials
- centimetre grid paper
- ruler

What is the area formula for a parallelogram?

1. Jadzia wanted to find the area of a parallelogram. Check the method she used.



2. How is the area of Jadzia's rectangle related to the area of her parallelogram? Explain your answer. Hint: Compare the length and width of the rectangle to the **base** and **height** of the parallelogram.

3. Try Jadzia's method with your own parallelogram. Do you get the same result?

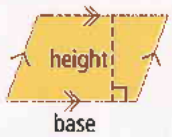
4. **Reflect** Brainstorm the steps you need to find the accurate area of a parallelogram. Develop a formula to explain what you are doing.

base

- a side of a polygon
- short form is *b*

height

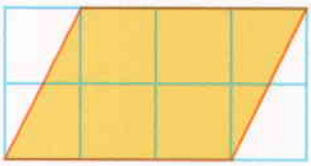
- distance from the base to the opposite side or vertex, measured at right angles to the base
- short form is *h*



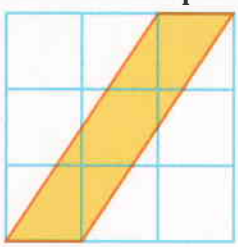
Example: Calculate Parallelogram Areas

Robert drew these parallelograms on centimetre grid paper. Use the formula $A = b \times h$ to calculate the area of each parallelogram.

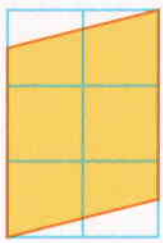
a)



b)



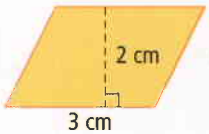
c)



Solution

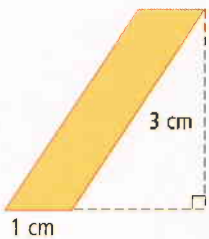
a) $A = b \times h$
$A = 3 \times 2$
$A = 6$
The area of the parallelogram is 6 cm^2.

Use square centimetres for area.



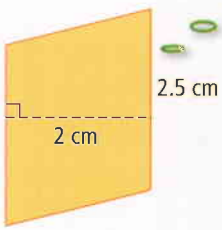
The centimetre grid tells me base = 3 cm height = 2 cm

b) $A = b \times h$
$A = 1 \times 3$
$A = 3$
The area of the parallelogram is 3 cm^2.



This time, I have to extend the line of the base to measure the height.

c) $A = b \times h$
$A = 2.5 \times 2$
$A = 5$
The area of the parallelogram is 5 cm^2.



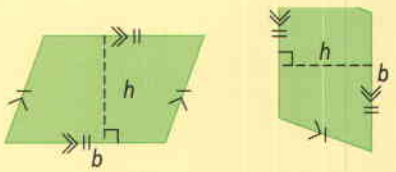
There is no horizontal side. But I can use one vertical side as the base, and measure the height from that.

Key Ideas

- You can find the area of a parallelogram if you know its base and height. Use the formula
  area = base × height *or* $A = b \times h$

A is the short form for area.
b is the short form for base.
h is the short form for height.

- The height of a parallelogram is always at right angles to its base.



Communicate the Ideas

1. In your journal, compare the formulas for the area of a parallelogram and the area of a rectangle.
How are they similar? How are they different?

2. What's wrong? Natasha calculated the area of a parallelogram with base 5 cm and height 4 cm.

Area = 5 × 4
= 20
The area is 20 cm.

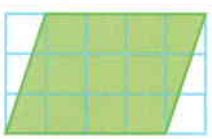
Explain the error in Natasha's solution. Why is correcting this error important?

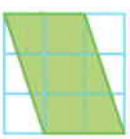
Check Your Understanding

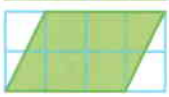
Practise

For help with questions 3 to 5, refer to the Example.

3. Zoë drew these parallelograms on centimetre grid paper. Calculate the area of each one.

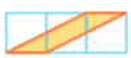
a)


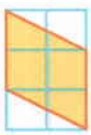
b)


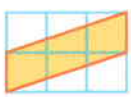
c)


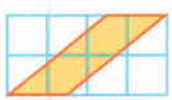
d)


4. Sameh drew these parallelograms on centimetre grid paper. Calculate the area of each one.

a)


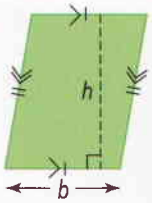
b)


c)


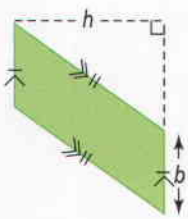
d)


5. Measure the base and height of each parallelogram. Then, find the area.

a)



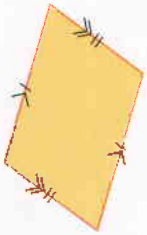
b)



Apply

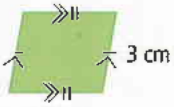
6. a) Measure the base and height of this parallelogram. Then, find the area.

b) What was unusual about measuring the parallelogram? Explain.

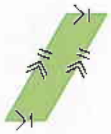


7. a) Can you find the area of parallelogram A with the given information? Explain why or why not.

b) Explain how you can find the height of parallelogram B.

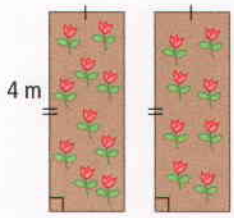


Parallelogram A



Parallelogram B

8. Madra is choosing a garden layout.



Rectangular layout

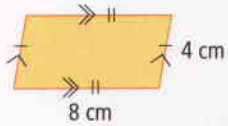
Parallelogram layout

a) Predict which layout gives a greater area for Madra's flowers.

b) Calculate the area of each layout. Compare to your prediction.

9. Joel measured the parallelogram shown and then calculated the area.

$A = b \times h$
$A = 8 \times 4$
$A = 32$

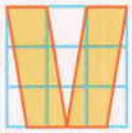


The area of the parallelogram is 32 cm^2.

There is an error in Joel's work. Find the error and describe what Joel should have done.

Try This!

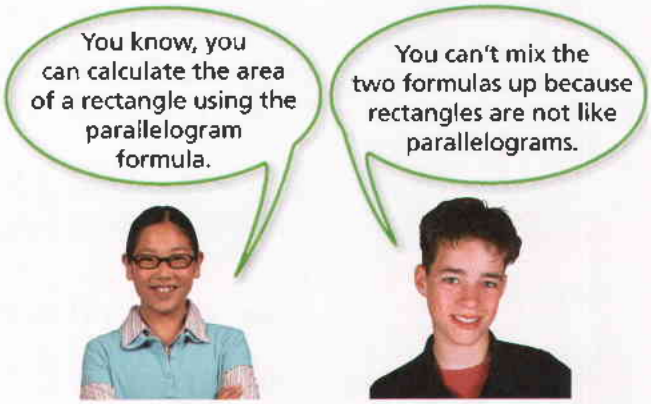
10. Victor planned a decal with his first initial. He used centimetre grid paper. What is the area of Victor's decal?



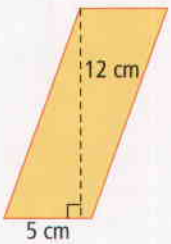
Extend

11. a) Who do you agree with, Monica or Michel? Explain why.

b) Make a statement that shows why the *other* person could also be right.



12. Katie is constructing a shelf for her videos and DVDs. She is designing parallelogram-shaped wooden dividers to sort the movies.

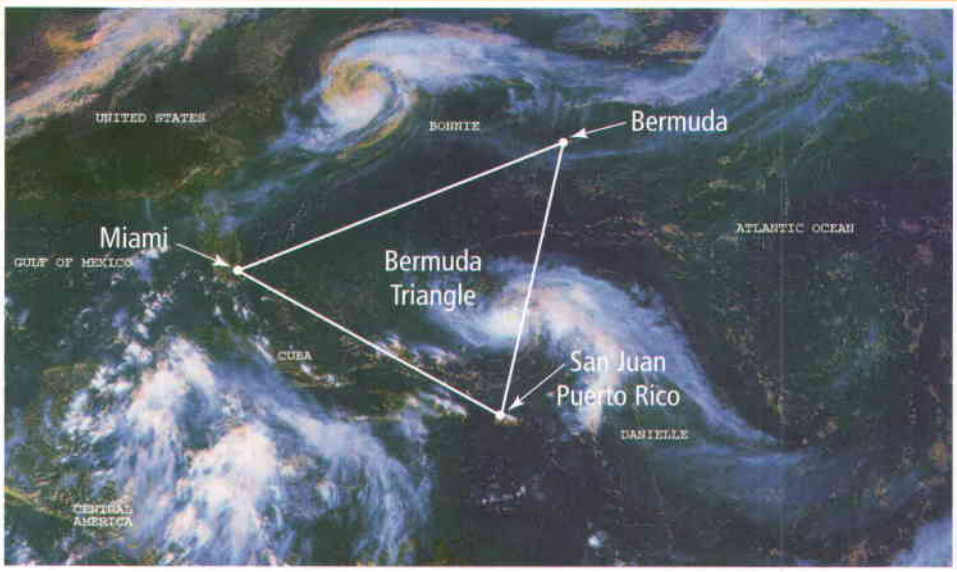


a) How much wood will Katie need for 8 dividers?

b) Create a plan for Katie to make her 8 dividers.
Research the shapes and sizes of wood available.
How can Katie conserve wood?

1.3 Area of a Triangle

Focus on...
- area
- triangles
- base and height



The Bermuda Triangle is one of the most mysterious regions on Earth. A number of strange things have occurred there over the years, including the unexplained disappearances of planes and ships.

How large do you think the Bermuda Triangle is? Can you use a formula you already discovered to answer this question?

Materials

Optional:
- centimetre grid paper
- ruler

triangle
- three-sided closed figure

Making Connections

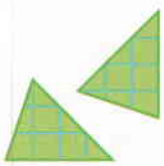
Shapes that are identical, but in different positions, are congruent. Learn more about congruence in Chapter 2.

Discover the Math

How can you find the area of a triangle?

1. Stefan was trying to calculate the area of a **triangle**. He used what he knew about the area of a parallelogram to help him. Find the total area of Stefan's parallelogram.

2. Next, Stefan cut out the two triangles.
- **a)** Do the triangles have equal areas? Explain.
- **b)** What else about the two triangles could be equal?



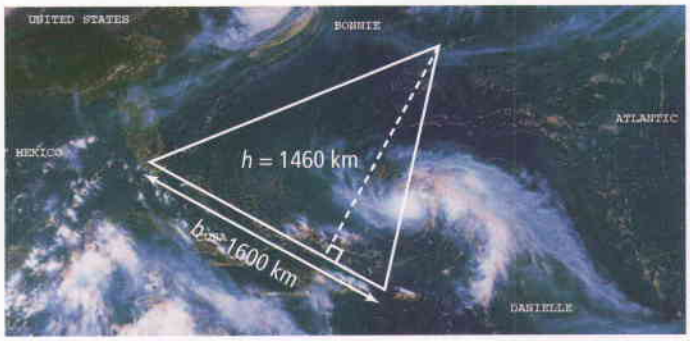
3. **a)** How is the area of the parallelogram from step 1 related to the area of each triangle? Explain.
b) Use this information to calculate the area of each triangle.

4. **a)** How is the area of a triangle related to the area of a parallelogram with the same base and height?
   b) Write down the formula for finding the area of a parallelogram.

5. **Reflect** Modify your answers from step 4. Make them into a formula for finding the area of a triangle.

Example: Apply the Triangle Area Formula

Find the area of the Bermuda Triangle.
Use the formula for the area of a triangle:
area = base × height ÷ 2
or
$A = b \times h \div 2$



Solution

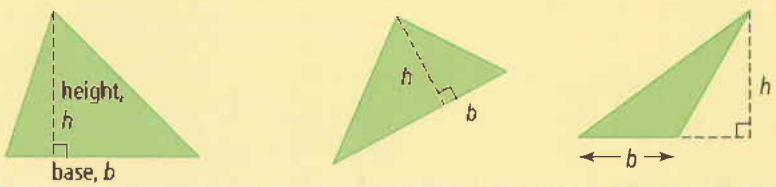
base = 1600 km
height = 1460 km
$A = b \times h \div 2$
$A = 1600 \times 1460 \div 2$ C 1600 × 1460 ÷ 2 = 1168000.
$A = 2\ 336\ 000 \div 2$
$A = 1\ 168\ 000$
The area of the Bermuda Triangle is 1 168 000 km^2.

Did You Know?

1 168 000 km^2 is large enough to swallow all of the Great Lakes!

Key Ideas

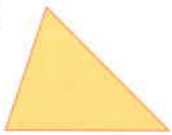
- The area of a triangle is related to the area of a parallelogram.
- The area of a triangle can be found by using the formula
  $A = b \times h \div 2$ or $A = \frac{b \times h}{2}$
- The base and height always form a right angle.

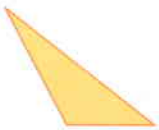


Communicate the Ideas

1. Your classmate missed this lesson. How could you explain to your classmate how to measure the height of this triangle?

2. Sketch or trace each triangle. Label the base and height of each triangle. In each case, explain how you know which measures to identify.

a) 

b) 

c) 

3. a) Draw a triangle to match this solution:

Area = base × height ÷ 2
= 5 × 4 ÷ 2
= 10

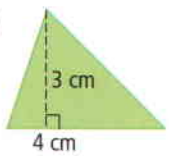
The area is 10 cm^2.

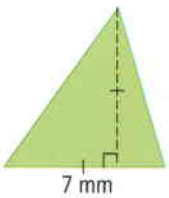
b) Exchange with a partner. Did you draw the same triangles? Are different triangles possible? Explain.

Check Your Understanding

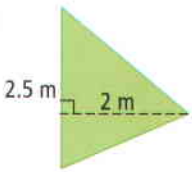
Practise

4. Identify the base and height of each triangle.

a) 

b) 

c) 

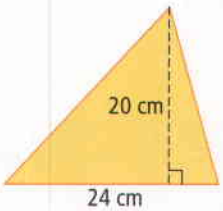
d) 

For help with questions 5 to 7, refer to the Example.

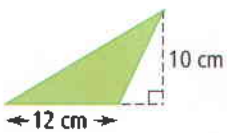
5. Find the area of each triangle in question 4.

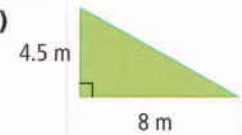
6. Find the area of each triangle.

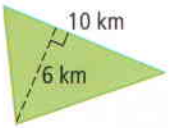
a) 

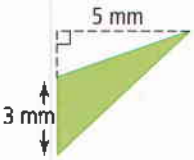
b) 

7. Find the area of each triangle.

a) 

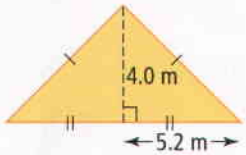
b) 

c) 

d) 

Apply

8. Kristin is painting a mural to cover one end wall of her attic room. What area will Kristin have to paint?

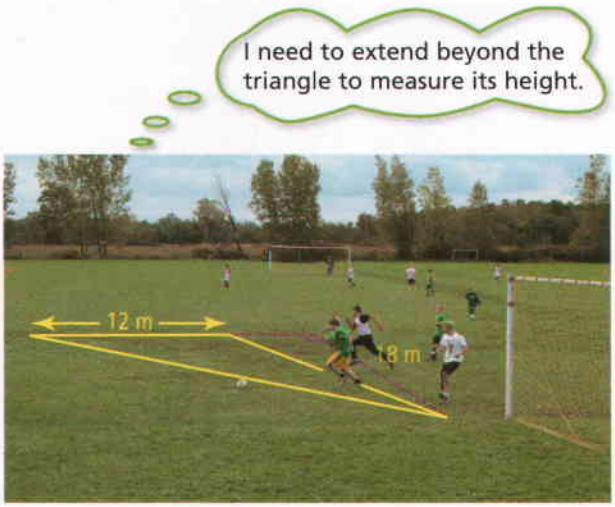


9. a) Where does the $b \times h$ part come from in the formula $A = b \times h \div 2$?

b) Where does the "$\div 2$" come from in the formula $A = b \times h \div 2$?

c) How is the area of a triangle related to the area of a parallelogram with the same base and height? Use pictures, numbers, and symbols to explain.

10. Mac is a defender for his soccer team. The coach has assigned Mac to cover the region shown. What area is Mac defending?



11. If two triangles have the same area, do they also have an equal perimeter? Find out. Hint: Draw several triangles with the same area. Measure their perimeters.

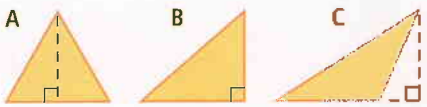
Chapter Problem

12. Sarah is adding two triangular reflectors to the back panel of her go-kart.

a) What total perimeter must Sarah cut out for the reflectors?

b) Sarah is painting one side of the reflectors with a reflective paint. What is the total area that must be painted?

13. a) Without measuring or calculating, rank the triangles in order from least area to greatest.



b) Measure the base and height of each triangle.

c) Calculate the area of each triangle. Compare these results to your prediction. What do you observe?

Try This!

14. Create a short triangle quiz. Your quiz should reflect the types of questions asked in this section. Include triangles of different kinds and in different positions.

Extend

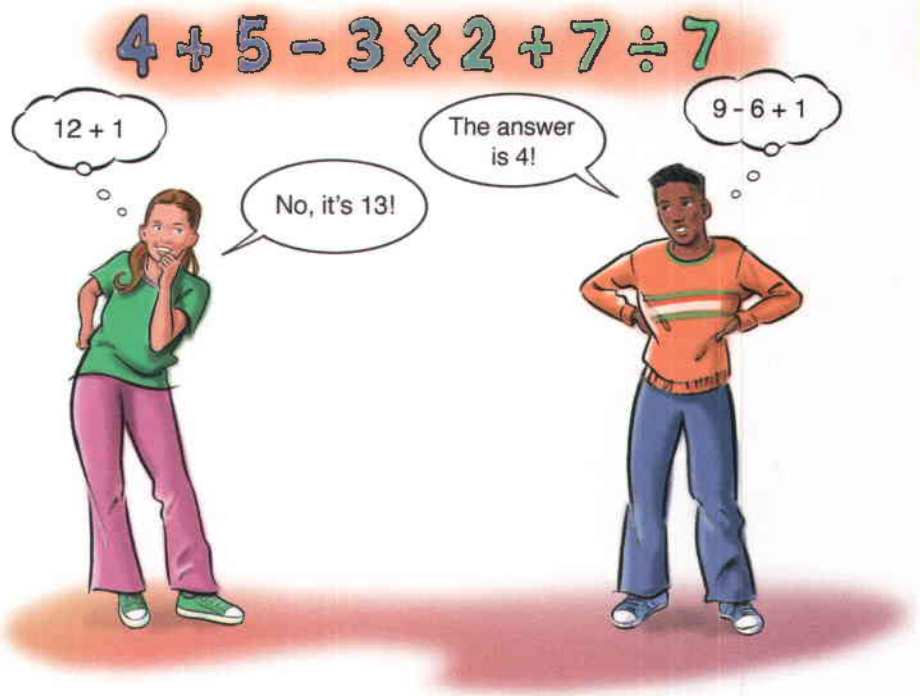
15. Lindsay is building a tree house. The floor of the tree house needs to be a triangle that joins three large branches. The base of the triangle needs to be 4.0 m and the total area is to be 5.0 m^2.

a) Draw several floor plans that meet Lindsay's needs.

b) Lindsay also wants to paint the edge of the floor a bright orange. Will each design require the same amount of paint for the edge? Explain.

1.4 Apply the Order of Operations

Focus on...
- order of operations
- perimeter and area



In math, you often have to do several operations in one calculation.

How does the order of the operations affect the answer? What can you do to change the order?

Discover the Math

How do brackets work in the order of operations?

1. How many different answers can you get for this expression if you do the operations in different orders?

   $4 + 5 - 3 \times 2 + 7 \div 7$

2. What is the *correct* answer? How do you know?

3. If brackets appear in an expression, the operations in the brackets are done first. Insert brackets in the expression from step 1 to get several different answers. How many different answers can you get by inserting brackets?

4. **Reflect** Think about steps 1 to 3.
   a) What is the advantage of inserting brackets in expressions?
   b) What is the advantage of having a specific order of operations?

Example: The Order of Operations

Cora has found a winning ticket for a music CD in her box of cereal. To claim her prize, she must answer this skill-testing question:
$3 \times 3 - (2 - 0.2) \div 0.3 + 4 \times 2$
Use the **order of operations** to find the answer.

Solution

Method 1: Pencil and Paper

Do brackets first.

$3 \times 3 - (2 - 0.2) \div 0.3 + 4 \times 2$
$= 3 \times 3 - 1.8 \div 0.3 + 4 \times 2$
$= 9 - 6 + 8$
$= 3 + 8$
$= 11$

Multiply and divide. There are three separate operations of this kind.

Add and subtract, in order from left to right. Subtract first.

Method 2: Calculator

$3 \times 3 - (2 - 0.2) \div 0.3 + 4 \times 2$
$= 3 \times 3 - 1.8 \div 0.3 + 4 \times 2$
$= 9 - 6 + 8$
$= 3 + 8$
$= 11$

For the bracket: (c) 2 (−) 0.2 (=) 1.8

For the multiplications and division:
(c) 3 (×) 3 (=) 9., 1.8 (÷) 0.3 (=) 6., 4 (×) 2 (=) 8.

Now, add and subtract, *in order from left to right*. Subtract first.

order of operations

- correct sequence of steps for a calculation

B Brackets, then
O Order
D } Division and
M } Multiplication, in order from *left to right*
A } Addition and
S } Subtraction, in order from *left to right*

Technology Tip

- You can use brackets with some calculators. For this example, key in (c) 3 (×) 3 (−) (2 (−) 0.2) (÷) 0.3 (+) 4 (×) 2 (=) 11.

Key Ideas

- Some mathematical expressions include brackets and +, −, ×, and ÷ operations.
- When evaluating expressions, the correct order of operations must be followed. The term "BODMAS" can be used to help remember the order.

In the expression $7 + 4 \times (5 - 3)$, do the brackets first.

Communicate the Ideas

1. How is it useful to have a single, standard order of operations?
2. In the skill-testing question $3 \times 3 - (2 - 0.2) \div 0.3 + 4 \times 2$, what if you add before subtracting in the third step?
   $9 - 6 + 8 = 9 - 14 =$ ■
   Can you claim the prize? Why or why not?
3. Use a flow diagram to show the correct order for the operations in this expression.
   $12 \div (3 + 1) - 18 \div (2 \times 3)$

Check Your Understanding

Practise

For help with questions 4 to 9, refer to the Example.

4. Answer this skill-testing "warm-up" question:
   $3 + 4 \times 2$
   Show all your steps.

5. Answer this skill-testing "challenge" question:
   $3 \times 7 - (6 - 1) \div 4 + 12$
   Show all your steps.

6. Evaluate each expression.
   a) $6 + 2 \times 5$ **b)** $12 \div 3 - 2$
   c) $4 \times 10 \div 5$ **d)** $54 \div 9 \div 3$
   e) $(7 - 2) \times 8$ **f)** $3 \times (8 - 1)$

7. Evaluate.
   a) $25 + 5 + 3 \times 2$ **b)** $4 + (23 - 7) \div 8$
   c) $(6 + 2) \times 3 - 9$ **d)** $18 - 2 \times (4 - 2)$

8. Evaluate.
   a) $27 \div (9 \div 3) - 8$
   b) $(14 - 2) \div 3 + (12 - 2) \times 3$

9. Which operation do you perform first in each expression? Explain why.
   a) $7 + 2 \times 5$ **b)** $4 \times (5 - 2)$ **c)** $12 \div 4 \times 2$

10. Is each statement true or false? Explain.
    a) "According to BODMAS, division is always done before addition."
    b) "According to BODMAS, addition is always done before subtraction."

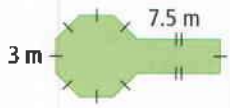
Apply

11. What's wrong? To claim a prize, Vanya answers a skill-testing question:

$$\begin{aligned} & 64 \div 16 \div 4 + 3 - 2 \times 2 \\ = \ & 64 \div 4 + 3 - 2 \times 2 \\ = \ & 16 + 3 - 2 \times 2 \\ = \ & 16 + 1 \times 2 \\ = \ & 16 + 2 \\ = \ & 18 \end{aligned}$$

    a) Find two errors in Vanya's solution.
    b) Give a correct solution.

12. You can use this expression to calculate the perimeter of Leon's patio:
    $(7 \times 3) + (2 \times 7.5 + 3)$



    a) Explain what the expression in each set of brackets means.
    b) Simplify the expression.
    c) What is the advantage of using this expression to find the perimeter?

13. Evaluate.

a) $(2.1 + 3.6) \times 2$

b) $(3.4 + 7.1) \div (3.6 + 1.4)$

c) $8 \div (0.4 \div 0.2) \div 2 - 3 + 5 - 4$

d) $(8 + 12 - 3 - 1) \div [7 - (4 + 1)]$

e) $2 + 9 \div [1.5 \times (5 - 3)]$

14. a) Put brackets into each expression to make the equation true.

$4 + 6 - 5 \times 2 = 6$

$4 + 6 - 5 \times 2 = 0$

$4 + 6 - 5 \times 2 = 10$

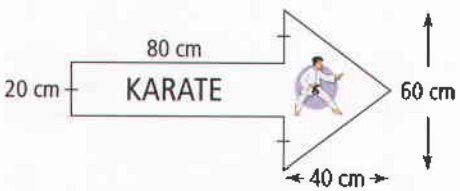
b) Look at the three expressions in part a). Why is it important that everyone follow the same order of operations when evaluating expressions? Explain.

c) For one of these expressions, you can leave the brackets out and still get the given value, if you follow BODMAS correctly. Which expression is it? Explain.

Try This!

15. Don and Phil are organizing a karate tournament. They are painting several large wooden arrows to show directions. Phil suggests finding the area from the single expression

$80 \times 20 + 60 \times 40 \div 2$



a) Where do you think the first part of this expression, 80×20, comes from?

b) Where does the second part of the expression come from?

c) Twelve arrow signs are needed for the directions. Use brackets to create a new expression for the total area that needs painting. Evaluate this expression.

Extend

16. A five-sided shape can be split into a square and an isosceles triangle. You can find the total area by simplifying this expression:

$6 \times 6 + 6 \times 4 \div 2$

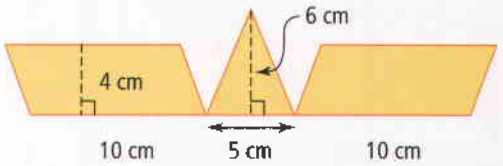
a) Simplify the expression to find the total area, in square centimetres.

b) Draw a diagram of this composite shape. Can it be drawn a different way? Explain.

c) In what different way could you split your shape to find its area?

d) Use your splitting from part c) to write down a new expression for the area. Check that this gives the same value as the original expression.

17. Roland's Aeronautical School has an airplane crest as a logo.



a) Write an expression that you can use to find the total area of the crest. Evaluate your expression.

b) What facts did you have to assume about the shape to find its area?

Making Connections

What's My Order?

Use these simple rules to play the game *What's My Order?*

- Create a secret order of operations (different from BODMAS).
- Use it to do a calculation.
- Challenge a classmate to discover what your order is, based on your calculation and result.
- Switch roles with your classmate and play again.

1.5 Area of a Trapezoid

Focus on...
- area
- trapezoids
- base and height

The wave pool at Wild Waterworks in Stoney Creek, Ontario, is the largest of its type in Canada. It creates waves over a metre high.

The pool is roughly in the shape of a **trapezoid**. How can you measure the swimming area? How would it help to split the area up into triangles?

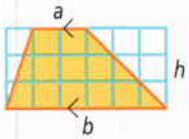
trapezoid
- four-sided figure with one pair of opposite sides parallel

Materials
- ruler
- protractor
- centimetre grid paper and pencil

vertex
- point on a figure where two sides meet

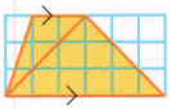
Discover the Math

How can you find the area of a trapezoid?



1. On a blank sheet of centimetre grid paper, draw a large trapezoid. Mark the two parallel sides a and b with parallel markings. Mark the height h.

2. **a)** Estimate the area by counting squares.
   b) Measure the lengths of the parallel sides of the trapezoid and label them on your shape. Also measure and label the height of the trapezoid.



3. **a)** Draw a diagonal line from one **vertex** of the trapezoid to the opposite vertex to form two triangles.
   b) Explain how you can find the area of these triangles.
   c) Find the area of the two triangles.
   d) How can you use your answers from part c) to calculate the area of the trapezoid?
   e) Use this method to find the area of the trapezoid.
   f) Compare this result to your estimate from step 2. How close are they?

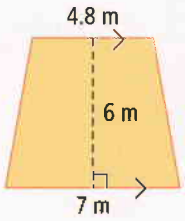
Which measures do I need for each triangle? Which measure is the same for both?

4. **a)** Try to write a formula that gives the area of a trapezoid, using the symbols A, a, b, and h.
   b) Test your formula. Substitute the measures and calculate the area.

5. **Reflect** Describe the steps you need to find the area of a trapezoid.

Example: Backyard Area

Elvira is replacing the sod in one part of her backyard. Determine the area that must be covered. Round your answer to the nearest square metre.



Solution

Method 1: Split Into Triangles

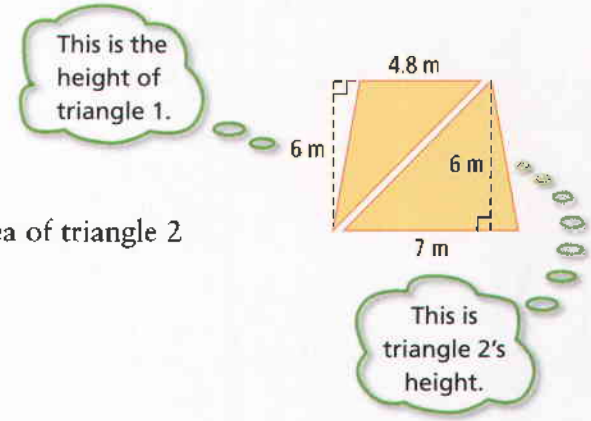
Split the trapezoid into two triangles:

Area of triangle 1 = $4.8 \times 6 \div 2$
= 14.4

Area of triangle 2 = $7 \times 6 \div 2$
= 21

Area of trapezoid = Area of triangle 1 + Area of triangle 2
= 14.4 + 21
= 35.4

Elvira needs about 36 m^2 of sod.



Method 2: Use a Formula

Use this formula for the area of a trapezoid:

$A = (a + b) \times h \div 2$

$A = (4.8 + 7) \times 6 \div 2$ **Remember BODMAS. Do brackets first.**

$A = 11.8 \times 6 \div 2$ **Do multiplication and division, from left to right.**

$A = 35.4$

C 4.8 + 7 = × 6 ÷ 2 = 35.4

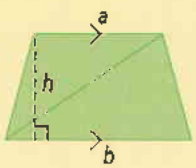
or C (4.8 + 7) × 6 ÷ 2 = 35.4

Elvira needs about 36 m^2 of sod.

Key Ideas

- The area of a trapezoid can be found by
  - splitting the trapezoid into two triangles
  - finding the area of each triangle
- The two triangles that make up the trapezoid have the same height.
- The formula for the area of a trapezoid is

$A = (a + b) \times h \div 2$ or $A = \dfrac{(a + b) \times h}{2}$



Communicate the Ideas

1. Use pictures and diagrams to explain where the trapezoid formula comes from.

2. Use an organizer to describe the ways in which parallelograms and trapezoids are
   a) alike **b)** different

3. Mya tells Joe that to use the trapezoid area formula, you have to know BODMAS. Joe does not believe that there is any connection. Who is right? Explain.

4. Draw a trapezoid to match this calculation.
   $A = (a + b) \times h \div 2$
   $A = (4 + 6) \times 3 \div 2$
   $A = 10 \times 3 \div 2$
   $A = 15$
   The area of the trapezoid is 15 cm^2.

Literacy Connections

Making Tables
A table is a form of organizer. You can use a table like this to show likenesses and differences.

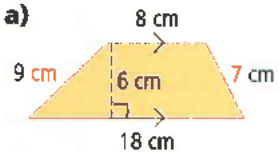
	Parallelograms	Trapezoids
Alike		
Different		

Check Your Understanding

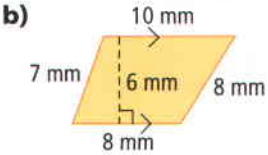
Practise

5. Identify the values of a, b, and h in each trapezoid.

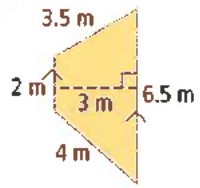
a)



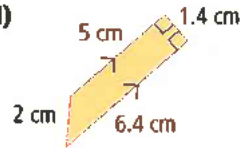
b)



c)

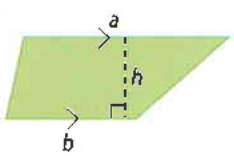


d)

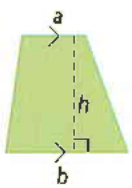


6. For each trapezoid, measure a, b, and h with a ruler.

a)

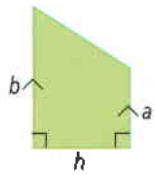


b)

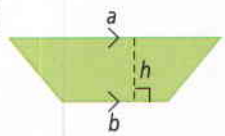


7. Measure a, b, and h.

a)



b)

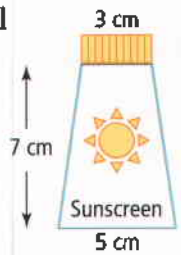


For help with questions 8 to 12, refer to the Example.

8. Find the area of each trapezoid in question 5.

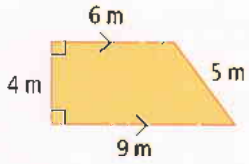
9. Find the area of each trapezoid in questions 6 and 7.

10. Calculate the area of the label on the bottle of sunscreen.



11. Have a friend use a ruler and centimetre grid paper to draw a trapezoid. Find its area.

12. Karsten is replacing the sod in one part of his backyard. Determine the area that must be covered. Round your answer to the nearest square metre.



Apply

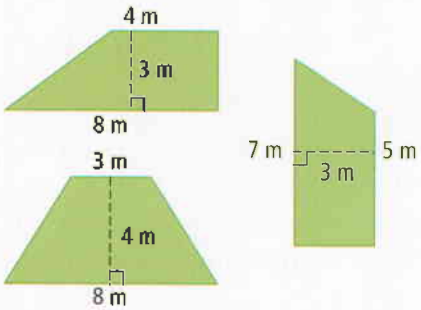
13. Regional Road signs in Ontario are in the shape of a trapezoid.

How much metal is needed to make 50 signs?

14. Research to find different uses of measurement in technology, the arts, and everyday life. Do any of these involve trapezoids? What about other shapes? Go to your local reference library, or search the Internet. Go to www.mcgrawhill.ca/links/math7 for a place to start.

Internet Connect

15. Study these trapezoids. Without calculating, which ones have the same area? How do you know?

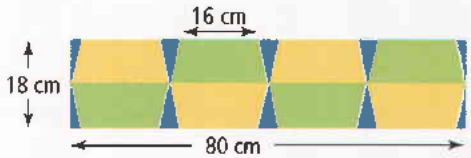


16. a) Use this plan to calculate an approximate area of the wave pool in Wild Waterworks.

b) How accurate do you think this answer is? Justify your answer.
c) How could you improve the accuracy?
d) Why is the wave pool such an unusual shape?

Try This!

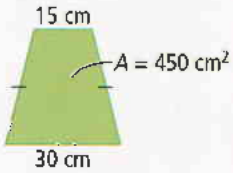
17. A quilt pattern uses green and yellow trapezoids. Each green piece is the same shape and size.



a) Find the area of each trapezoid.
b) Find the total green area.
c) Find the total blue area.
d) Explain how you solved each part.

Extend

18. Alex is designing a sign in the shape of a trapezoid.



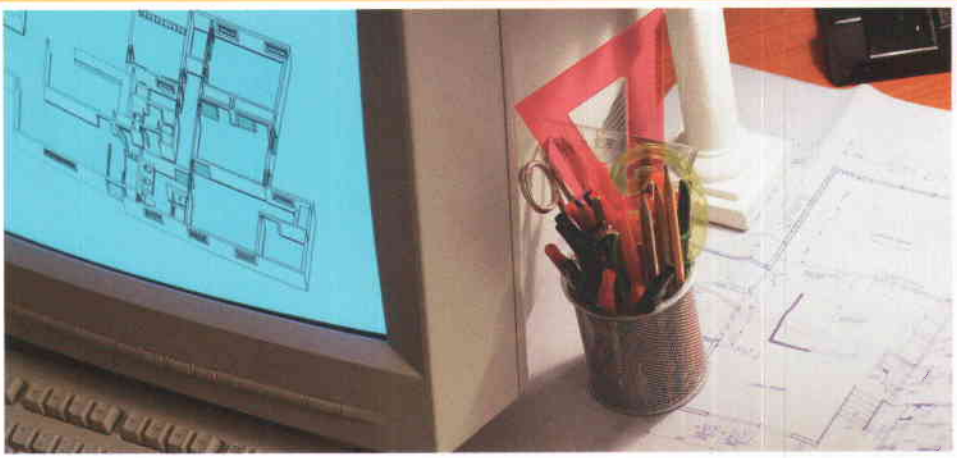
a) What is the height of Alex's sign?
b) Explain how you found your answer.

19. There is another way to discover the formula for the area of a trapezoid. You can use a parallelogram instead of two triangles.

a) Draw and cut out two identical trapezoids. Measure the lengths of the parallel sides, a and b, and the height, h.
b) Use the two trapezoids to create a parallelogram.
c) How can you now find the area of each trapezoid?

1.6 Draw Trapezoids

Focus on...
- perimeter and area of trapezoids
- constructing trapezoids



Trapezoids are common shapes in large structures like bridges and buildings. Computer software, such as *The Geometer's Sketchpad®*, makes it easy to create and adapt drawings and design models.

Even with pencil and paper, you can explore properties of trapezoids, such as area and perimeter.

Discover the Math

Materials
- ruler
- centimetre grid paper
- scissors

or
- centimetre linking cubes

Optional:
- BLM 1-6A Use a Geoboard to Construct Trapezoids

How can you construct a trapezoid, given its perimeter or area?

Part 1: Draw a trapezoid, given its perimeter

1. On a sheet of centimetre grid paper, try to draw a trapezoid that has a perimeter of 20 cm. Draw lightly, since you may need to make changes to your figure.

2. a) Measure the length of each side.
b) Add the lengths to get the perimeter. How close to 20 cm were you able to get?
c) Describe the process you used to draw this trapezoid.

3. a) Use 24 centimetre cubes to create a single, long strip.
b) Split the strip into four pieces. Choose your own lengths.
c) Using the four pieces, try to form a trapezoid with perimeter 24 cm. You can change your lengths if you need to.
d) When you have a good trapezoid model, copy it on a piece of centimetre grid paper. Hint: Measure the sloping sides.

4. **Reflect** Review your methods and difficulties in completing steps 1 to 3. How can you improve at drawing trapezoids when the perimeter is given?

Part 2: Draw a trapezoid, given its area

1. **a)** Design a trapezoid that has an area of 40 cm^2. Use centimetre cubes or strips of centimetre grid paper to create your design.
   b) Draw your trapezoid on centimetre grid paper.
   - Draw and label the height, h.
   - Verify that a and b are parallel. Adjust your diagram if necessary.

2. **a)** Measure a, b, and h.
   b) Calculate the area of your trapezoid.
   c) How close to 40 cm^2 were you able to get?
   d) Describe the process you used to draw this trapezoid.

3. **a)** Try to create a trapezoid that has a perimeter of 40 cm and an area of 60 cm^2. Describe the method you used to construct the trapezoid.
   b) Calculate the perimeter and area. How close were you?

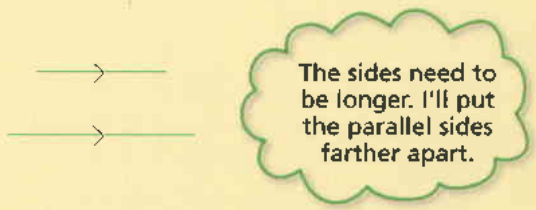
4. Create a problem similar to the one in step 3. Trade with a partner. Try to solve each other's problem.

5. **Reflect** Review your methods and difficulties in both parts of the activity. How can you improve at drawing trapezoids, when you are given
   a) the perimeter **b)** the area **c)** the perimeter *and* the area?

Key Ideas

- You can construct a trapezoid by creating a quadrilateral with one pair of opposite sides parallel.

- You can change the area or perimeter of a trapezoid by changing its side lengths and/or its height.

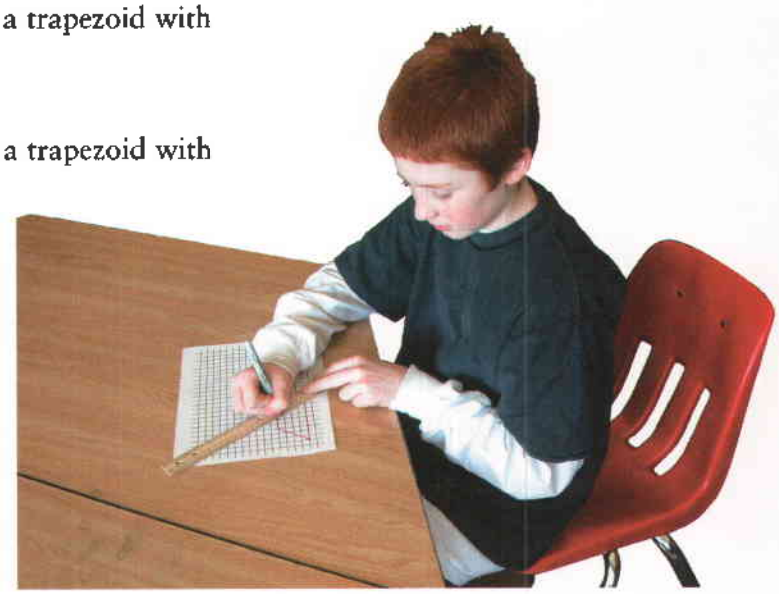


Communicate the Ideas

1. a) Describe a method you prefer to draw a trapezoid with a given perimeter.
b) What difficulties might you have?

2. a) Describe a method you prefer to draw a trapezoid with a given area.
b) What difficulties might you have?

3. a) Describe how you can construct a trapezoid with a given perimeter and area.
b) What strategies or shortcuts did you need to learn to solve this type of problem? Compare your strategies with a classmate's.



Check Your Understanding

Practise

For questions 4 to 6, use centimetre grid paper or centimetre linking cubes.

4. Draw a trapezoid with each perimeter. Use whole numbers for the side lengths.
a) 18 cm **b)** 26 cm
c) 10 cm **d)** 40 cm

5. Draw a trapezoid with each area.
a) 20 cm^2 **b)** 80 cm^2
c) 36 cm^2 **d)** 72 cm^2

6. Draw a trapezoid with perimeter 30 cm and area 30 cm^2.

Apply

7. a) Draw a trapezoid with perimeter 40 cm.
b) Calculate the area of the trapezoid you drew in part a).
c) Explore making other trapezoids with perimeter 40 cm, but different areas. Hint: Use grid paper for sketches.

8. Describe your methods for questions 4 to 7.

Try This!

9. a) Draw a trapezoid with perimeter 50 cm. Can you do this in more than one way? Explain.
b) Draw another trapezoid with perimeter 50 cm and area 80 cm^2. Describe your techniques.

Extend

For question 10, use centimetre grid paper.

10. a) Draw a triangle with vertical side 4 cm and horizontal side 3 cm. Measure the sloping side. How long is it? Does your measure appear exact?
b) Use your triangle from part a) to create trapezoids that fit exactly on centimetre grid paper. Label dimensions on your trapezoids.
c) Look for, and describe, any patterns in the perimeters of your trapezoids.
d) Look for, and describe, any area patterns.

Use Technology

Construct and Manipulate a Trapezoid Using *The Geometer's Sketchpad®*

Focus on...

- constructing trapezoids

This is another way to do the investigation on pages 34 and 35.

Materials

- computers
- *The Geometer's Sketchpad®* software, Version 4.0

Alternatives:

- TECH1.6A Construct and Manipulate a Trapezoid (GSP 4)
- TECH1.6B Construct and Manipulate a Trapezoid (GSP 3)

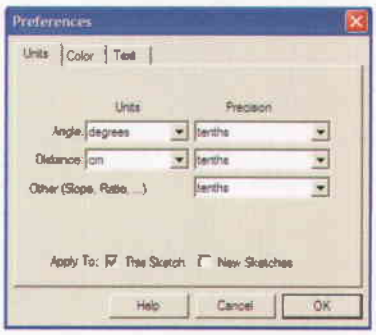
Technology Tip

- Holding the **Shift** key while dragging makes it easier to draw a horizontal segment.

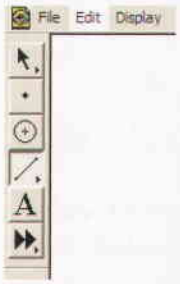
Part 1: Construct a Trapezoid

1. Open *The Geometer's Sketchpad®* and begin a new sketch.

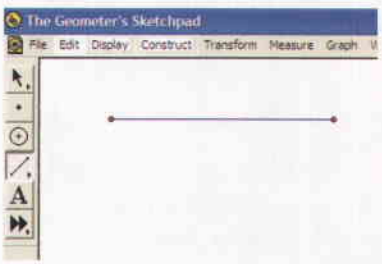
2. From the **Edit** menu, choose **Preferences**. Set preferences as shown.



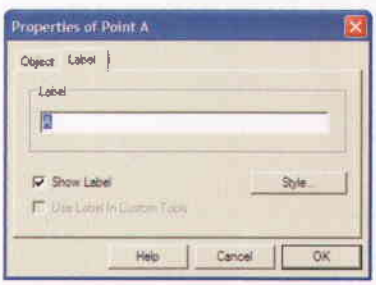
3. **a)** Choose the **Straightedge Tool** by clicking on , on the Toolbar. The Toolbar is at the left of the screen.



b) Using the **Straightedge Tool**, draw a horizontal line segment near the top of the sketch.



4. Label one endpoint A.
   a) Choose the **Text Tool** from the Toolbar.
   b) Move the cursor to one endpoint until the cursor's hand turns dark.
   c) Click on the point. A letter label should appear.
   d) To change the letter to "A," check that the cursor is still dark, and double-click. This panel should appear.
   Type "A" in the panel, and click **OK**.



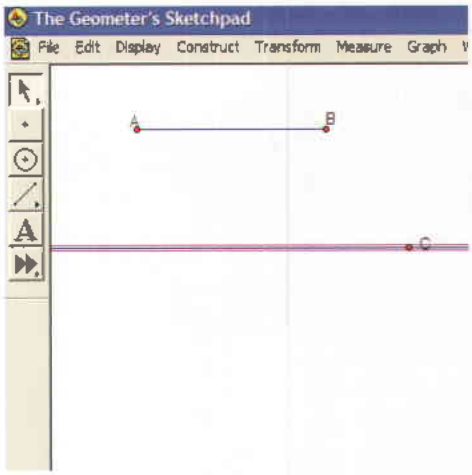
5. Repeat step 4 to label the other point B.

6. a) Choose the **Selection Arrow Tool** from the Toolbar.
b) Click in a blank part of the screen. This is called **deselecting**.
c) Use the **Selection Arrow Tool** to try selecting and deselecting points A and B and the line segment AB, singly and in combinations.
d) Try moving a label around an object by clicking and dragging it. Then, put it back neatly.
e) Deselect again.

Technology Tip

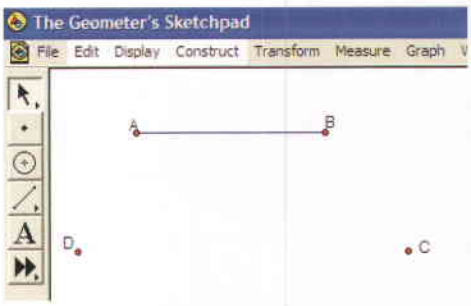
- Before you select a new object, make sure that you deselect first, by clicking somewhere in the white space. Then, select the objects you want.

7. a) Choose the **Point Tool** from the Toolbar. Place a point below and to the right of the line segment.
b) Label the new point C.



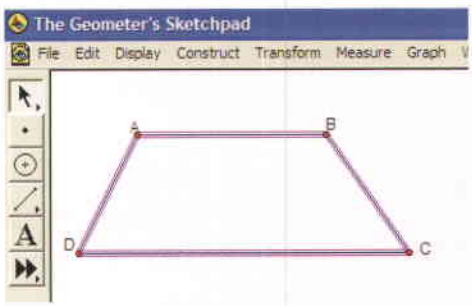
8. a) Choose the **Selection Arrow Tool**. Keeping point C selected, select the line segment AB.
b) From the **Construct** menu, choose **Parallel Line**. A line will appear across the screen. The line should go through point C. It should be parallel to line segment AB.
c) Choose the **Point Tool** from the Toolbar. Place a second point on the line through C. Label this point D.

9. a) Deselect, and select the line through C and D. From the **Display** menu, choose **Hide Parallel Line**. Your sketch should look like this.
If you accidentally hide some points as well, choose **Undo Hide** from the Edit menu.



b) Deselect, and select the points A, B, C, and D, *in clockwise order*.

c) From the **Construct** menu, choose **Segments**. A trapezoid should appear.
If your diagram looks like a bow tie, you probably selected the points in the wrong order. Choose **Undo Construct Segments** from the **Edit** menu. Then, select the points in the correct order and construct the trapezoid.



10. Click on and drag any corner of the trapezoid. Does the shape stay a trapezoid? Why or why not? Hint: What is true about sides AB and CD?

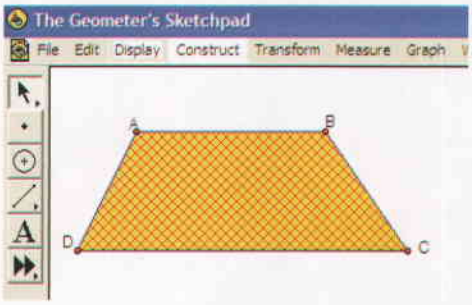
Part 2: Measure and Manipulate the Trapezoid

1. Begin with your trapezoid from part 1.

a) To make sure nothing is selected, deselect.

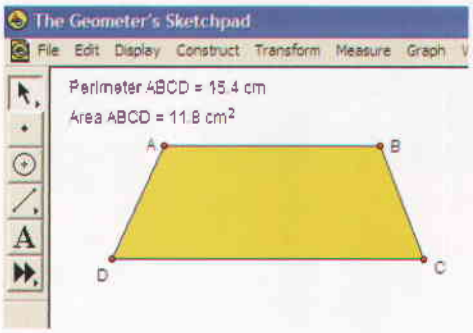
b) Select points A, B, C, and D again, in clockwise order.

c) From the **Construct** menu, choose **Quadrilateral Interior**. The inside of the trapezoid should become coloured. You are now ready to measure your trapezoid.



2. a) From the **Measure** menu, choose **Perimeter**. Then, deselect the measure.

b) Select the trapezoid interior. From the **Measure** menu, choose **Area**.



3. a) Click and drag one corner and describe what happens to the trapezoid.

b) Repeat part a) for the other corners.

4. Move the corners to create a trapezoid with a perimeter of 30 cm. Can you do this by moving just one point? Explain.

5. Move the corners to create a trapezoid with an area of 40 cm^2. (The perimeter need not be 30 cm.) Can you do this by moving just one point? Explain.

6. a) Try to create a trapezoid that has a perimeter of 40 cm and an area of 60 cm^2. Can you do this by moving just one point? Which point is best to move, and why?

b) Describe what you did.

7. Reflect Review your methods and problems in both parts of the activity. Explain how you created trapezoids with

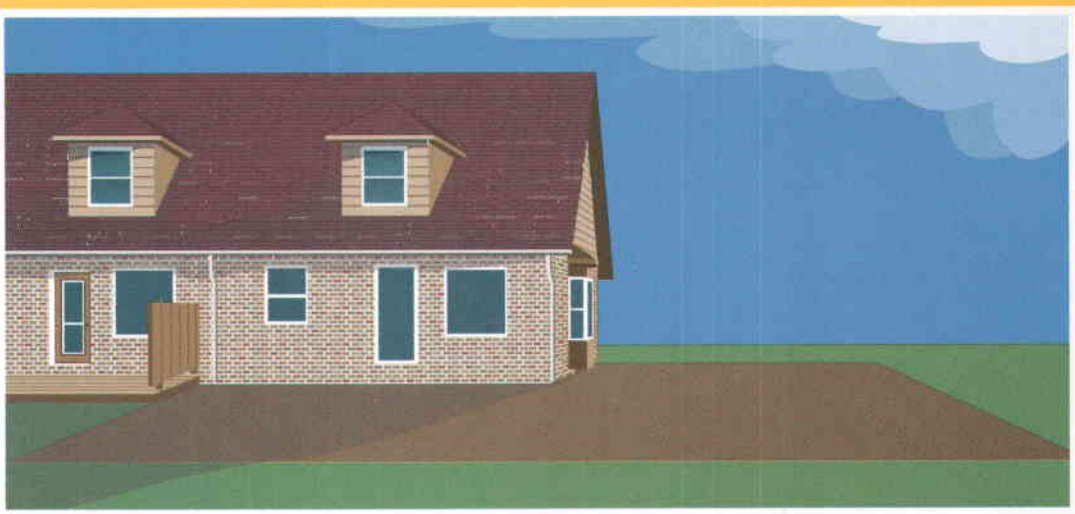
a) given perimeters

b) given areas

c) given perimeters and areas

1.7 Composite Shapes

Focus on...
- splitting and combining shapes
- perimeter
- area



Earlier, you found the area of a trapezoid by splitting the shape up into two triangles.

Suppose that you want to lay sod in this backyard. You also want to fence the perimeter. Can you split the backyard into simpler shapes to help you find its perimeter and area?

Discover the Math

composite shape
- two-dimensional shape that can be split into two or more simpler shapes

What strategies can I use to measure composite shapes?

Example 1: Area of a Composite Shape

Nina's backyard needs to be covered with fresh sod. Sod costs $8.99 per square metre. How much sod will Nina need? How much will it cost?

Solution

Understand

- What is the area of the backyard?
- How much will it cost to sod?

Plan

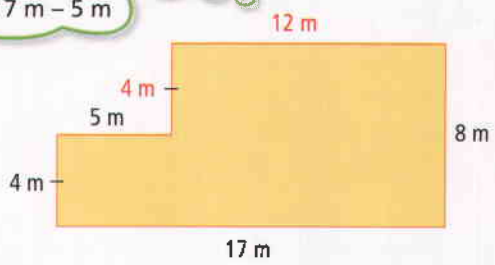
1. Identify the missing dimensions. Then, add them to the diagram.
2. To find the area, split the composite shape into two rectangles.
3. Find the area of each rectangle. Add to get the total area.
4. Multiply the area by the cost of sod per square metre to find the total cost.

Strategies
Make a picture or diagram

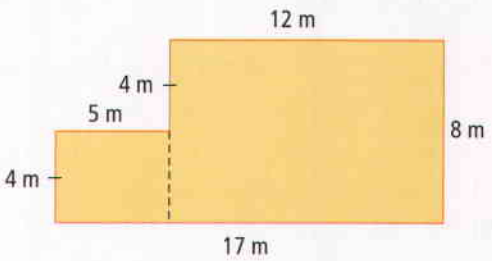
Do It!

1. The missing dimensions are 4 m and 12 m.

Same length as 17 m – 5 m



2. Split the backyard like this:



3. Area of small rectangle = length × width
$= 4 \times 5$
$= 20$
Area of large rectangle = length × width
$= 12 \times 8$
$= 96$
Add the areas of the two rectangles.
Total area = Area of small rectangle + Area of large rectangle
$= 20 + 96$
$= 116$
The area of Nina's backyard is 116 m^2.

My bedroom is 4 m by 3 m. That's 12 m^2. It makes sense for a yard to be about ten times as big.

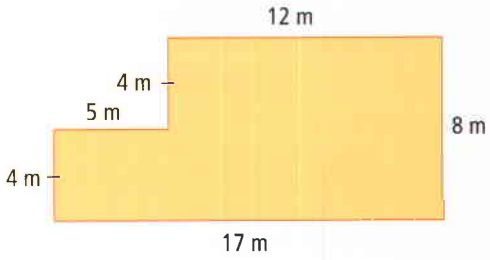
4. Cost of sod = 116×8.99
$= 1042.84$
The total cost for sod is \$1042.84.

Look Back

- The large rectangle looks about five times the area of the small one. $20 \times 5 = 100$. That's close to 96 m^2.
- For the cost, estimate: 100 m^2 × \$10 per square metre is \$1000. This is close to the calculated cost.

Example 2: Cost of a Fence

Nina's family wants to build a fence around their backyard. Fencing costs \$19 per metre. Nina offers to use her math skills to calculate the cost. Model her solution.



Solution

$P = 4 + 5 + 4 + 12 + 8 + 17$ **Add lengths, going around the outside of the shape.**

$P = 50$

The perimeter of Nina's backyard is 50 m.

Cost of fencing $= 50 \times 19$

$= 950$

The total cost for the fence is \$950.

I can't just add the rectangle perimeters. If I did, I'd include lengths that go through the *inside* of the yard. Nina doesn't want a fence through the middle of her yard!

Example 3: Go-Kart Side Panels

Rupau is constructing two side panels for his go-kart. He also wants to paint the outside of each panel.

a) Find the perimeter that must be cut.

b) Find the area that must be painted.

Solution

a) $P = 1.1 + 2.0 + 0.5 + 1.2 + 1.0$

$P = 5.8$

Rupau must cut a perimeter of 5.8 m.

I need to pick a starting point on the shape. Then, I can add lengths as I go all the way around.

b) To find the total area, split the composite shape into a rectangle and a triangle.

Shape	Diagram	Calculation	Area
Rectangle	0.5 m, 2.0 m	Area of rectangle $= l \times w$ $= 2.0 \times 0.5$ $= 1$	1 m^2
Triangle	0.6 m, 0.8 m	Area of triangle $= b \times h \div 2$ $= 0.8 \times 0.6 \div 2$ $= 0.24$	0.24 m^2
		Area of each side panel	1.24 m^2

Strategies
What strategy is used here?

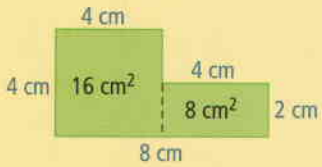
Area of both side panels $= 2 \times 1.24$

$= 2.48$

Rupau needs to paint an area of 2.48 m^2.

Key Ideas

- You can find the area of a composite shape by dividing it into simpler shapes. Add the areas of the simpler shapes to get the total area.
- The perimeter of a composite shape is the total distance *around the outside.*



Communicate the Ideas

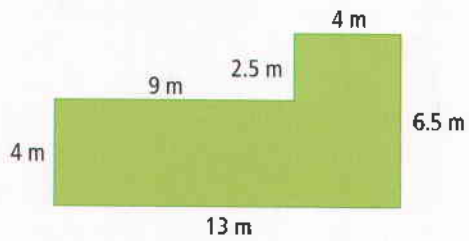
1. Draw an example of a composite shape that contains two simpler shapes.
2. Identify three or more examples of composite shapes that appear at home, in school, or elsewhere.
3. Identify the simple shapes that combine to make the composite shapes in questions 1 and 2. Find the area of each composite shape:
   a) Split the shape.
   b) Find the area of each part. Then, find the total area.

Check Your Understanding

Practise

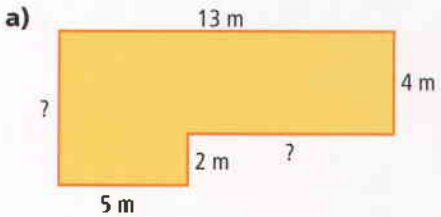
For questions 4 to 6, refer to Example 1.

4. Find the area of this composite shape.
   a) Split the shape.
   b) Find the area of each part. Then, find the total area.

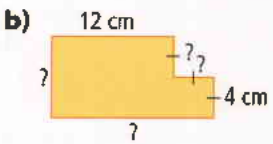


5. Find the missing dimensions of each composite shape.

a)



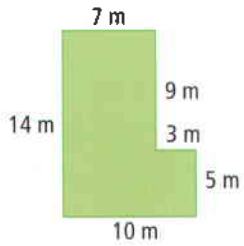
b)



6. Find the area of each shape in question 5.

For questions 7 and 8, refer to Example 2.

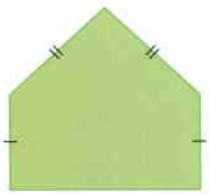
7. Calculate the perimeter of this shape.



8. Find the perimeter of each figure in questions 4 and 5.

9. Describe how to split each composite shape into simpler shapes.

a)

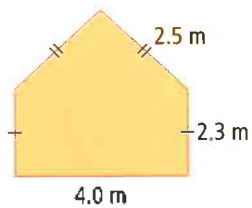


b)

For questions 10 and 11, refer to Example 3.

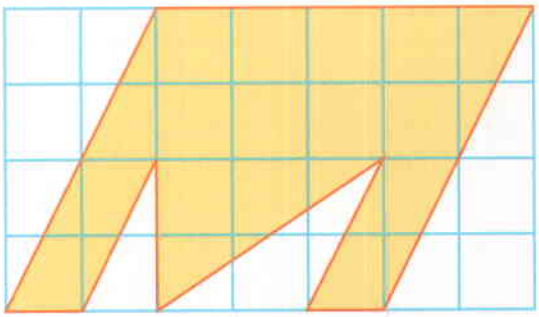
10. Find the perimeter and the area of each shape in question 9. Measure any dimensions you need.

11. Naveed is building a frame for the front of his shed. Determine the total length of wood needed.



12. To find the area of a composite shape, you can add areas of simpler shapes. Why does this not work for the perimeter?

13. Sabra is the manager of a rock band called M-pathy. She is planning to order concert T-shirts with the band's logo.



Embroidery costs $0.25 per square centimetre. Sabra needs to find the total cost to embroider 300 shirts.

a) Which strategy will you use to solve this problem? Why?

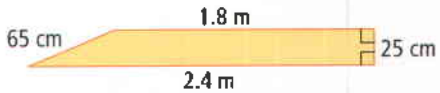
b) Use your strategy to solve the problem.

c) Show how you could have used a different strategy.

Apply

Chapter Problem

14. Sarah is constructing two side panels for her go-kart. She wants to paint the outside of each panel.



a) Find the perimeter that must be cut.

b) Find the area that must be painted.

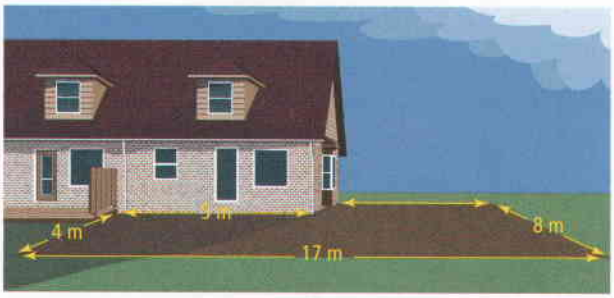
15. Choose a room in your home or school. Suppose you decided to wallpaper the walls of this room.

a) What total area would you need to wallpaper?

b) You want to add a wallpaper border. Where will you place it? How much border will you need?

c) Research the cost of wallpaper and borders. How much will it cost to redecorate the room?

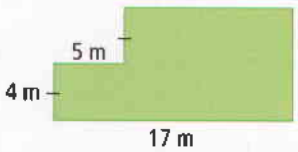
16. Example 1 showed one way to split Nina's backyard into simpler shapes.



a) Find another way to split Nina's backyard. Use this method to find the total area.

b) Compare this answer to the one found in Example 1. Does this make sense? Explain.

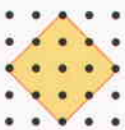
17. a) Josh solved Nina's problem a different way: "I thought of the shape as a large rectangle with a small rectangle removed." How do you think Josh calculated the area?



b) Find the area using Josh's method.

c) Compare this answer to the one found in Example 1. Does this make sense? Explain.

18. The square shown was created on a geoboard. The horizontal and vertical distance between pegs is 1 cm.

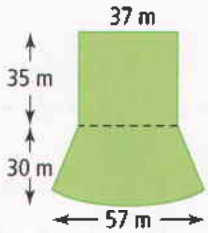


a) How can you find the area of this square?

b) Describe another way that you could solve this problem.

Try This!

19. You can estimate the swimming area in this wave pool by splitting up the pool into a rectangle and a trapezoid.



a) Find the area of the rectangle.

b) Find the approximate area of the whole pool. Compare this result to the one you found earlier (page 33, question 16).

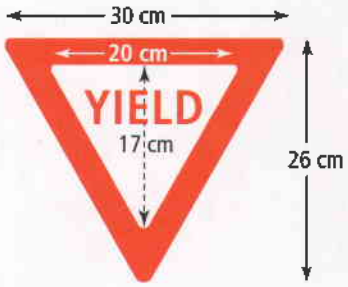
c) Which result do you think is more accurate? Explain why.

d) Can you find a more accurate answer? If so, describe how. If not, explain why not.

Extend

20. Repeat question 18 for this geoboard square.

21. Blue County is planning to paint 1320 new yield signs. Each yield sign is an equilateral triangle. The diagram shows the dimensions.



a) Each can of red paint covers 2 m^2 and costs $5. How much will all the red paint for this project cost? Justify any estimates you made to find your answer.

b) Extend your budget estimate to include other costs. Consider the white paint for the inside and the word YIELD, labour costs, gas for the trucks, and so on.

CHAPTER 1

Review

Key Words

Match the key words to the correct descriptions.

1. the perpendicular distance from the base of a shape to its opposite side or vertex

2. a shape that can be split into two or more simpler shapes

3. these contain operations to be done first

4. calculated by splitting into two different-shaped triangles

5. a measure of how much space a two-dimensional shape covers

A area

B area of a parallelogram

C area of a trapezoid

D height

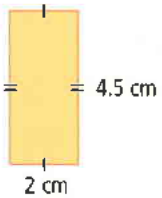
E brackets

F composite shape

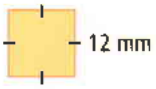
1.1 Perimeters of Two-Dimensional Shapes, pages 12–17

6. Find the perimeter of each shape.

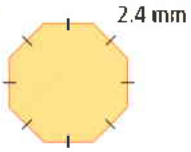
a)



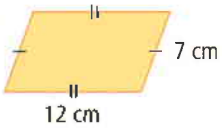
b)



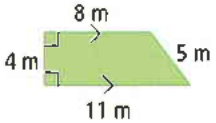
c)



d)

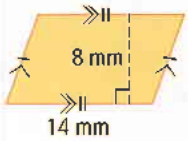


7. What length of fence is needed to surround the yard shown?



1.2 Area of a Parallelogram, pages 18–21

8. What is the area of the top of the machine part?



9. Draw a parallelogram to match this calculation.

$A = b \times h$

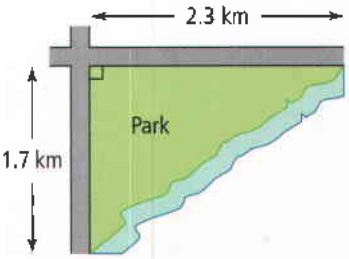
$A = 6 \times 3$

$A = 18$

The area of the parallelogram is 18 cm^2.

1.3 Area of a Triangle, pages 22–25

10. A park is bounded by a river and two roads.

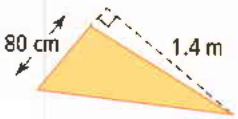


a) Find the area of the park.

b) Describe your method.

c) How accurate do you think your answer is? Explain.

11. Karsten is designing a flag to fly at the back of his go-kart. Determine the area of Karsten's flag.



1.4 Apply the Order of Operations, pages 26–29

12. Evaluate each expression.

a) $13 - 9 \div 3$ **b)** $3 \times (16 \div 2) - 5$

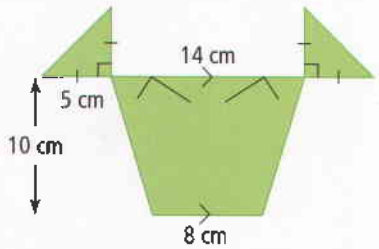
c) $8 \times 3 \div 6 \div 3$ **d)** $20 + (12 - 2) \div 5 \times 3$

13. What's wrong? Find each error and explain how to correct it.

a)
$4 \times 4 + 6 \div 2$
$= 16 + 6 \div 2$
$= 22 \div 2$
$= 11$

b)
$81 \div 9 \div 3$
$= 81 \div 3$
$= 27$

14. Frieda is designing a logo for her hockey team, the Bulls.

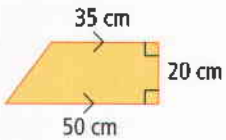


a) Write an expression for the area of each ear.
b) Write an expression for the area of the face.
c) Find the total area.

1.5 Area of a Trapezoid, pages 30–33

For questions 15 and 16, refer to this plan of the side panel of a CD storage case.

15. a) What shape is the side panel? Explain how you know.
b) Determine the area of the side panel.



16. Split the side panel shape into simpler shapes. Find the area of each part and add them together to get the total area. Compare this to your answer to question 15b). Does this make sense? Explain.

1.6 Draw Trapezoids, pages 34–36

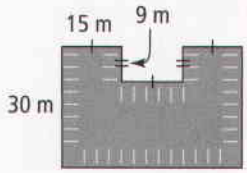
17. a) Can all trapezoids be split into a rectangle and a triangle? Support your answer with diagrams.
b) Can you draw a trapezoid that cannot be split into two triangles? Explain.

18. a) Draw a trapezoid that has a perimeter of 36 cm.
b) Explain your method.

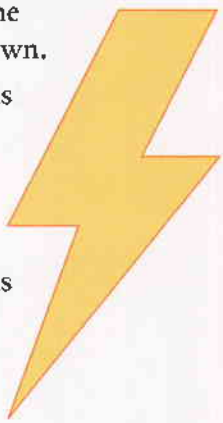
19. a) Draw a trapezoid that has an area of 48 cm^2.
b) Explain your method.
c) Calculate the area of the trapezoid you have drawn. How close is it to 48 cm^2?

1.7 Composite Shapes, pages 40–45

20. a) Find the missing dimensions of the parking lot.
b) Find the area.
c) Find the perimeter.



21. The Bulls' archrivals are the Electric, whose logo is shown.



a) Measure any dimensions you need, and find the area of the logo. Show all measurements and calculations.
b) Measure any dimensions you need, and find the perimeter of the gold trim. Show all measurements and calculations.

CHAPTER 1

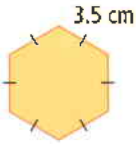
Practice Test

Strand	NSN	MEA	GSS	PA	DMP
Questions	1–8,11–14	1–7,11–14	9, 10		

Multiple Choice

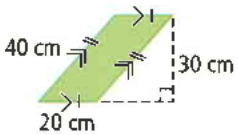
For questions 1 to 5, choose the best answer.

1. What is the perimeter of this shape?



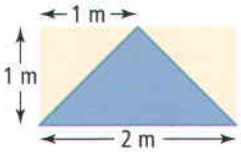
A 3.5 cm **B** 7 cm
C 14 cm **D** 21 cm

2. Matt is adding a piece of wood to the side of a ladder. What is the area of wood that Matt must cut?



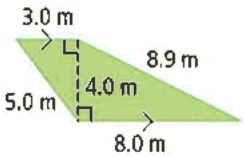
A 300 cm^2 **B** 400 cm^2
C 600 cm^2 **D** 800 cm^2

3. What is the area of the blue region of the flag?



A 0.5 m^2 **B** 1 m^2
C 2 m^2 **D** 4 m^2

4. The perimeter of the trapezoid is



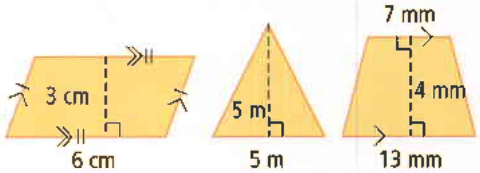
A 12 m **B** 20.9 m
C 24.9 m **D** 28.9 m

5. Look at the trapezoid in question 4. The area is

A 6 m^2 **B** 22 m^2
C 23 m^2 **D** 32 m^2

Short Answer

6. Identify each figure. Then, find its area.



7. Simplify each expression, following the correct order of operations. Show all steps.

a) $5 + 9 \div 3$
b) $12 - (6 - 3)$
c) $3 \times (4 - 2 + 5)$

8. Simplify each expression. Show all steps.

a) $6 + 12 \div 3 - 4 \div 2$
b) $2.4 + 3 \times 1.1 + 4.8 \div (4 \div 0.2)$

9. a) Draw a trapezoid that has a perimeter of 26 cm.
b) Explain how you drew the trapezoid.
c) Draw a different trapezoid with the same perimeter. Compare the areas of the two trapezoids.

10. a) Draw a trapezoid that has an area of 38 cm^2.
b) Calculate the area of the trapezoid you have drawn. How close is it to 38 cm^2?
c) Draw a different trapezoid with the same area. Compare the perimeters of the two trapezoids.

11. a) Draw a two-dimensional shape to match this area calculation.

$A = (a + b) \times h \div 2$

$A = (15 + 9) \times 4 \div 2$

$A = 48$

The area is 48 cm^2.

b) Find the perimeter of your shape.

Extended Response

12. The layout of an outdoor fairground is shown.

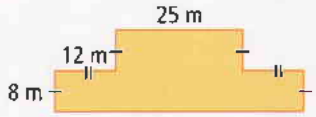
a) Copy the composite shape. Show how you can split it into simpler shapes.

b) Calculate the area of the fairground.

c) Find the length of fencing needed to surround the whole perimeter.

d) Fencing costs $15 per metre. What will it cost for the entire fence?

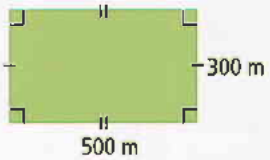
13. a) Find the perimeter of the building shown in the floor plan.



b) Copy the composite shape. Show two different ways you can split it.

c) Find the area using each way to split the shape. Are your answers the same? Explain.

14. The formula for the perimeter of a rectangle is $P = (2 \times l) + (2 \times w)$. Can this also be written as $P = 2 \times (l + w)$? Use the example shown here and at least one other to explain.



Chapter Problem Wrap-Up

1. Use these shapes to design a model go-kart.

- Use at least three different shapes.
- Include at least one composite shape.
- Decide on the sizes of the shapes you will use.
- If you use round wheels, do not include them in any calculations.

Include sketches of your design.

2. Calculate

a) the area of each shape

b) the total area of material you will need

c) the total length of all cuts

Geometry and Spatial Sense

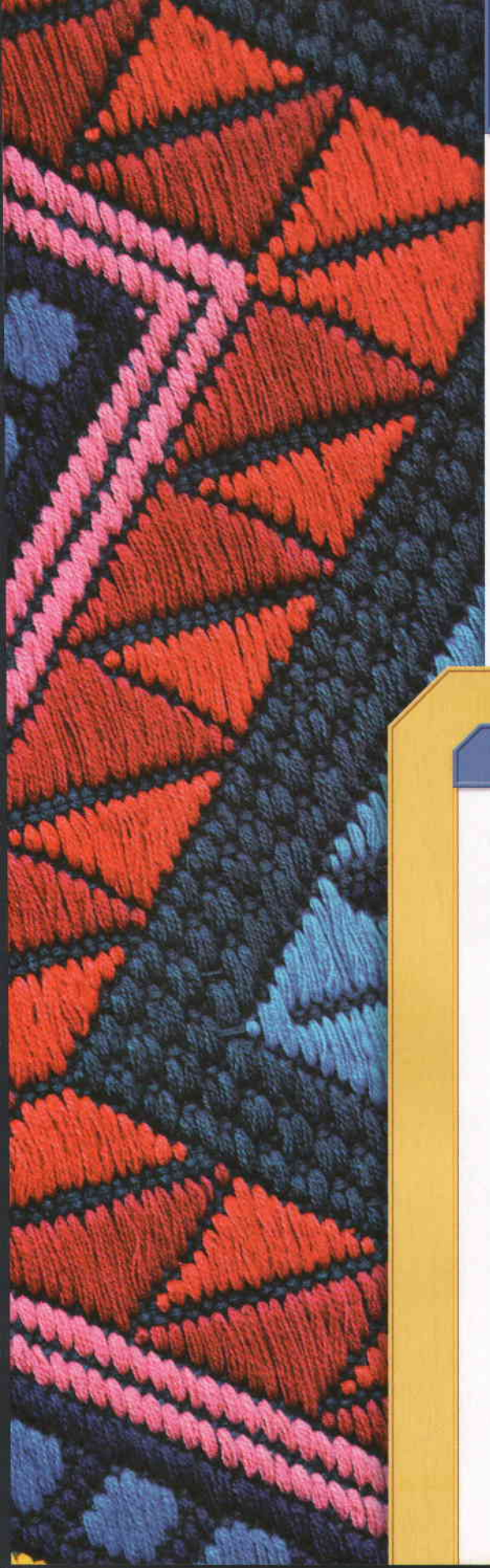
- Identify, describe, compare, and classify geometric figures.
- Identify congruent and similar figures.
- Use mathematical language effectively to describe geometric concepts, reasoning, and investigations.
- Identify two-dimensional shapes that meet certain criteria.
- Identify and explain why two shapes are congruent.
- Create and solve problems involving congruence.

Measurement

- Demonstrate an understanding of and apply accurate measurement strategies.

Key Words

equilateral triangle
isosceles triangle
scalene triangle
acute triangle
right triangle
obtuse triangle
quadrilateral
congruent
similar



CHAPTER 2

Two-Dimensional Geometry

Geometric shapes are used in the design of buildings, bridges, vehicles, clothing, toys, and more. What two-dimensional shapes do you recognize in the pattern used on the material in the photograph?

Artists and designers learn a lot about shapes. They explore ways of putting shapes together to make attractive designs.

Chapter Problem

Patterns on items such as fabric, wallpaper, and floor tiles often repeat. Each part of the pattern is called a pattern block. Look at the designs on items around you. Choose one that includes geometric shapes. Sketch a pattern block that you like from the design.

- Describe what you like about the pattern.
- Explain how the design is created.
- Describe what happens to the pattern block on each repetition. Is the pattern block turned through 90° or flipped upside-down? Are the colours changed?

In this chapter you will explore how shapes are used to create attractive patterns. You will make your own patterns and designs.

Get Ready

Line Segments

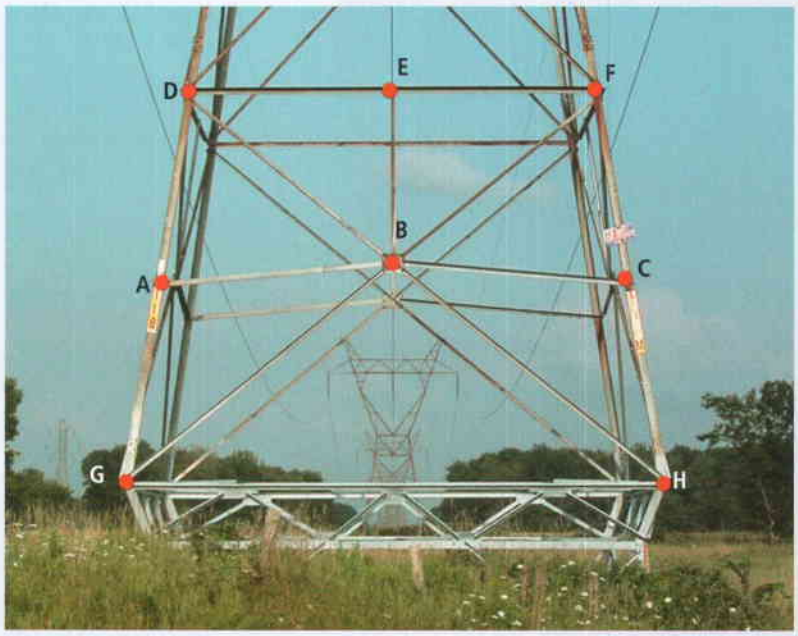
A **line segment** joins two points. It is named by its endpoints. The line segment shown is named AB or BA.

1. Name four different line segments in the photo of part of a hydro tower.

2. Use a ruler to measure each line segment that you named in question 1. Measure to the nearest tenth of a centimetre.

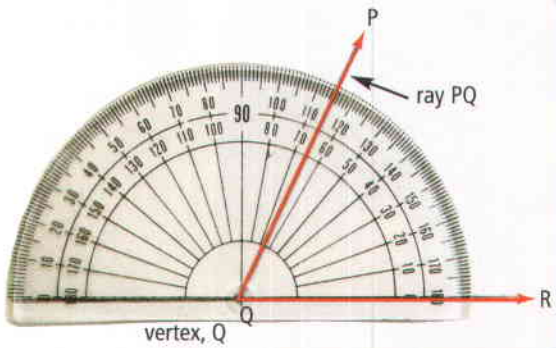
3. Some line segments in the photo have the same length. Name one pair. Use a ruler to check.

4. Find two line segments that are contained within another line segment. Name them.



Angles

- An angle is formed when two **rays** meet at a point **vertex**. An angle is named using one point on each and the vertex. The vertex is always named second. The angle shown is ∠PQR or ∠RQP. When there is clearly only one angle referred to, it can be named by just the vertex: ∠Q in this case.
- A protractor is used to measure the size of angles, in degrees. ∠Q = 65°.



5. Use a protractor to measure each angle in the photo of the hydro pylon.
   a) ∠DAB b) ∠DBF c) ∠AGH

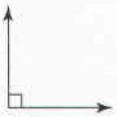
6. Use a ruler and a protractor to draw an angle with each measure.
   a) 55° b) 90° c) 120°

Classify Angles

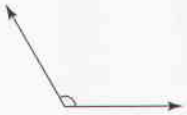
Angles are classified by their size.

An **acute angle** measures less than 90°.

A **right angle** measures 90°.



An **obtuse angle** measures more than 90° but less than 180°



7. Classify each angle that you drew for question 6.

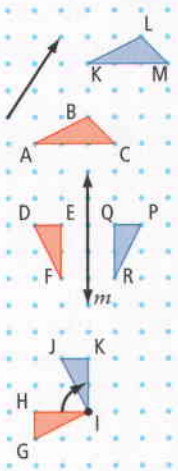
8. Find an example of each type of angle in the hydro tower photo.

Transformations

The diagram shows a translation of 2 units to the right and 3 units up. △KLM is the translation image of △ABC.

The diagram shows a reflection in the reflection line, m. △PQR is the reflection image of △DEF.

The diagram shows a rotation of 90° clockwise about the turn centre I. △JKI is the rotation image of △GHI.

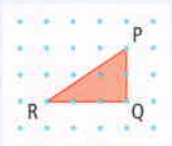


translation
- a slide

reflection
- a flip

rotation
- a turn

9. Copy △PQR onto dot or grid paper. Use different colours to show the image for each translation.



a) 5 units to the right and 3 units up
b) 3 units to the left and 4 units down

10. Make a new copy of △PQR. Show the image for each reflection.

a) in a horizontal reflection line that passes through P
b) in a vertical reflection line that passes through R

11. Make another copy of △PQR. Show the image for each rotation.

a) 90° clockwise about P
b) 180° counterclockwise about Q

2.1 Classify Triangles

Focus on...
- triangle types
- comparing sides
- comparing angles

The photo shows a truss bridge over the Erie Canal. What different shapes can you identify in the bridge?

Discover the Math

Materials
- ruler
- triangle dot paper
- scissors

Alternative
- BLM 2.1A Use a Geoboard
- TECH 2.1A Use *The Geometer's Sketchpad®* to Explore Classifying Triangles (GSP 4)
- TECH 2.1B Use *The Geometer's Sketchpad®* to Explore Classifying Triangles (GSP 3)

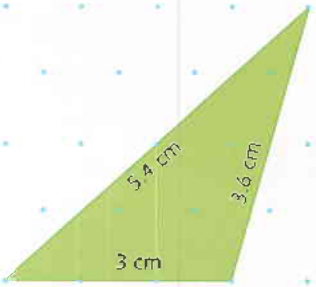
How can you classify triangles?

Work with a partner.

1. a) Draw five different triangles on triangle dot paper.

b) Measure the length of each side of your triangles. Write each measure close to the side, inside the triangle.

c) Cut out your five triangles.



2. a) Compare your triangles with those that your partner made. Sort the ten triangles into groups.

b) Write a description of each of your groups. What characteristics do the triangles in the group have in common?

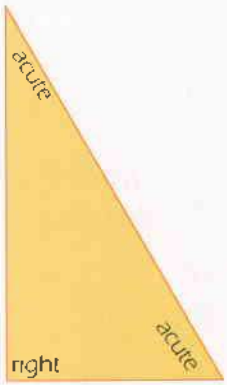
3. Use the **Glossary** at the back of this text to find a definition of each of the following:
   - **equilateral triangle**
   - **isosceles triangle**
   - **scalene triangle**

   Classify each of your groups of triangles.

Literacy Connections

Using a Glossary
The Glossary starts on page 481. It lists mathematical terms in alphabetical order. Each word is defined.

4. **a)** Take each of your five triangles and flip them over.
   b) Recall the different types of angles: acute, right, and obtuse. What type are the angles in each of your triangles? Write the angle type inside each vertex.



5. **a)** Compare your triangles with those that your partner has.
   Sort the ten triangles into groups by their angle types.
   b) Write a description of each group. What characteristics do the triangles have in common?

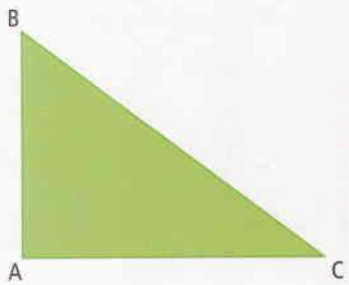
6. Use the **Glossary** to find a definition of each of the following:
   - **acute triangle**
   - **right triangle**
   - **obtuse triangle**

   Classify each of your groups of triangles.

7. **Reflect** Triangles are classified in two different ways. Write a brief summary of the two ways.

Example 1: Classify a Triangle

a) Measure the side lengths and the angles of $\triangle ABC$.
b) Classify the triangle in two ways. Give reasons for your answers.



Solution

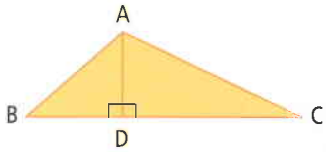
a) $AB = 3$ cm $\quad \angle A = 90°$
$AC = 4$ cm $\quad \angle B = 53°$
$BC = 5$ cm $\quad \angle C = 37°$

$\angle A$ looks like the corner of a sheet of paper which is 90°. Measure with a protractor to check.

b) $\triangle ABC$ is scalene, because the side lengths are all different.
$\triangle ABC$ is a right triangle, because $\angle A$ measures 90°.

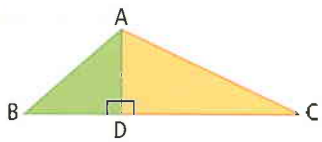
Example 2: Name and Classify Triangles

a) Identify all the triangles in the diagram.
b) Classify each triangle by its angle measures.



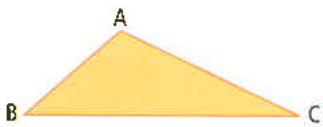
Solution

a)

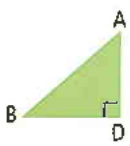


There are three different triangles: $\triangle ABC$, $\triangle ABD$, and $\triangle ACD$.

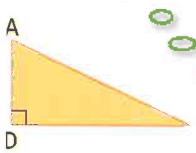
b)



$\triangle ABC$ is an obtuse triangle, because $\angle BAC$ is an obtuse angle.



$\triangle ABD$ is a right triangle, because $\angle ADB$ is 90°.



$\triangle ACD$ is a right triangle, because $\angle ADC$ is 90°.

The square mark at D means 90°.

Literacy Connections

Reading Diagrams

To interpret some diagrams, it may help to cover parts with your finger or with a piece of paper. Do this so that you can look at one shape at a time.

Key Ideas

- Triangles can be classified by their side lengths.

equilateral triangle	**isosceles triangle**	**scalene triangle**
• three equal sides	• two equal sides	• no equal sides



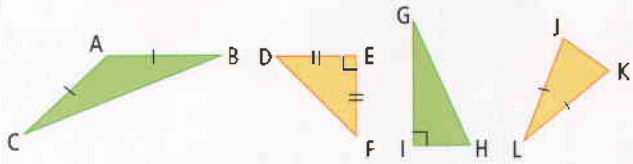
- Triangles can be classified by the size of their angles.

acute triangle	**right triangle**	**obtuse triangle**
• three acute angles	• one right angle	• one obtuse angle



Communicate the Ideas

1. What parts of a triangle do you compare to decide whether a triangle is equilateral, isosceles, or scalene?
2. How do you decide whether a triangle is acute, right, or obtuse?
3. Which one of the four triangles shown does not belong in the same group as the other three? Give reasons.
4. Sketch an acute scalene triangle. Justify your sketch.



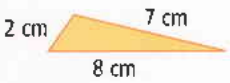
Check Your Understanding

Practise

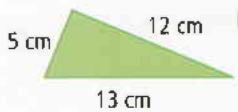
For help with Questions 5 to 9, refer to Example 1.

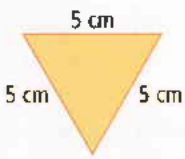
5. Classify each triangle as equilateral, isosceles, or scalene. Explain your choice.

a) 

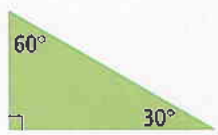
b) 

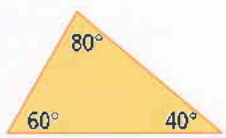
6. Classify each triangle by its side lengths. Explain your choice.

a) 

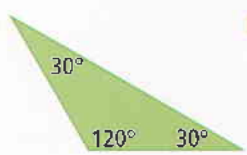
b) 

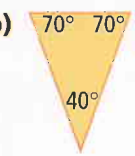
7. Classify each triangle as acute, right, or obtuse. Explain your choice.

a) 

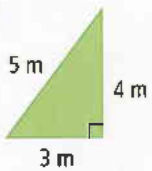
b) 

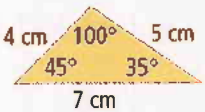
8. Classify each triangle by its angle measures. Explain your choice.

a) 

b) 

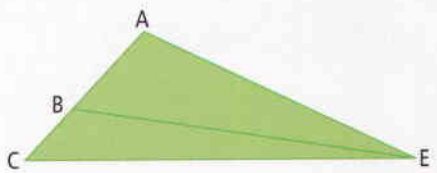
9. Classify each triangle in two ways. Give reasons for your answers.

a) 

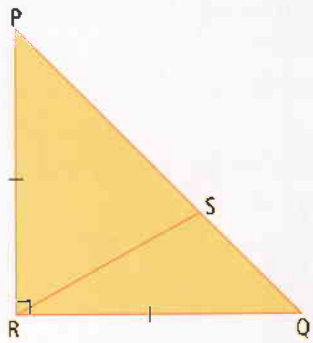
b) 

For help with questions 10 and 11, refer to Example 2.

10. a) Name all the triangles in the figure.
    b) Classify each triangle by its angle measures.

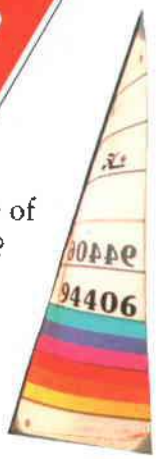


11. a) Name all the triangles in the figure.
    b) Classify each triangle in two ways.



Apply

12. Look at the objects in the pictures.



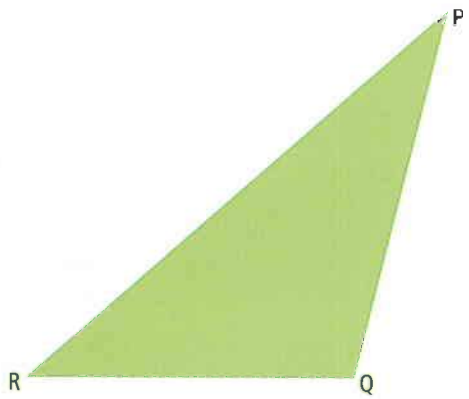
a) Name each object. What type of triangle is its shape closest to?

b) Describe two other examples of triangular objects you see in everyday life.

13. a) Measure each side of $\triangle PQR$, to the nearest tenth of a centimetre.

b) Measure each angle.

c) Classify the triangle in two ways.



14. Draw each triangle using a ruler and a protractor. Measure and record each side and angle that is not given. Classify each triangle in two ways. Hint: First sketch a triangle and mark the given information. Plan your steps. Draw and label the first side. Then measure and mark the first angle.

a) $\triangle ABC$ with AB = 5 cm, $\angle A = 60°$, AC = 5 cm

b) $\triangle DEF$ with DE = 4 cm, $\angle D = 60°$, $\angle E = 60°$

15. Draw each triangle using a ruler and a protractor. Measure and record each side and angle that is not given. Classify each triangle in two ways.

a) $\triangle KLM$ with KL = 8 cm, KM = 8 cm, $\angle K = 40°$

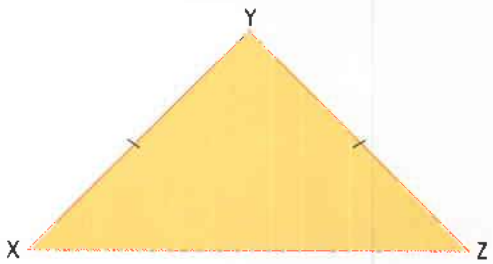
b) $\triangle PQR$ with PQ = 6 cm, $\angle P = 80°$, $\angle Q = 50°$

16. Use a ruler and a protractor to draw each triangle. Then, classify the triangle in two ways.

a) one angle of 65° between sides measuring 5 cm and 5 cm

b) one side measuring 6 cm between angles of 45° and 45°

17. a) How do you know that $\triangle XYZ$ is an isosceles triangle?



b) Are any of the angles in $\triangle XYZ$ equal? If so, which ones?

18. Use a ruler and a protractor to draw an isosceles triangle that has

a) only one 30° angle

b) two 30° angles

Classify each triangle by its angle measures.

19. Use a ruler and a protractor to draw $\triangle RST$. In the triangle RT = 5 cm, $\angle R = 60°$, and $\angle T = 60°$.

a) Measure and record each side and angle that is not given.

b) Classify $\triangle RST$ by its side measures and by its angle measures.

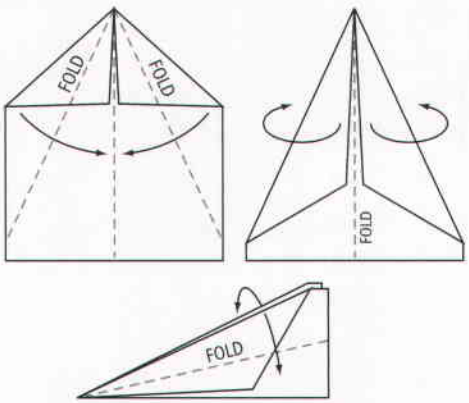
20. Use diagrams to support your answers.

a) When one angle in a triangle is a right angle, what type of angle are the other two angles?

b) When one angle in a triangle is obtuse, what type of angle are the other two angles?

c) In an equilateral triangle, what is the measure of each angle?

21. There are many paper airplane models. Here is one example.



a) What types of triangles do you see in the model shown?

b) Draw two other designs for paper airplanes. What types of triangles do they involve? Go to www.mcgrawhill.ca/links/math7 and follow the links if you need some suggestions.

Internet Connect

Try This!

22. a) Draw a triangle with one acute angle.

b) What type(s) of angle are the other two angles in your triangle? What type of triangle have you drawn?

c) Can you draw one or more triangles, with one acute angle, that give a different answer to part b)? Demonstrate and explain.

Extend

23. Why do you often see triangles in bridge designs? What type of triangle occurs most? Conduct Internet research to find out more about the different types of truss bridges and the role of triangle in their design.

Go to www.mcgrawhill.ca/links/math7 and follow the links to some helpful sites with information on bridges.

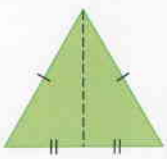
Internet Connect

24. Compare the sum of any two side lengths of a triangle with the length of the third side. What relationship is true?

Making Connections

Symmetry

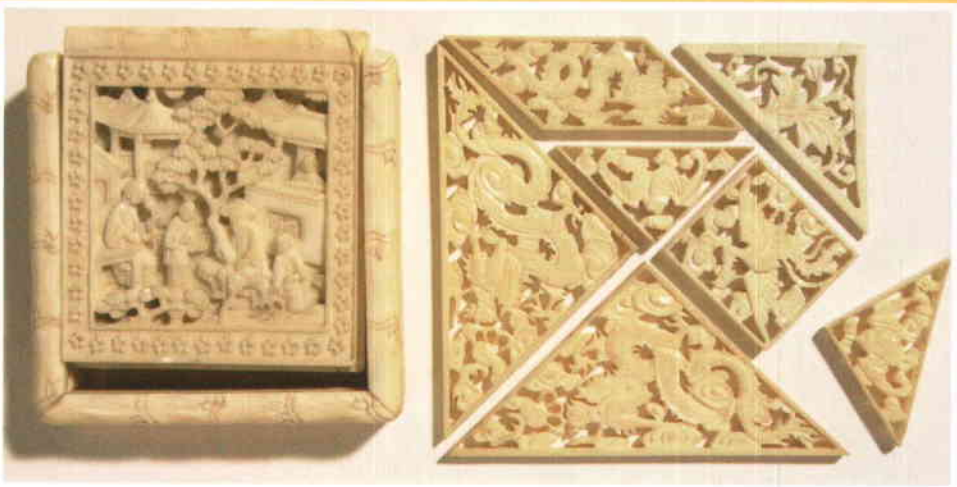
Draw a line from any vertex of an equilateral triangle through the middle of the opposite side. This is a line of symmetry. You can fold the triangle along this line and the sides match.



1. How many lines of symmetry does an equilateral triangle have?
2. How many lines of symmetry does an isosceles triangle have? Draw a diagram to illustrate your answer.
3. How many lines of symmetry does a scalene triangle have?

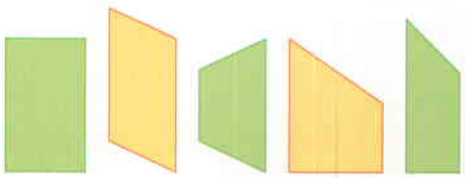
2.2 Classify Quadrilaterals

Focus on...
- quadrilaterals
- side lengths
- angle measures
- parallel sides



A tangram is a geometric puzzle that was invented in China. In the puzzle, a square is divided into seven geometric shapes. Many other figures can be made by rearranging the seven pieces.

Try to use all seven pieces of a tangram to make each of the **quadrilaterals** shown.



quadrilateral
- a closed shape with four straight sides

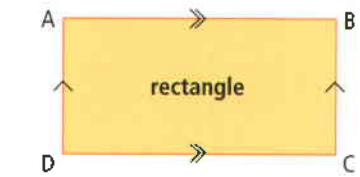
Discover the Math

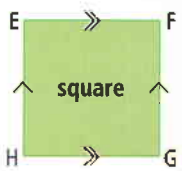
Materials
- ruler
- protractor

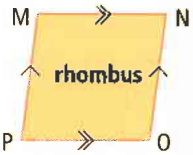
Optional
- BLM 2.2A Quadrilaterals

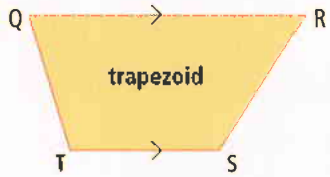
How can you distinguish quadrilaterals?

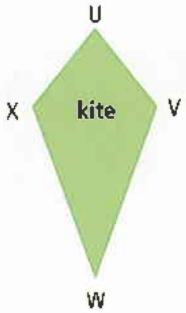
1. There are six special types of quadrilaterals. How would you sort them into two groups? Which shapes would you group together? Why?











Literacy Connections

Reading Diagrams
Matching arrowheads on opposite sides mean that the sides are parallel.

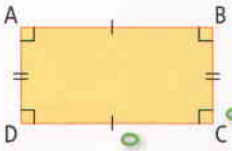
2. Copy and complete the table to compare the types of quadrilaterals. The first one has been done for you.

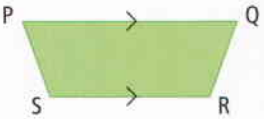
Quadrilateral Type	Side Lengths	Angle Measures	Parallel Sides?
Rectangle	opposite sides are equal	all angles are 90°	two pairs of opposite sides are parallel
Square			
Parallelogram			
Rhombus			
Trapezoid			
Kite			

3. **Reflect** How do you classify quadrilaterals? Write a short description of the features you need to look at to name the type of quadrilateral.

Example 1: Classify Quadrilaterals

Classify each quadrilateral. Give reasons.

a) 

b) 

Look at the equal marks on sides in the diagram.

The square mark on each corner means 90°.

Solution

a) AB = DC
AD = BC
$\angle A = \angle B = \angle C = \angle D = 90°$
Two pairs of opposite sides have equal lengths. All four angles are 90°.
Quadrilateral ABCD is a rectangle.

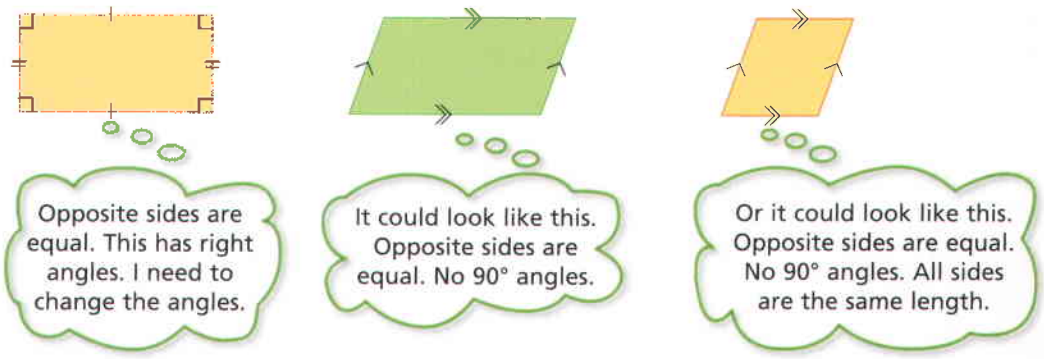
b) No sides are marked as equal.
One pair of opposite sides is parallel.
Quadrilateral PQRS is a trapezoid.

Example 2: Identify a Quadrilateral

A certain quadrilateral has two pairs of opposite sides that are equal and parallel. The quadrilateral contains no right angles. Identify and draw the quadrilateral.

Solution

Method 1: Draw a Diagram

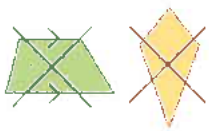


This is a parallelogram. This is a rhombus.

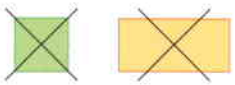
Strategies
Make a picture or diagram

The quadrilateral must be either a parallelogram or a rhombus.

Method 2: Work Backward



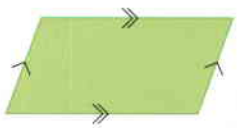
The quadrilateral has two pairs of opposite sides parallel. So, it is not a trapezoid or a kite.



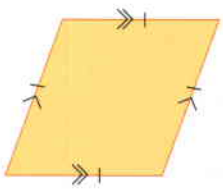
The quadrilateral contains no right angles. So, it is not a square or a rectangle.

Strategies
Work backward

The quadrilateral must be either a parallelogram or a rhombus.



Check: A parallelogram has two pairs of opposite sides that are equal and parallel. It has no right angles. There is no information on whether all four sides are the same length. If they are, the quadrilateral is the special type of parallelogram called a rhombus.

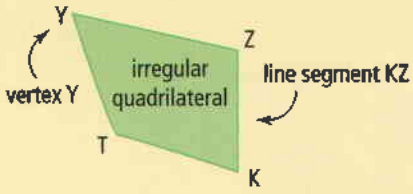


Literacy Connections

To learn about different problem solving strategies, refer to the Problem Solving section on pages xvi to xxi. The orange banner will help you find these pages. Refer to these pages whenever you need help deciding on a strategy to use to solve a problem.

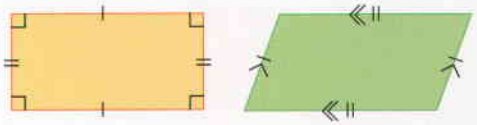
Key Ideas

- Quadrilaterals are closed shapes with four sides. They are formed by joining four line segments and contain an angle at each vertex.
- Quadrilaterals are classified according to their side and angle properties.



Communicate the Ideas

1. Compare a rectangle and a parallelogram. Use a chart to show how they are the same and how they differ.



2. How is a rhombus like a square? How is it like a parallelogram? Take turns explaining to your partner.

3. Draw a quadrilateral. Draw a shape that is not a quadrilateral. Compare your drawings with a partner's. List the criteria a shape must have to be a quadrilateral.

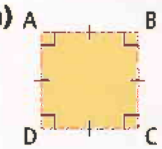
Check Your Understanding

Practise

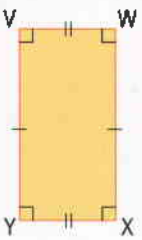
For help with Questions 4 to 8, refer to Example 1.

4. Classify each quadrilateral. Give reasons.

a)

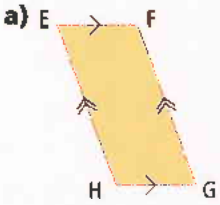


b)

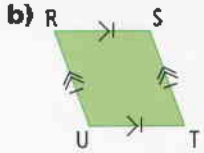


5. Classify each quadrilateral. Give reasons.

a)

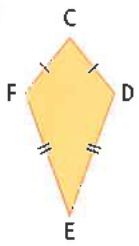


b)

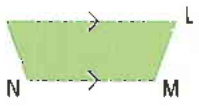


6. Describe each figure, and then classify it.

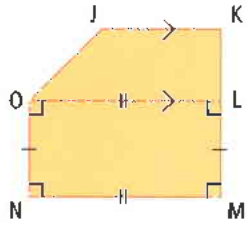
a)



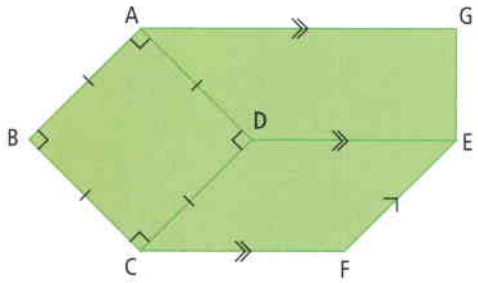
b)



7. Name and classify the two quadrilaterals found in the figure.



8. Name and classify the three quadrilaterals found in the figure.



For help with Question 9, refer to Example 2.

9. What shape am I? Match my description with my name.

Description

a) I have four equal sides, but no right angles.

b) I have no equal sides, but I do have one pair of parallel sides.

c) I have two pairs of equal sides, but no parallel sides.

d) I have four equal sides and four right angles.

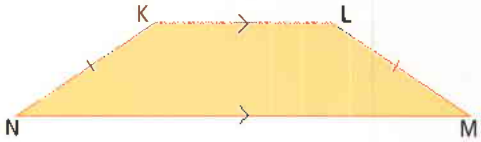
Name

A square **B** kite

C rhombus **D** trapezoid

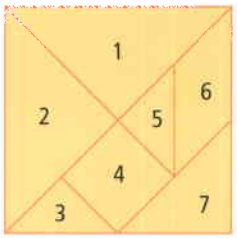
Apply

10. The quadrilateral shown is sometimes called an isosceles trapezoid. Explain why this name is appropriate.



11. a) Two of the seven tangram pieces are quadrilaterals. What type are they?

b) One other type of quadrilateral is formed by three pairs of neighbouring pieces in the completed tangram. What pieces? What type of quadrilateral do they form?



Did You Know?

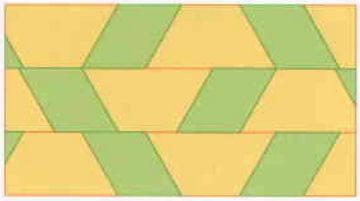
The Chinese legend of the tangram's origin tells of a man who accidentally broke a pane of glass while carrying it up a mountain. While trying to put the pieces back together, he realized that the pieces could be arranged to form many other shapes. His bad luck led to the invention of a new game.

Literacy Connections

Reading Special Shapes

This is a yin yang symbol. It is a Chinese symbol with many meanings. One meaning is that things have both positive and negative sides. What negative thing happened in the legend? What was the positive result?

12. **a)** Name the types of quadrilaterals found in the tile pattern shown.
b) Describe the pattern in which the tiles are laid.



13. Draw and label a quadrilateral that matches each description. Then, classify it.
Hint: First sketch a quadrilateral and mark the given information.
a) AB is parallel to CD, AB is twice as long as CD, $\angle A = 90°$
b) all sides measure 3 cm, DE is parallel to GF, DG is parallel to EF, DE is not at right angles to DG

Chapter Problem

14. Traditionally, patchwork quilts were made by sewing together square or rectangular pieces of fabric. Modern designs use many different shapes.

a) List all the geometric shapes that you can find in the patchwork quilt shown.
b) Design your own patchwork quilt containing at least 20 patches. Include at least two different types of quadrilaterals. Draw the design in your notebook.

Making Connections

You will explore more tiling patterns in Chapter 13.

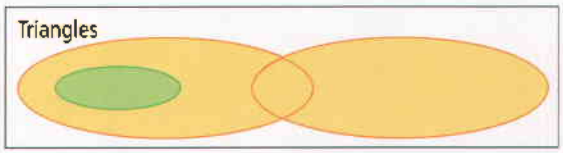
Try This!

15. One diagonal of a square divides the shape into two right isosceles triangles.

What types of triangles can be formed when one diagonal of each of the following quadrilaterals is drawn? Use diagrams to support your answers.
a) a rectangle
b) a kite

Extend

16. A Venn diagram uses nested and/or overlapping shapes to show relationships. The Venn diagram below can be used to show the relationships among types of triangles.

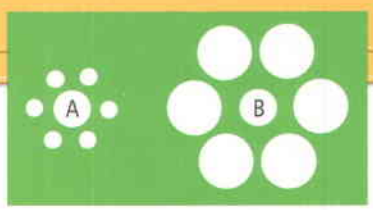


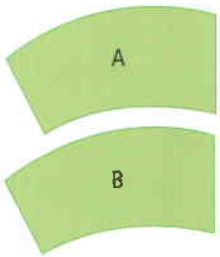
a) Make a larger copy of the diagram. Add labels to your diagram to show equilateral, isosceles, and right triangles.
b) What type of triangle is represented by the overlap of the two ovals?

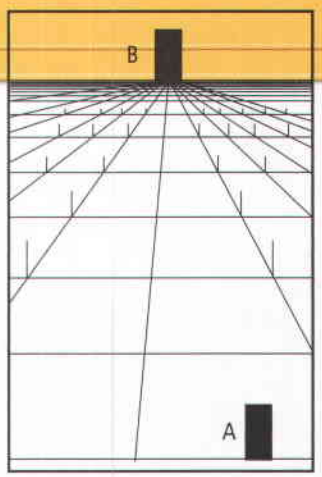
17. Draw and label a Venn diagram to show the relationships among the different types of quadrilaterals. Hint: Do question 16 first.

2.3 Congruent Figures

Focus on...
- matching figures
- comparing side lengths and angle measures
- congruence







Look carefully at the three diagrams. In which one(s) is figure A identical to figure B? What properties of the figures do you compare to decide?

Figures that have the same shape and size are **congruent**.

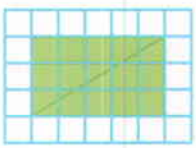
congruent
- same shape and size

Discover the Math

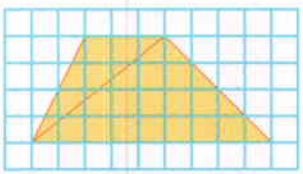
Materials
- grid paper
- scissors
- ruler
- protractor

How can you tell if two triangles are congruent?

1. On grid paper, draw any rectangle and one diagonal. Cut out the two triangles formed. Compare the triangles. Are they congruent? How can you tell?

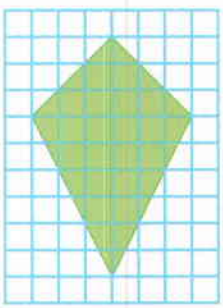


2. On grid paper, draw any trapezoid and one diagonal. Cut out the two triangles formed. Compare the triangles. Are they congruent? How can you tell?



3. a) On grid paper, draw any kite and one diagonal. Compare the two triangles formed. Are they congruent? How can you tell without cutting them out?

b) Draw a copy of your kite. This time draw the other diagonal. Compare the two triangles formed. Are they congruent? How can you tell without cutting them out?

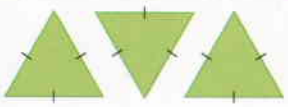


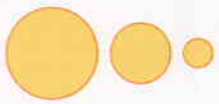
4. **Reflect** What must match if two triangles are congruent? What do you need to do to be certain?

Example 1: Identify Congruent Figures

Are the figures in each group congruent? Explain your answers.

a) 

b) 

c) 

Solution

a) The figures are not congruent because their shapes are different from each other.

b) The figures are all equilateral triangles. Their sides are marked as being the same size. The second triangle is a rotation image. The three triangles are congruent.

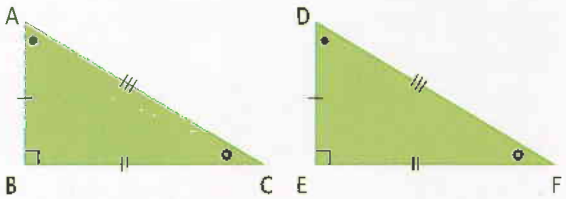
c) The figures are all the same shape, circles. The circles are not congruent because they are different sizes.

Example 2: Match Parts of Congruent Triangles

Compare $\triangle ABC$ and $\triangle DEF$.

a) List the corresponding equal angles and sides.

b) Are the two triangles congruent? Give reasons.



Solution

a)

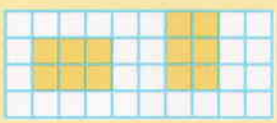
Corresponding angles:	Corresponding sides:
$\angle A = \angle D$	$AB = DE$
$\angle B = \angle E$	$AC = DF$
$\angle C = \angle F$	$BC = EF$

b) The corresponding angles and side lengths are equal. So, $\triangle ABC$ and $\triangle DEF$ are congruent.

Key Ideas

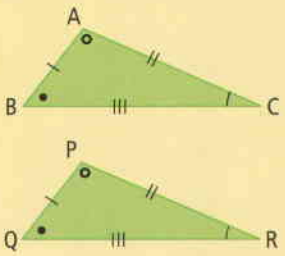
- Two figures are congruent if they have the same shape and the same size. Rotations and reflections are allowed.

Both rectangular, both measure 2 by 3, so they are congruent rectangles.



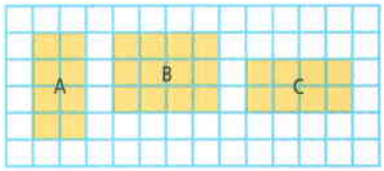
- Corresponding angles and sides of congruent figures have the same measures.

AB and PQ are corresponding sides. They are the same length. $\angle B$ and $\angle Q$ are corresponding angles. They contain the same mark. This means that the angles are of equal size.

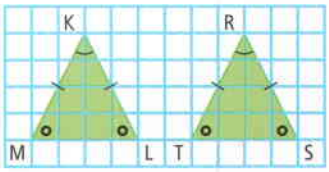


Communicate the Ideas

1. Which two of the rectangles shown are congruent? Why is the third rectangle not congruent?



2. Explain why the two triangles shown are congruent.



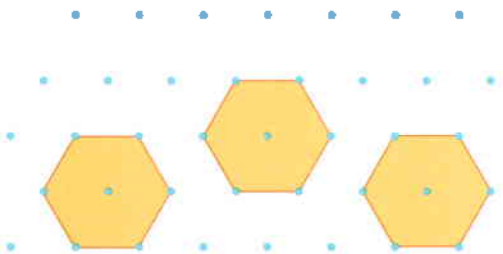
Check Your Understanding

Practise

For help with questions 3 to 6, refer to Example 1.

3. Are the figures in each group congruent? Justify your answer.

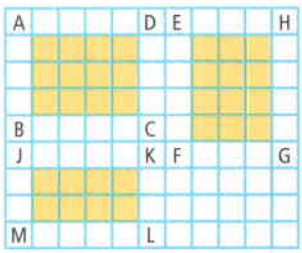
a)



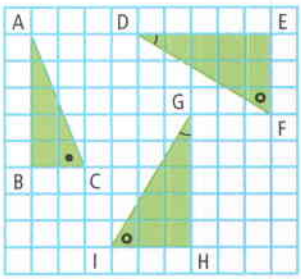
b)

c)

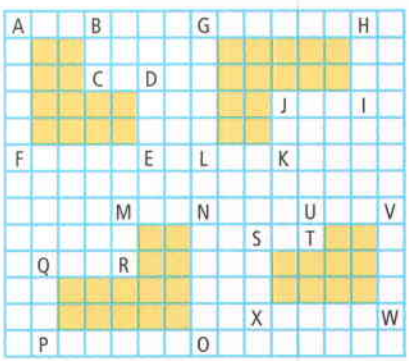
4. Which two rectangles are congruent? Explain.



5. Which triangles are congruent? Explain.

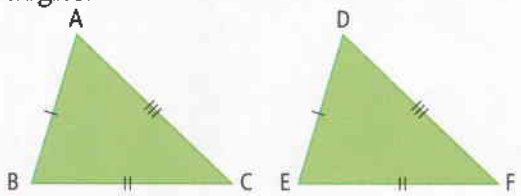


6. Are any of these figures congruent? Justify your answer.

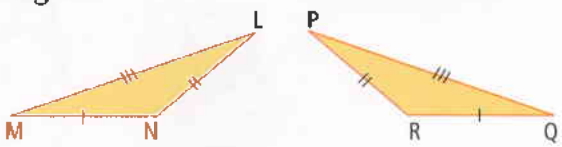


For help with questions 7 and 8, refer to Example 2.

7. $\triangle ABC$ and $\triangle DEF$ are congruent. List the corresponding sides and the corresponding angles.



8. $\triangle LMN$ and $\triangle PQR$ are congruent. List the corresponding sides and the corresponding angles.

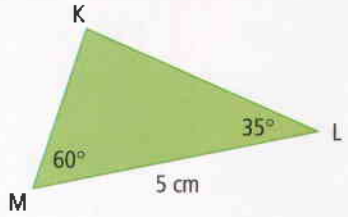


Apply

9. Examine the triangular end of the house roof frame.

a) Name two congruent right triangles.
b) Name two congruent acute triangles.
c) Name two congruent obtuse triangles.

10. Use a ruler and a protractor. Draw a triangle that is congruent to $\triangle KLM$.



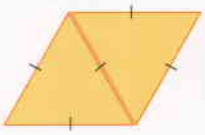
11. If two figures are the same shape, must they be congruent? Draw diagrams to illustrate your answer.

12. Are two rectangles with the same perimeter always congruent to each other? Explain, using diagrams to illustrate your answer.

13. If two figures have the same area, are the figures congruent? Use diagrams to illustrate your answer.

Try This!

14. If you place two congruent equilateral triangles together with two sides aligned, you always get a rhombus.



Draw and name the geometric figure(s) that you can create by placing the following triangles with two equal sides aligned.

a) two congruent isosceles triangles
b) two congruent right scalene triangles

Extend

15. Draw three equilateral triangles. Add line segments to divide

a) the first triangle into two congruent triangles
b) the next triangle into three congruent triangles
c) the next triangle into four congruent triangles

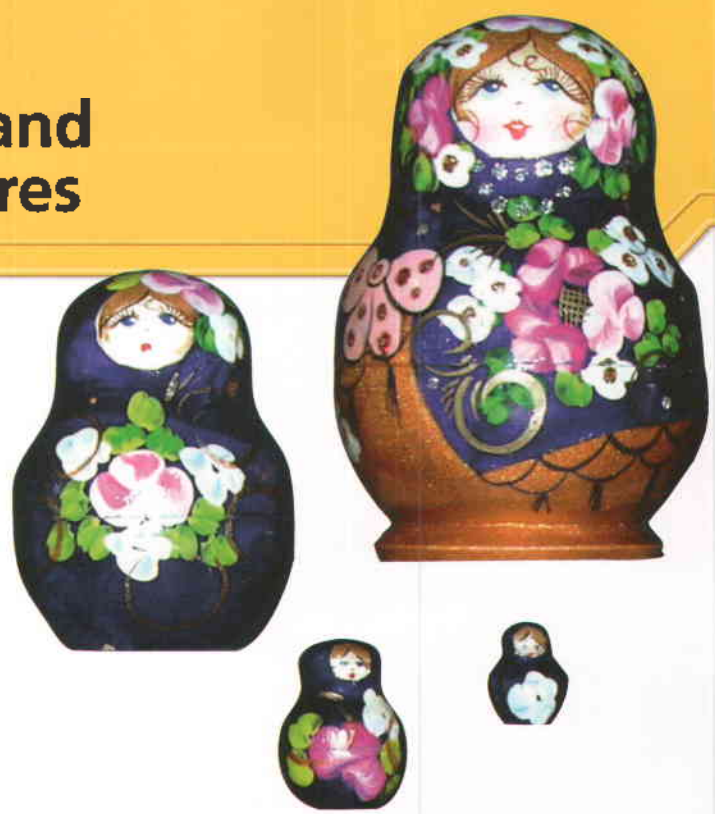
2.4 Congruent and Similar Figures

Focus on...

- comparing angles
- patterns in side lengths
- congruent figures
- similar figures

Compare the dolls in the photograph. How are they alike? How do they differ?

Are the figures congruent? Are they similar?



similar

- same shape but different size

Discover the Math

Materials

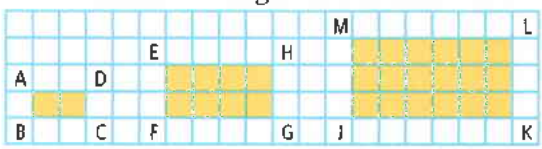
- grid paper
- ruler
- protractor

Optional

- BLM 2.4A Recording Sheet
- BLM 2.4B Large Triangles

How are similar figures related?

1. Three similar rectangles are shown.



a) Compare the length of rectangle EFGH with the length of rectangle ABCD. Compare the widths of these two rectangles. What do you notice?

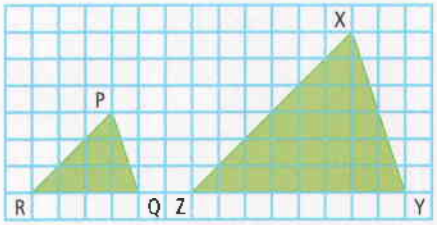
b) Compare the length of rectangle MJKL with the length of rectangle ABCD. Compare the widths of these two rectangles. What do you notice?

c) Copy and complete the table.

Rectangle	ABCD	EFGH	MJKL
$\frac{\text{length}}{\text{width}}$			

d) What do you notice about the value of $\frac{\text{length}}{\text{width}}$ for the three rectangles? What does this tell you about the shape of the three rectangles?

2. Two similar triangles are shown.



a) Make larger copies of the triangles on centimetre grid paper.

b) Use a protractor to measure the angles in each triangle. What do you notice?

c) Copy and complete to compare the lengths of corresponding sides of the triangles.

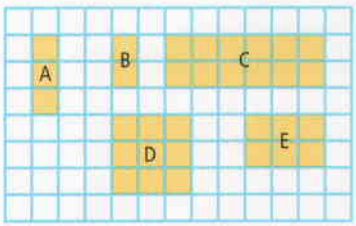
$\frac{PQ}{XY} = \frac{\blacksquare}{\blacksquare}$ $\frac{PR}{XZ} = \frac{\blacksquare}{\blacksquare}$ $\frac{RQ}{ZY} = \frac{\blacksquare}{\blacksquare}$

d) Compare the three ratios in part c). What do you notice?

3. **Reflect** How are the angles in similar figures related? How are the sides of similar figures related?

Example 1: Identify Congruent or Similar Figures

Examine the figures shown.



a) Explain why there are no congruent pairs among them.

b) Are there any similar figures? Give reasons.

Solution

a) To be congruent, figures must have the same shape and size. The dimensions of the rectangles are

A: 3 by 1 B: 2 by 1 C: 6 by 2

D: 3 by 3 E: 3 by 2

None of the rectangles are identical, so none of them are congruent.

b) Compare rectangle A and rectangle C.

$\frac{\text{length of C}}{\text{length of A}} = \frac{6}{2}$ $\frac{\text{width of C}}{\text{width of A}} = \frac{3}{1}$

For both dimensions, rectangle C is three times rectangle A.

So, rectangles A and C are similar.

Check whether any other figures are similar.

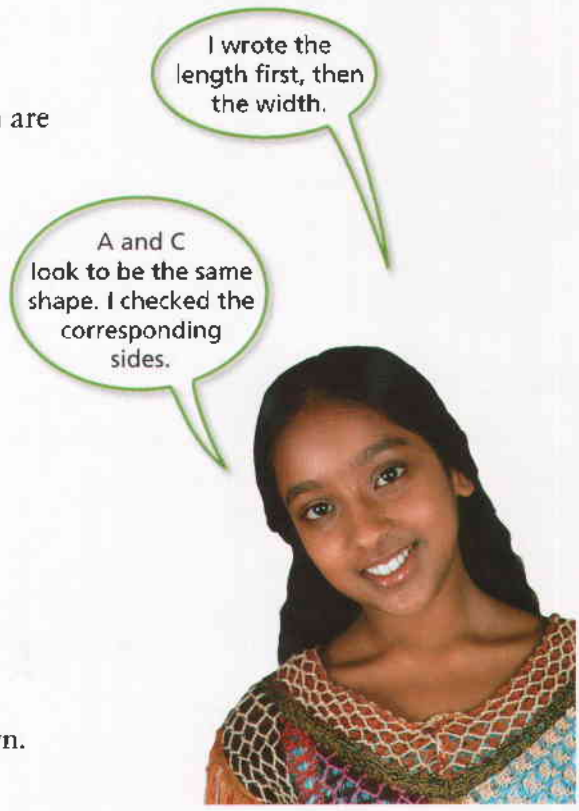
D is the only square shown.

Compare rectangle B and rectangle E.

$\frac{\text{length of E}}{\text{length of B}} = \frac{3}{2}$ $\frac{\text{width of E}}{\text{width of B}} = \frac{2}{1}$

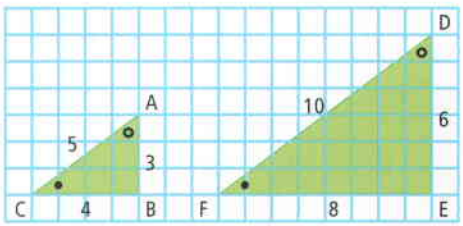
These ratios are not the same.

Rectangles A and C are the only similar figures shown.



Example 2: Match Parts of Similar Triangles

Compare the corresponding angles and sides of $\triangle ABC$ and $\triangle DEF$. Are the two triangles similar? Give reasons.



Solution

Compare corresponding angles:

$\angle A = \angle D$ $\angle B = \angle E$ $\angle C = \angle F$

∠B and ∠E are both 90° because of the grid lines.

Compare corresponding sides:

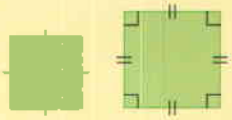
$\frac{AB}{DE} = \frac{3}{6}$ $\frac{BC}{EF} = \frac{4}{8}$ $\frac{AC}{DF} = \frac{5}{10}$

Each side of $\triangle DEF$ is double the length of the corresponding side of $\triangle ABC$.

$\triangle ABC$ and $\triangle DEF$ are similar because they are the same shape. Each side of $\triangle DEF$ is twice the corresponding side of $\triangle ABC$.

Key Ideas

- Similar figures have the same shape but may be different in size.



- Corresponding angles in similar figures are equal.

∠R = ∠U, ∠S = ∠V, ∠T = ∠W

- The lengths of corresponding sides in similar figures are in proportion.

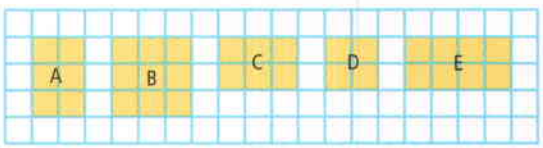
Each side of $\triangle UVW$ is double the length of the corresponding side of $\triangle RST$.

Communicate the Ideas

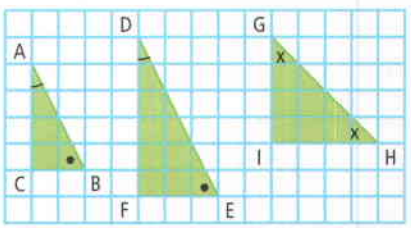
1. Compare the rectangles shown. Justify your answers to the following.

a) Which are congruent?

b) Which are similar?



2. Compare the three triangles shown. Which two are similar? Why is the third not similar?



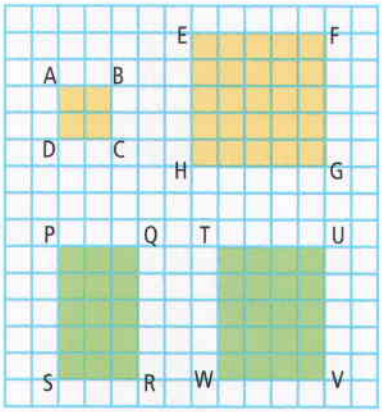
Check Your Understanding

Practise

For help with Questions 3 to 6, refer to Example 1.

3. Are the figures in each pair similar? Give reasons for your answers.

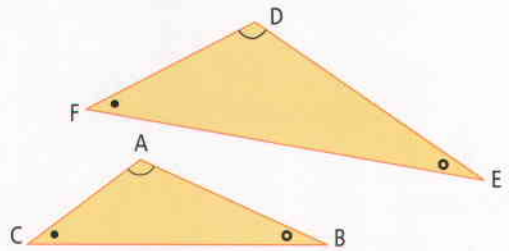
a)



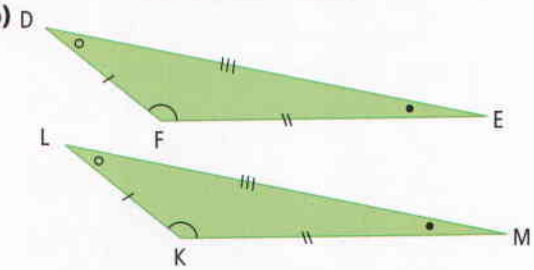
b)

4. Are the triangles in each pair congruent? If not, are they similar? Explain your answers.

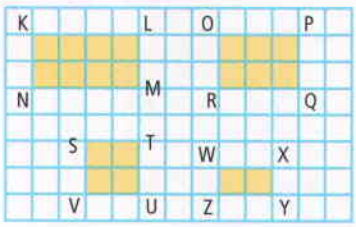
a)



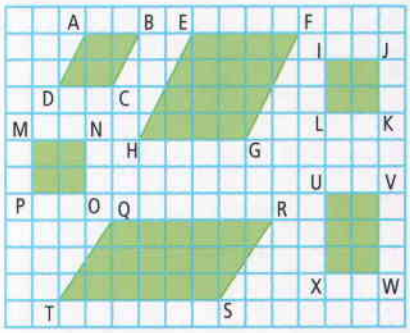
b)



5. Which of the rectangles shown are similar? Explain why.

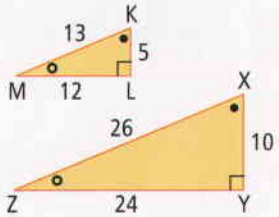


6. List the similar quadrilaterals. List the congruent ones. Give reasons for your choices.

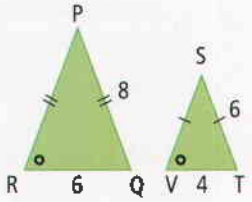


For help with questions 7 and 8, refer to Example 2.

7. Compare the corresponding angles and sides of $\triangle KLM$ and $\triangle XYZ$. Are the two triangles similar? Give reasons.

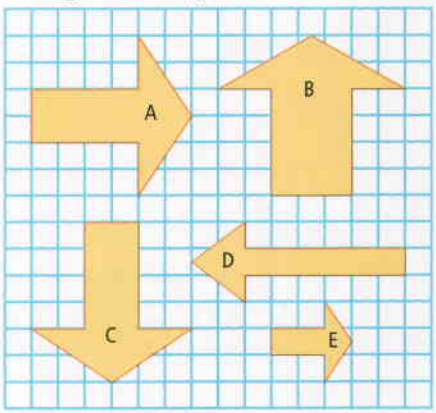


8. Compare the corresponding angles and sides of $\triangle PQR$ and $\triangle STV$. Are the triangles similar? Give reasons.



Apply

9. Compare the figures.



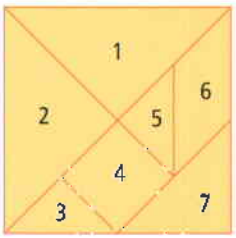
a) Which arrow is congruent to A?

b) Which arrow is similar to A? Explain.

Chapter Problem

10. What congruent and similar shapes are used in the design of this quilt?

11. Consider the seven pieces of the tangram.



a) Are any pieces congruent? Explain.

b) Are any pieces similar? Explain.

12. Is each statement true? Explain your decision.

a) All squares are similar to each other.

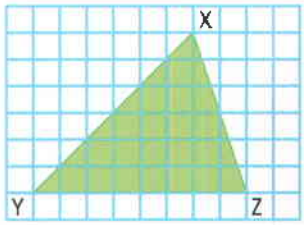
b) All rectangles are similar to each other.

c) All right isosceles triangles are similar to each other.

d) All rhombi are similar to each other.

13. You can tell if two rectangles are similar by using the "diagonal test." Place the smaller rectangle on top of the larger one as shown. If the diagonals align, as in figure A, then the rectangles are similar. If the diagonals do not align, as in B, then the rectangles are not similar. Draw several rectangles on grid paper. Use the diagonal test to check which are similar.

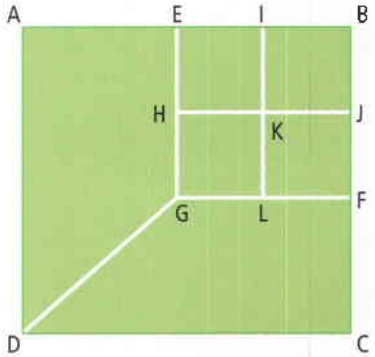
14. a) Use grid paper to draw a triangle that is similar to the one shown.



b) Compare your similar triangle with those drawn by other students. Are the triangles that you have drawn similar to each other? Are they congruent? Explain.

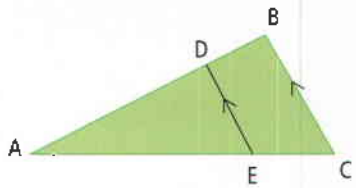
Try This!

15. Make a list of the congruent figures found in the diagram. Then, make a list of all the similar figures that you can find.



Extend

16. In $\triangle ABC$, a line segment DE is drawn parallel to BC. How are $\triangle ABC$ and $\triangle ADE$ related? Justify your answer.



17. The national flag of Canada is twice as long as it is wide. The two red rectangles are similar to the complete flag. What can you deduce about the shape of the white rectangle? Explain.

Use Technology

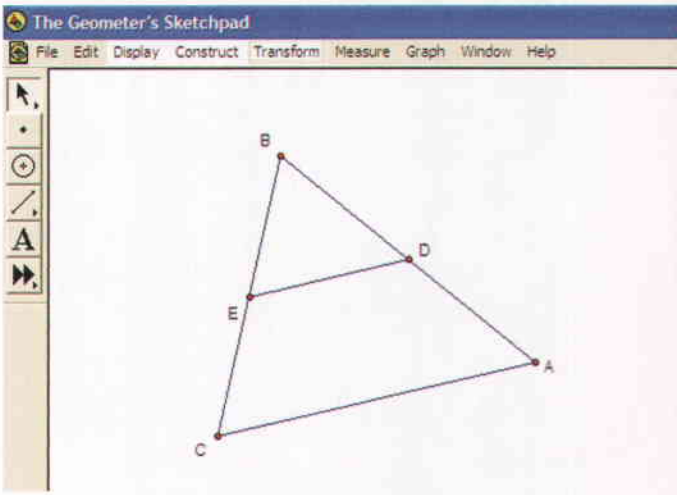
Focus on...
- Exploring the properties of similar triangles

Identify Similar Triangles Using *The Geometer's Sketchpad®*

Materials
- The Geometer's Sketchpad® software
- computers

Optional
- TECH 2.4A Identify Similar Triangles (GSP4)
- TECH 2.4B Identify Similar Triangles (GSP3)
- BLM 2.4C Identify Similar Triangles Without Technology

1. Use *The Geometer's Sketchpad®* to construct and label a triangle ABC.

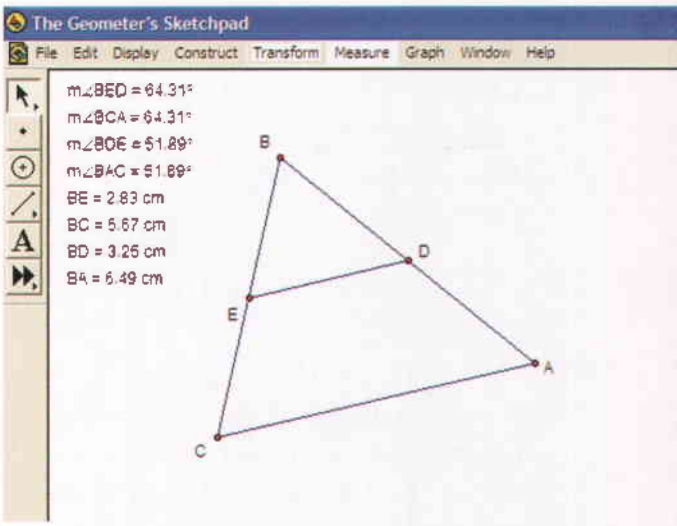


2. a) Select line segment AB. **Construct its Midpoint.**

b) Repeat the previous step to construct the midpoint for line segment BC.

c) Select points D and E. **Construct** line segment DE.

3. If $\triangle ABC$ and $\triangle DBE$ are similar triangles, then what is true about the measures of their corresponding angles? Check your answer by measuring corresponding pairs of angles.



4. a) Make a conjecture about how the lengths of corresponding sides of $\triangle ABC$ and $\triangle DBE$ are related.

b) Check by measuring the lengths of corresponding sides.

5. Extend your investigation by changing the shape of $\triangle ABC$. Do the patterns still hold?

6. **Reflect** How can you use technology to check whether two triangles are similar?

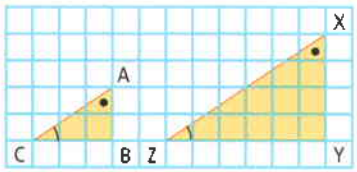
CHAPTER 2

Review

Key Words

1. Draw and label diagrams to show the meaning of each word.
   - **a)** isosceles triangle
   - **b)** obtuse triangle
   - **c)** rhombus
   - **d)** trapezoid

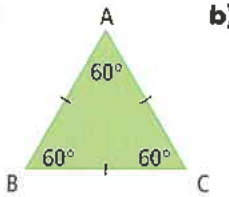
2. Compare the two shapes shown. How are the triangles related? Explain.



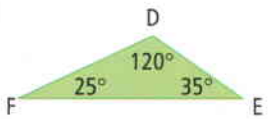
2.1 Classify Triangles, pages 54–59

3. Classify each triangle in two ways. Give reasons for your answers.

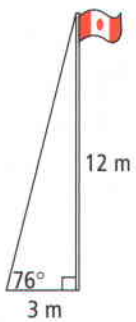
a)



b)



4. A support wire from the top of a 12-m flag pole reaches the ground 3 m away from the foot of the flag pole. What type of triangle is formed?

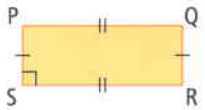


5. Use a ruler and a protractor to draw each triangle. Then, classify the triangle in two ways.
   - **a)** one angle of 50° between sides measuring 4 cm and 4 cm
   - **b)** one side measuring 7 cm between angles of 25° and 40°

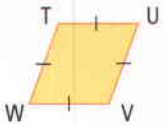
2.2 Classify Quadrilaterals, pages 60–65

6. Classify each quadrilateral. Explain your choice.

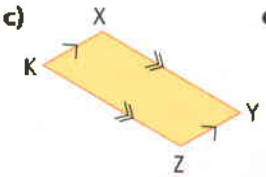
a)



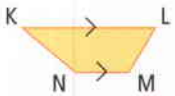
b)



c)



d)



7. Look at the spider's web. What types of quadrilaterals can you find?

2.3 Congruent Figures, pages 66–69

8. Draw two congruent shapes. Explain why they are congruent.

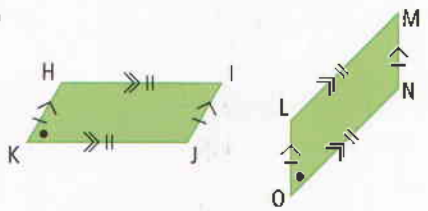
9.

a) Examine the picture of the provincial flag of Ontario. Find two different pairs of congruent figures.

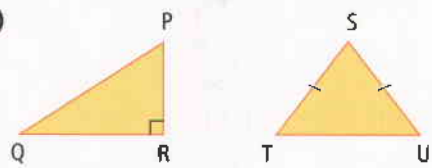
b) Find three other flags that use different shapes in their design. Sketch the flags and list the congruent figures.

10. In each part, are the shapes congruent? Explain your answer. If the shapes are congruent, list their equal sides and angles.

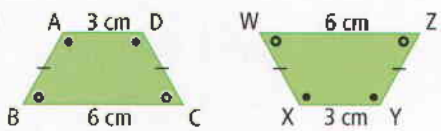
a)



b)



c)

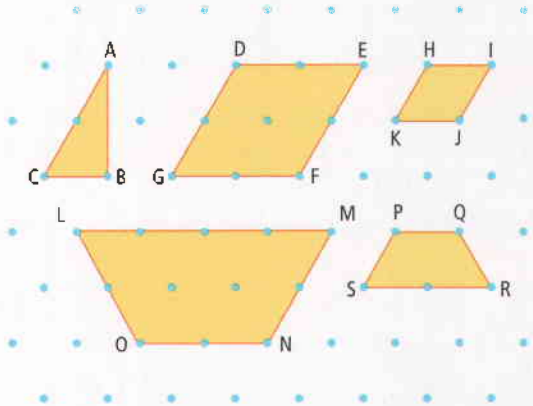


11. If two triangles have the same perimeter, are they congruent? Draw diagrams to illustrate your answer.

2.4 Congruent and Similar Figures, pages 70–74

12. Draw two similar figures. Explain how you can tell that they are similar.

13. Make a list of the similar figures found in the diagram. Are there any congruent figures? Explain.

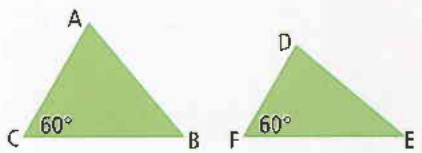


14. Decide whether each image is similar to the original. Can the image also be congruent? Explain.

a) a photocopy of a figure

b) a photograph of a figure

15. Both triangles contain a 60° angle.



a) Are the triangles congruent? Give reasons for your answer.

b) Are the triangles similar? Give reasons for your answer.

CHAPTER 2

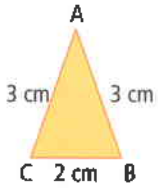
Practice Test

Strand Questions	NSN	MEA 5, 8, 9	GSS 1–11	PA	DMP

Multiple Choice

For questions 1 to 6, select the correct answer.

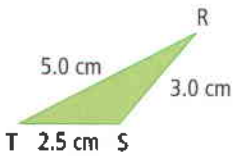
1.



$\triangle ABC$ can be classified as

A an obtuse scalene triangle
B an acute isosceles triangle
C a right scalene triangle
D an acute equilateral triangle

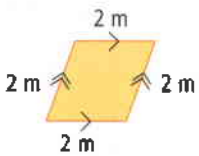
2.



$\triangle RST$ can be classified as

A an obtuse isosceles triangle
B an acute equilateral triangle
C an obtuse scalene triangle
D a right isosceles triangle

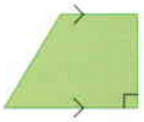
3.



The quadrilateral can be classified as

A a rectangle
B a square
C a trapezoid
D a rhombus

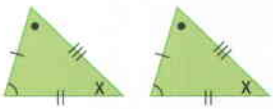
4.



The quadrilateral can be classified as

A a parallelogram
B a square
C a kite
D a trapezoid

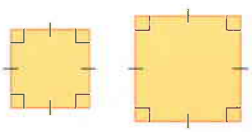
5.



The two shapes are

A isosceles triangles
B congruent triangles
C similar angles
D congruent angles

6.



The two shapes are

A similar triangles
B congruent squares
C similar squares
D congruent rectangles

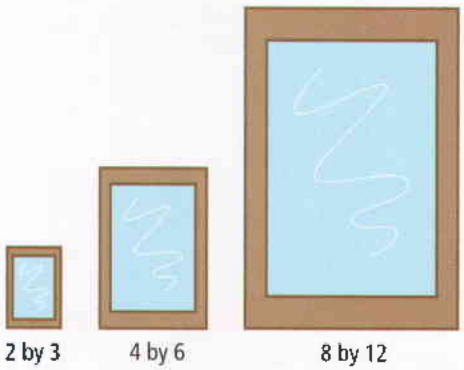
Short Answer

7. Use a ruler and a protractor to draw each triangle. Then, classify the triangle in two ways.

a) In $\triangle XYZ$, $\angle Y$ is a right angle. Sides XY and YZ are each 5 cm.

b) $\triangle ABC$ with AB = 5 cm, BC = 7 cm, and $\angle B = 60°$

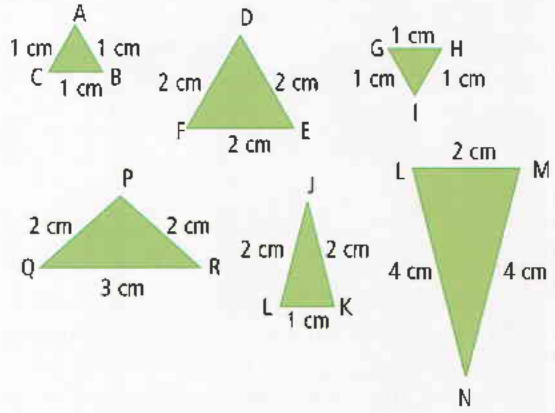
8. Compare the three photo frames shown. Which are similar rectangles? Explain your reasoning.



Extended Response

9. Explain why a right triangle can never be similar to an obtuse triangle. Draw a sketch to help in your explanation.

10. Which triangles are congruent? Which are similar? Explain why.



11. The height of square ABCD is half the height of square EFGH. ABCD has a perimeter of 16 cm. Use a ruler to draw the two quadrilaterals. Label the dimensions of both. Are the figures congruent? similar? Explain.

Chapter Problem Wrap-Up

Patterns that use a variety of shapes are more interesting. Design a pattern for the front of your binder, or for another similar purpose. You may draw it on paper, and then create it using pieces of coloured tissue paper, fabric, wood, or other materials you choose.

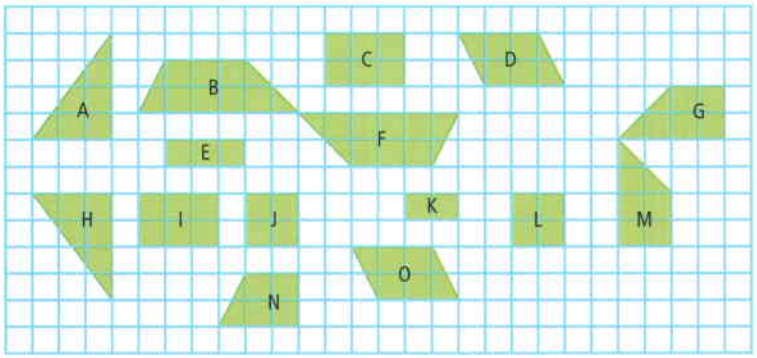
Your pattern block should include
- two different quadrilaterals
- two different triangles
- some congruent figures
- some similar figures

Write an e-mail to a friend giving a brief description of your design. List its geometric properties.

Making Connections

Transformations and Congruence

The diagram shows a variety of shapes on grid paper.



Materials

- grid paper
- scissors

Optional

- tracing paper
- pattern blocks
- Mira

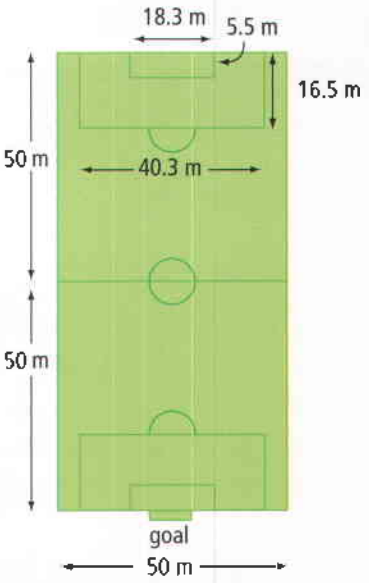
1. Identify pairs of shapes that are related by a translation, rotation, or reflection. To help you decide, you can cut the shapes out of a piece of grid paper. Tracing paper, or a Mira, may also be helpful.
2. Describe the transformation that relates each pair. Draw diagrams as necessary. For a translation, show the translation arrow. For a reflection, show the mirror line. For a rotation, show the turn centre and the angle of rotation.
3. List pairs of congruent shapes in the diagram. Compare this list with your answers in step 1. What do you notice? How can you explain this?

Making Connections

What's math got to do with sports?

Geometry is found on all sports playing surfaces. Squares, rectangles, and circles are the most common shapes used in marking out the playing areas.

The plan of a soccer pitch is shown. What shapes can be seen when a soccer game is being played?



Create a Logo

TASK

New School Logo!

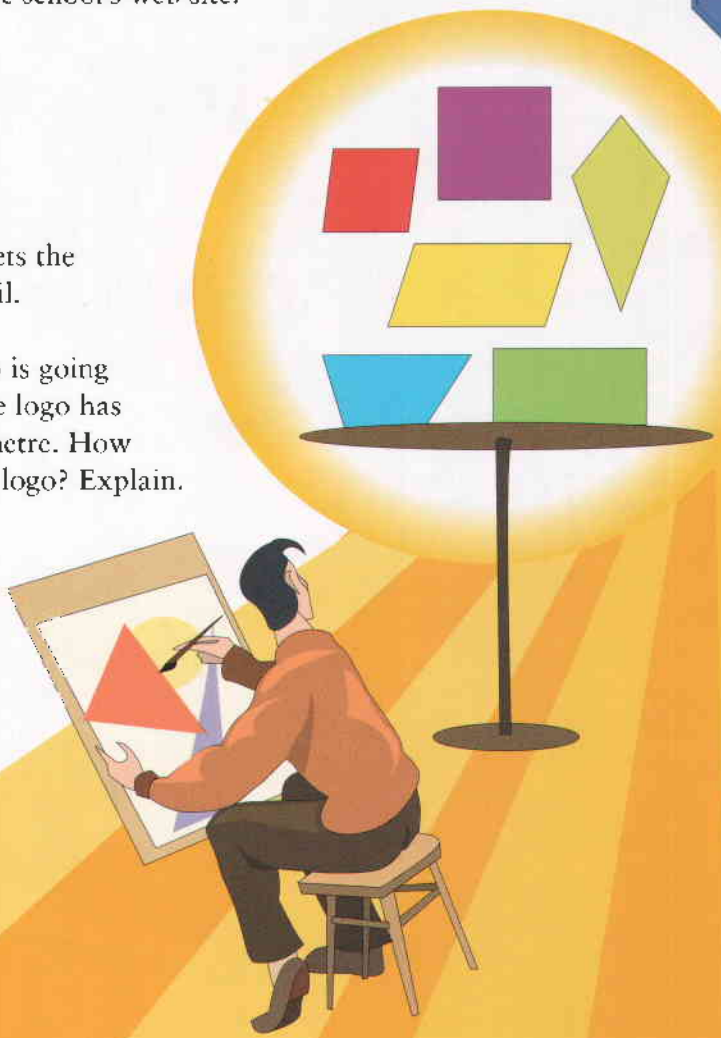
Create a new logo that might be used on a crest for team shirts, on school banners, and on the opening page of the school's web site.

The student council wants a logo with
- at least two congruent shapes
- at least two similar shapes
- at least two different shapes

1. Create a logo. Explain how your logo meets the requirements set out by the student council.

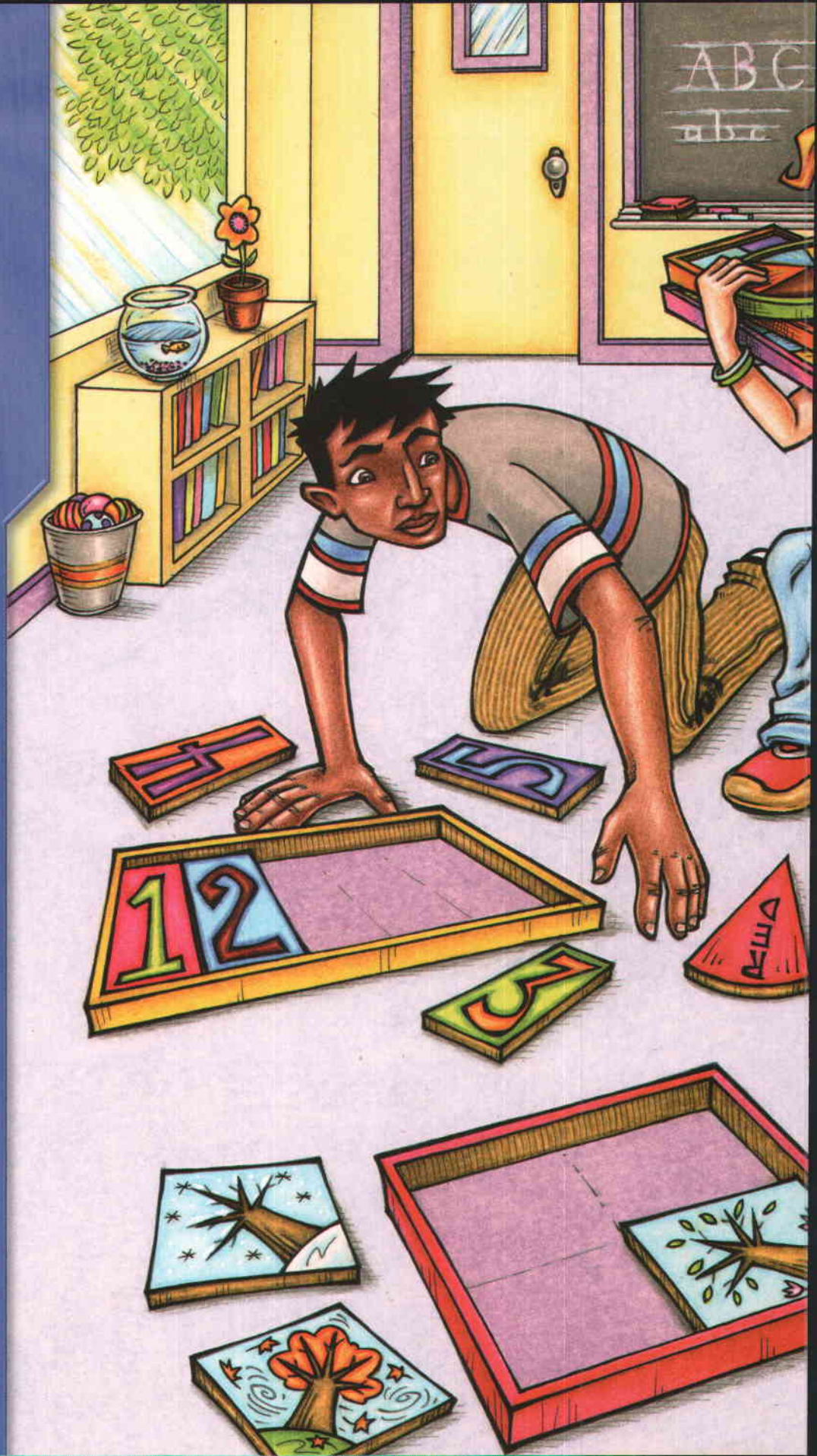
2. In order to make a school crest, your logo is going to be sewn onto material. Every line in the logo has to be sewn. Sewing costs $0.20 per centimetre. How much will it cost to sew one crest of your logo? Explain.

3. The school is creating a large banner. Adding colour costs $4 per square metre. Design and price the banner. Consider the following:
   - How large a banner will your school need?
   - Will the banner have a large logo?
   - What else will be on the banner?



Number Sense and Numeration

- Generate, compare, and order multiples.
- Understand and explain operations with fractions using manipulatives.
- Add and subtract fractions with simple denominators using concrete materials, drawings, and symbols.
- Relate the repeated addition of fractions with simple denominators to the multiplication of a fraction by a whole number.
- Ask "what if" questions, pose problems involving simple fractions, and investigate solutions.
- Solve problems involving fractions using appropriate strategies and calculation methods.



Key Words

equivalent fractions

common denominator

multiple