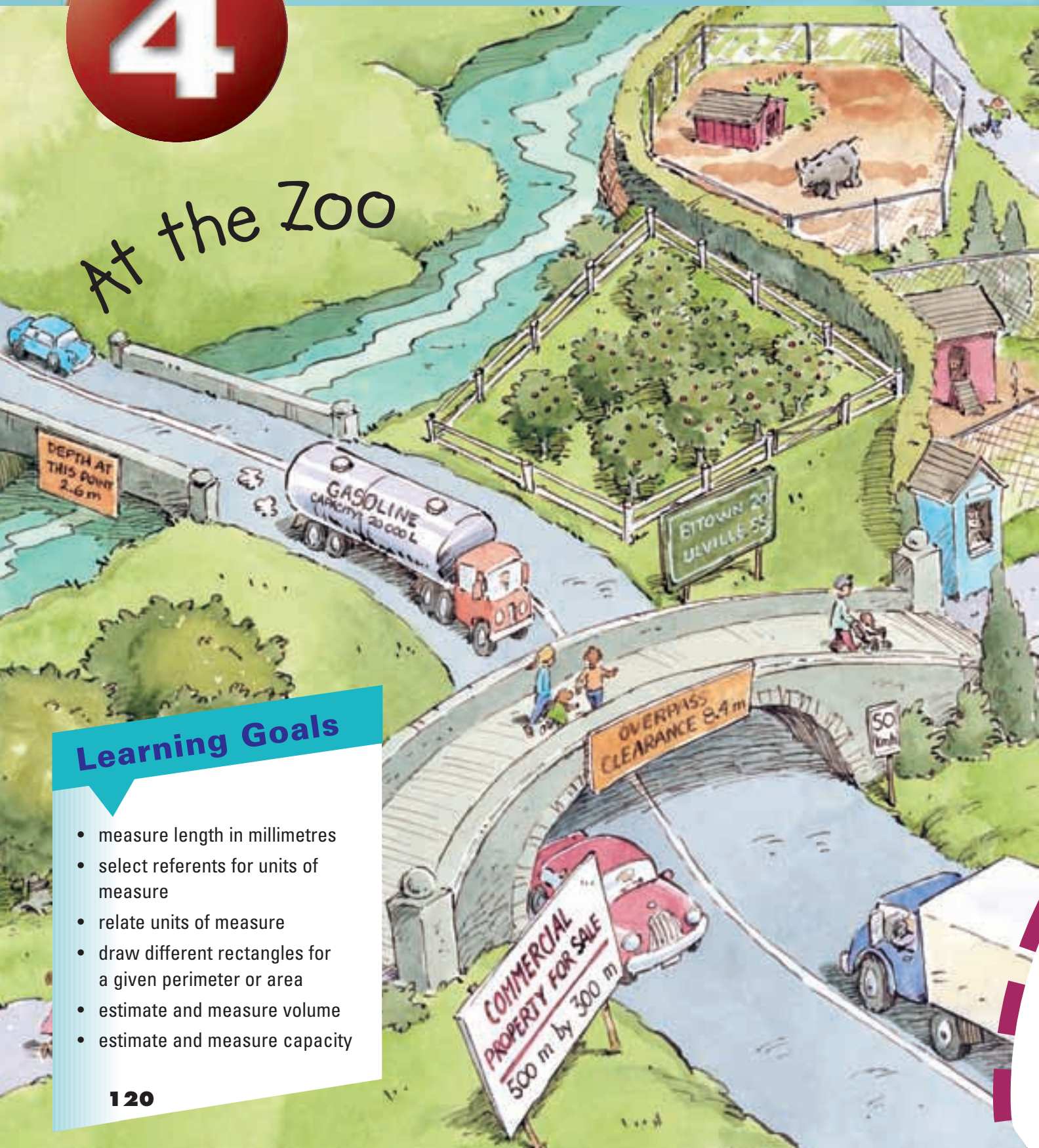
UNIT 4

Measurement



Learning Goals

- measure length in millimetres
- select referents for units of measure
- relate units of measure
- draw different rectangles for a given perimeter or area
- estimate and measure volume
- estimate and measure capacity

Key Words

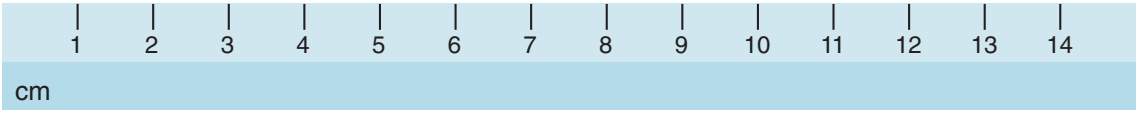
- millimetre (mm)
- referent
- perimeter
- area
- volume
- cubic centimetre (cm^3)
- dimensions
- cubic metre (m^3)
- capacity
- litre (L)
- millilitre (mL)
- displacement

- Which measurements can you find in this picture?
- Which measurements describe length? Height? Width?
- What does "500 m by 300 m" on the property for sale sign mean?
- Do you think the property for sale is larger or smaller than your school's property?
- What does "Capacity 20 000 L" on the gasoline truck mean?
- Which unit would you use to measure the perimeter of the apple orchard? The length of the rhinoceros? The length of a seal's whiskers? The area of the petting zoo?

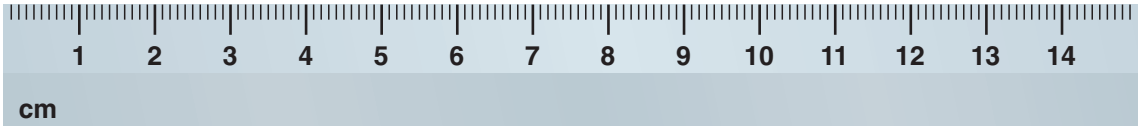
LESSON 1

Measuring Length

This ruler shows centimetres.



This ruler shows centimetres and **millimetres**.
We use the symbol **mm** for millimetres.



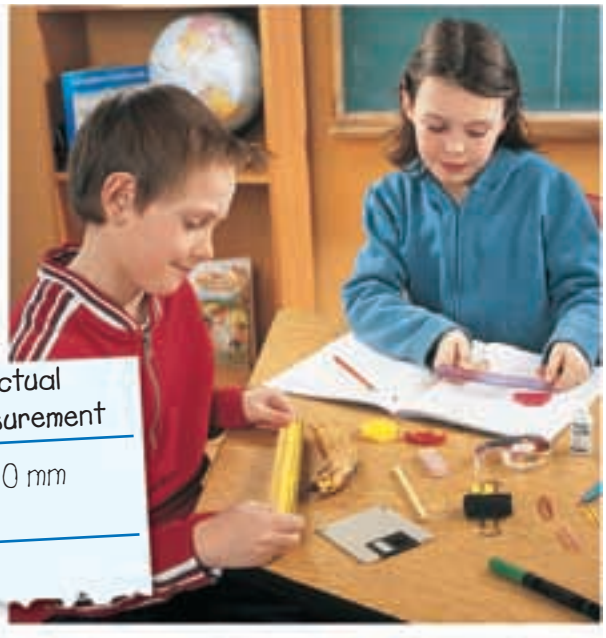
How many millimetres are in 1 cm?

Explore

You will need a ruler and a metre stick or tape measure marked in centimetres and millimetres.
Have a scavenger hunt.

➤ Estimate to find an object whose length fits each description:

- about 25 mm
- about 80 mm
- about 250 mm
- between 500 and 1000 mm
- shorter than 10 mm



➤ Measure to check your estimate.
Record your results in a table.

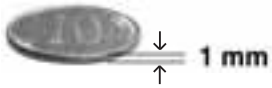
Given measurement	Object	Actual measurement
about 25 mm	an eraser	30 mm

Show *and* Share

Share your strategies for estimating with other students.
Record your strategies in a class list.

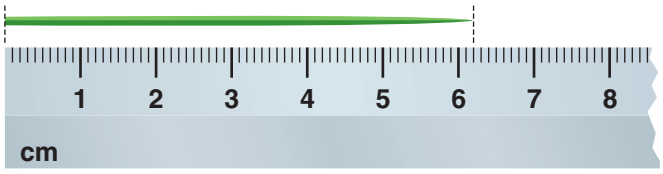
Connect

You can use millimetres to measure the length, width, height, or thickness of small objects.
A dime is about 1 mm thick.



You can use the thickness of a dime as a **referent** for 1 mm. A referent is used to estimate a measure.

This pine needle is about 6 cm long.
To be more precise,
you read the length in millimetres.
The pine needle is 62 mm long.



One millimetre is one-tenth of a centimetre.
So, you can also read the length of the pine needle in centimetres.
The pine needle is 6.2 cm long.
You say: 6 and 2 tenths centimetres

Centimetres and millimetres are related.

A referent for 1 *cm* is the width of my little finger. There are 10 *mm* in 1 *cm*.

So, that means 1 *mm* is $\frac{1}{10}$ of a centimetre, or 0.1 *cm*.

Metres and centimetres are related.

A referent for 1 *m* is the width of the classroom door. There are 100 *cm* in 1 *m*.

So, that means 1 *cm* is $\frac{1}{100}$ of a metre, or 0.01 *m*.

Metres and millimetres are related.

And there are 1000 *mm* in 1 *m*.

Practice

Use a ruler or metre stick when it helps.

1. Copy and complete each table.

a)

cm	1	2	3	4	5	6	7	8	9	10	11	12
mm	10	20										

b)

mm	1	2	3	4	5	6	7	8	9	10	11	12
cm	0.1	0.2										

c)

m	1	2	3	4	5	6	7	8	9	10	11	12
mm	1000	2000										

2. What patterns do you see in each table in question 1?

3. Copy and complete. How can you use a ruler to help you?

a) 8 cm = ☐ mm **b)** 20 cm = ☐ mm **c)** 63 cm = ☐ mm

4. Copy and complete.

a) 60 mm = ☐ cm **b)** 40 mm = ☐ cm **c)** 100 mm = ☐ cm

5. Copy and complete.

a) 2000 mm = ☐ m **b)** 6000 mm = ☐ m **c)** 9000 mm = ☐ m

d) 5 m = ☐ mm **e)** 2 m = ☐ mm **f)** 8 m = ☐ mm

6. Name another referent for each unit of measure. Explain each choice.

a) 1 mm **b)** 1 cm **c)** 1 m

7. Draw each item. Measure its length in millimetres.

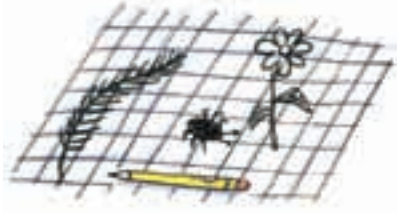
a) a pencil **b)** a needle

8. Draw a picture of each thing. Use grid paper when it helps.

a) a feather 15 cm long **b)** an insect 14 mm long

c) a label 6 cm long and 4 cm wide **d)** a flower 10 cm tall

9. Use a ruler to draw each item.
Write each measure.
Trade pictures with a classmate.
Check your classmate's measures.



a) a worm 8.5 cm long **b)** a straw 13.8 cm long

10. Which items would you measure in millimetres?
Which units would you use to measure the other items?
Explain your choice.

a) the length of a driveway
b) the length of the sash of a "Coureur de bois"
c) the depth of a footprint in the sand
d) the width of a baby's finger

11. **a)** How are millimetres and centimetres related?
b) How are millimetres and metres related?

12. Which is longer? How do you know?
a) 6 cm or 80 mm **b)** 25 cm or 200 mm **c)** 9 m or 7000 mm

13. Suppose you found a leaf that was 88 mm long.
a) Is its length closer to 8 cm or 9 cm? How do you know?
b) What other way could you write the length of the leaf?
Show your work.

14. Which unit would you use to measure each item?
Explain your choice.

a) the height of a house
b) the length of an eyelash
c) the width of a calculator
d) the thickness of a bannock

15. Nicole drew a line longer than 8 cm but shorter than 99 mm.
How long might the line be? How do you know?

16. Estimate the length of each line segment in millimetres. Then measure and record the actual length in millimetres and in centimetres.

a) _____ **b)** _____

At Home

Measure the height of a relative.
Draw a picture.
Write the height using as many different units as you can.
Round when you need to.

Reflect

Name 2 items whose length, width, height, or thickness you would measure in millimetres. Explain why you would use millimetres and not any other unit.

LESSON 2

Strategies Toolkit

Explore

Ernesto made a 1-m square garden this year.
He plans to enlarge the garden. Ernesto will increase each of the four side lengths by 2 m each year.
What will the perimeter and the area of Ernesto's garden be in 6 years?

Show *and* Share

Describe the strategy you used to solve the problem.

Connect

Helen raises Angora rabbits.
When Helen got her first pair of rabbits, she built a 2-m by 1-m pen for them.
As Helen's rabbit population grew, she increased the size of the pen by doubling the length and the width.
What were the perimeter and area of Helen's pen after she increased its size 5 times?

Strategies

- Make a table.
- Use a model.
- Draw a diagram.
- Solve a simpler problem.
- Work backward.
- Guess and test.
- Make an organized list.
- Use a pattern.

What do you know?

- Helen's first pen measured 2 m by 1 m.
- She increased the size of the pen by doubling the length and width.
- She did this 5 times.

Think of a strategy to help you solve the problem.

- You can **use a pattern**, then **make a table**.
- Use Colour Tiles to model each pen.
- List the dimensions, the perimeter, and the area of each pen.

Record your list in the table.

	Length	Width	Perimeter	Area
Original Pen	2 m	1 m	6 m	2 m^2
First Increase	4 m	2 m	12 m	8 m^2
Second Increase				

Look for patterns.
Continue the patterns to find
the perimeter and the area after 5 increases.

Check your work.
What pattern rules created the patterns in your table?

Practice

Choose one of the **Strategies**

1. Harold is designing a patio with congruent square concrete tiles. He has 72 tiles.
   Use grid paper to model all the possible rectangular patios Harold could build. Label the dimensions in units.
   Which patio has the greatest perimeter? The least perimeter?

2. Suppose you have a 7-cm by 5-cm rectangle.
   You increase the length by 1 cm and decrease the width by 1 cm.
   You continue to do this.
   What happens to the perimeter of the rectangle? The area?
   Explain why this happens.

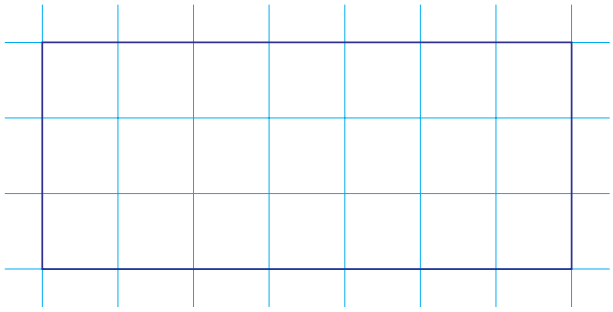
Reflect

How does using a pattern or making a table help you solve a problem?
Use pictures, words, or numbers to explain.

LESSON 3

Exploring Rectangles with Equal Perimeters

What is the perimeter of this rectangle?
What is its area?
How do you know?



Explore

You will need a geoboard, geobands, and 1-cm grid paper.

Simon wants to build a rectangular pen in his backyard for his potbelly pig, Smiley.
Simon has 22 m of wire mesh for a fence to enclose the pen.
Simon wants the greatest possible area for the pen.

- Use a geoboard to make models of all possible rectangles. Draw each model on grid paper.
- Find the area of each pen.
- Write the perimeter of each pen.
- Record your work in a table.
- Find the pen with the greatest area.

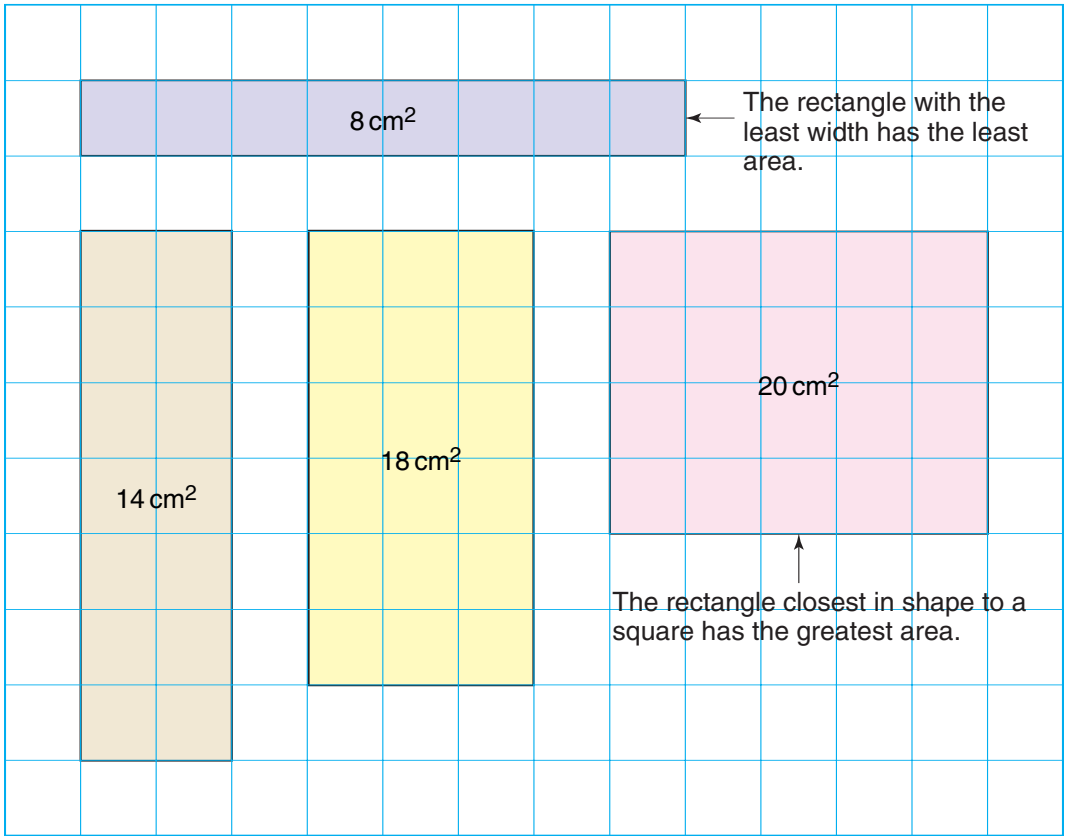
Show *and* Share

Share your work with another pair of students.
What do you notice about the shape of the rectangle with the greatest area?
What do you notice about the width of the rectangle with the least area?

Length	Width	Area	Perimeter

Connect

Rectangles with equal perimeters can have different areas.
Each rectangle below has perimeter 18 cm.

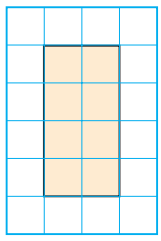


Practice

1. Copy each rectangle onto 1-cm grid paper. For each rectangle:

- Find the perimeter.
- Draw a rectangle with the same perimeter but greater area.
- Draw a rectangle with the same perimeter but lesser area.
- Find the area of each rectangle you draw.

a)



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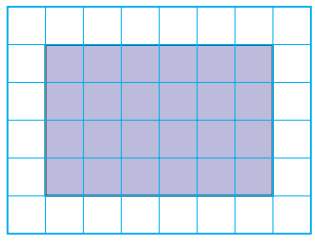
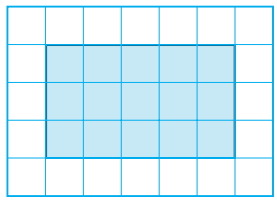


c)



2. Use 1-cm grid paper.
Draw all possible rectangles with each perimeter.
Find the area of each rectangle.
a) 16 cm **b)** 20 cm **c)** 14 cm

3. Draw 2 different rectangles with each perimeter below.
One rectangle has the least area.
The other rectangle has the greatest area.
Find the area of each rectangle you draw. Use a geoboard to help you.
a) 10 cm **b)** 12 cm **c)** 8 cm

4. Suppose you want to make a rectangular garden with a perimeter of 24 m.
a) The garden must have the greatest possible area.
What should the dimensions of the garden be?
b) Which garden would you design if you do not like garden work?
Explain your design.
Show your work.

5. Describe a situation where both area and perimeter are important.

6. Use a geoboard to make a rectangle with each perimeter and area.
Record your work on dot paper.
a) perimeter 24 units and area 32 square units
b) perimeter 14 units and area 10 square units
c) perimeter 8 units and area 4 square units

7. Xavier has 16 m of fencing to put around his square flower garden.
a) What are the side lengths of Xavier's garden? How do you know?
b) What is the area of his garden?

8. Sarah has 100 cm of trim for each rectangular placemat she is making.
a) List the lengths and widths of 6 possible placemats.
b) Which placemat in part a would be the best size?
Give reasons for your choice.

Reflect

Write a letter to a friend to explain the difference between area and perimeter.

Who Can Fill the Page?

You will need 2 sheets of 1-cm grid paper,
and a number cube labelled 1 to 6.
The goal of the game is to cover the grid paper with rectangles.

- Each of you has a sheet of grid paper.
  Take turns to roll the number cube twice.
  Multiply the numbers.
  The product is the perimeter of a rectangle in centimetres.

- On the grid lines, draw as many different rectangles as you can with that perimeter. The rectangles must not overlap.
  If it is not possible to draw a rectangle, roll again.

- Play then passes to your partner.

- The first person to cover her grid paper with rectangles is the winner.

LESSON 4

Exploring Rectangles with Equal Areas

Explore

You will need Colour Tiles or congruent squares, and 1-cm grid paper.
The Magic Carpet Store has donated 36 congruent squares of carpeting to Ms. Hannibal's Grade 5 class.
The students plan to place the squares together to make a rectangular carpet for their reading nook.

- Use the squares.
  Find all the possible rectangles the class can make.
- Draw each rectangle on grid paper.
- Record the measurements of each rectangle in a table.
  Look for patterns in your table.

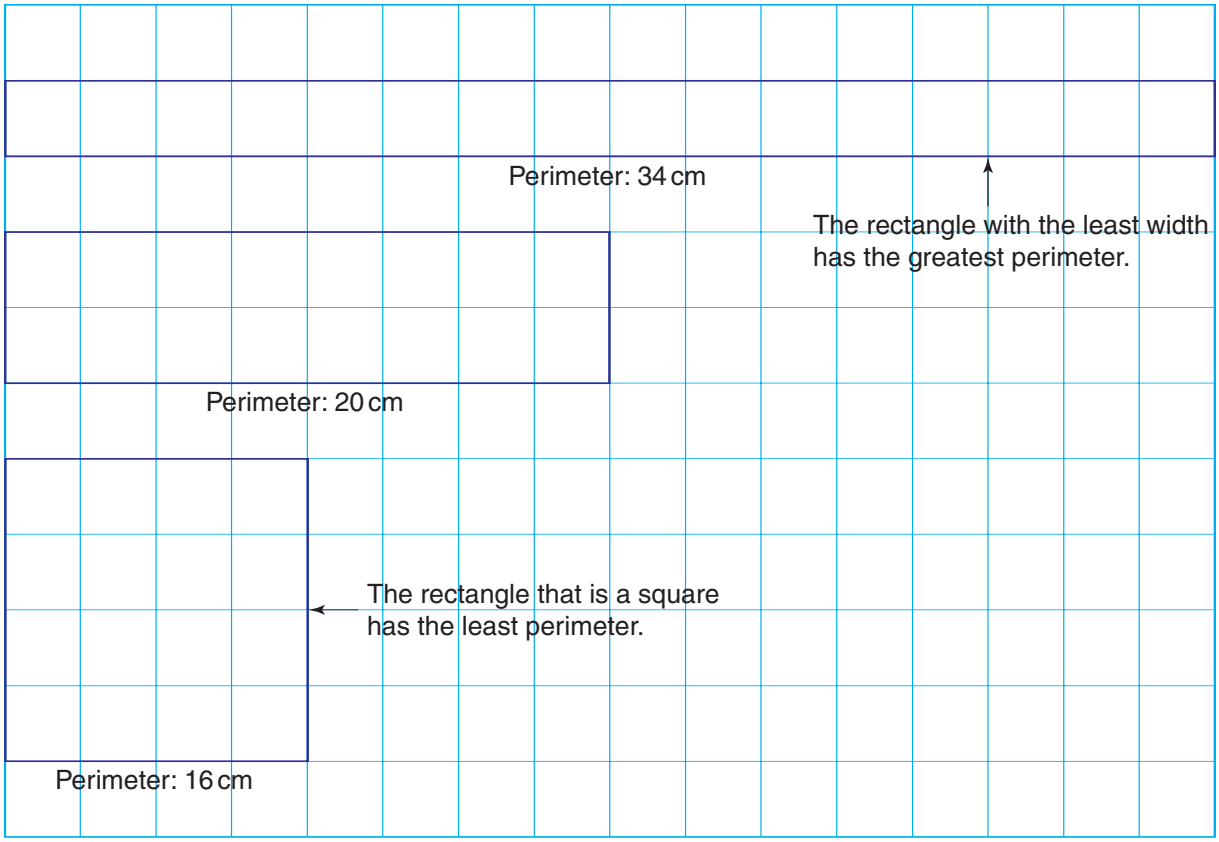
Length	Width	Perimeter	Area
36 units	1 unit	74 units	36 square units

Show *and* Share

How are all the rectangles you made the same?
How are the rectangles different?
What patterns did you find in the table?
Which rectangle do you think the class will use? Explain your choice.

Connect

Rectangles with equal areas can have different perimeters.
Each rectangle below has area 16 cm^2.



Practice

Use Colour Tiles or congruent squares when they help.

1. Use 1-cm grid paper.
Draw all the possible rectangles with each area.

a) 8 cm^2 **b)** 15 cm^2 **c)** 20 cm^2 **d)** 14 cm^2

2. This table shows the measures of some of the floors of rectangular dog pens you can build with 48 congruent concrete squares.

Length (units)	Width (units)	Perimeter (units)
48	1	
24	2	

a) Copy and extend the table.
Use whole numbers only.
b) Which pen would take the most fencing?
c) Which pen would you build? Explain.

3. The area of a rectangular garden plot is 64 m^2.
a) What is the greatest perimeter the garden could have?
b) What is the least perimeter?
c) Why might a person make the garden with the least perimeter?
Show your work.

4. Use 1-cm grid paper.
Draw a rectangle with each area and perimeter.
a) area 20 cm^2 and perimeter 18 cm
b) area 18 cm^2 and perimeter 22 cm
c) area 2 cm^2 and perimeter 6 cm
d) area 12 cm^2 and perimeter 26 cm

5. Salvio wants to make a rectangular pumpkin patch with an area of 30 m^2.
a) Use grid paper. Sketch all the possible rectangles.
b) Find and record the perimeter of each rectangle.
c) Why might Salvio make the patch with the greatest perimeter?

6. How do the length and width of a rectangle relate to its area?
Draw a diagram to illustrate your answer.

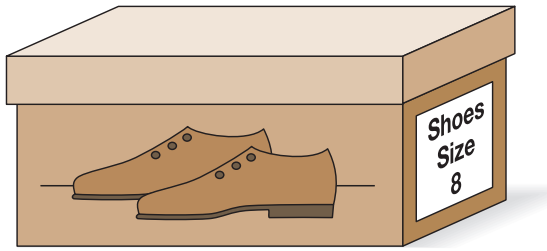
Reflect

Suppose you know the area of a rectangle.
Can you find its perimeter? Explain.

LESSON 5

Exploring Volume

How could you find out how much space there is inside this shoe box?



Explore

You will need an empty box and collections of items like those shown here.

- Choose a bag of items.
  Estimate how many of the items will fill the box.
  Fill the box.
  Record your work.
- Choose another bag and repeat the activity.

Show *and* Share

Share your work with another group of students.
Talk about how you estimated.
Which item or items more accurately measure how much space is inside your box? Why?

Connect

The amount of space inside an object is a measure of the **volume** of the object.

You can find the volume of a box by filling it with identical items, then counting them.

➤ This box holds 144 sticks of chalk.
It has a volume of about 144 sticks of chalk.

We use "about" to describe the volume because the items do not fill the space.

➤ This box holds 24 oranges.
It has a volume of about 24 oranges.

➤ This box holds 80 sugar cubes.
It has a volume of 80 sugar cubes.

The sugar cubes fill the box without leaving any spaces.

Practice

1. Find a small box.
   Estimate its volume in orange Pattern Blocks.
   Fill the box to check your estimate.
   Record your work.

2. Find a small cup.
   Estimate its volume in acorns.
   Fill the cup to check your estimate.
   Record your work.

3. Suppose you filled the cup in question 2 with dried blueberries.
   Do you think you would need more dried blueberries or
   more acorns to fill the cup?
   Explain your choice.

4. Which item in each set would you use to get the best measure of the volume of a tissue box? Explain each choice.
   a) golf balls, acorns, or sugar cubes
   b) lima beans, Snap Cubes, or yellow Pattern Blocks

5. The volume of one box is about 8 tennis balls.
   The volume of another box is about 4 tennis balls.
   What can you say about the size of the second box compared to the first box?

6. What is the volume of each object?

a)

b)

c)

Reflect

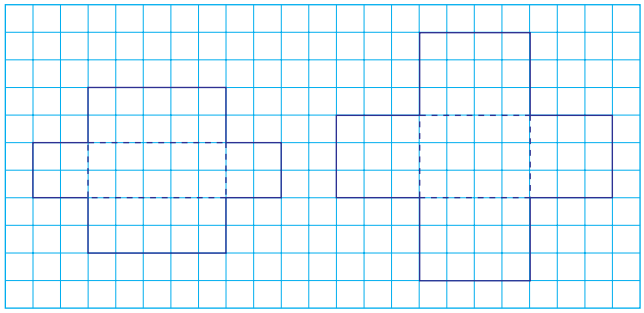
Think of the items you have used to find volume.
Which item do you think gives the best estimate?
Explain why you think so.

LESSON 6

Measuring Volume in Cubic Centimetres

Explore

You will need a copy of these nets, scissors, tape, and centimetre cubes.



- Cut out each net.
  Fold and tape four of the faces to make an open box.
- Estimate how many centimetre cubes each box can hold.
- Fill each box to check your estimate.
  Record your results in a table.

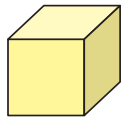
Show *and* Share

Share your results with another pair of students.
What strategies did you use to estimate the volume of each box?
Is there another way, besides counting every cube, to find how many cubes fill each box? Explain.

Connect

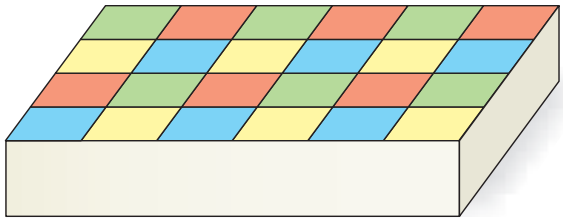
A centimetre cube has a volume of one **cubic centimetre** (1 **cm^3**).

The length of each edge of this centimetre cube is 1 cm.

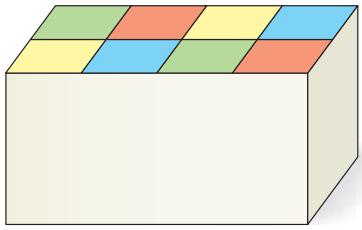


We can use cubic centimetres to measure volume.

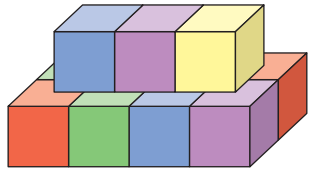
➤ This box holds 4 rows of 6 cubes, or 24 cubes.
The volume of this box is 24 cubic centimetres, or 24 cm^3.



➤ This box holds 2 layers of cubes.
There are 2 rows of 4 cubes, or 8 cubes in each layer.
So, the volume of this box is 16 cubic centimetres, or 16 cm^3.



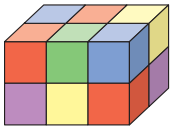
➤ The volume of an object is also the space it occupies.
This object has 8 cubes in the bottom layer
and 3 cubes in the top layer.
The volume of this object is 11 cubic centimetres,
or 11 cm^3.

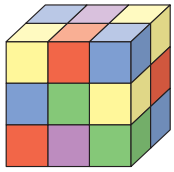


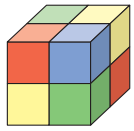
Practice

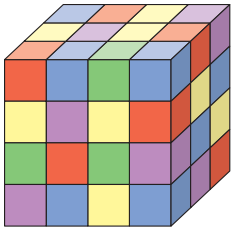
You will need centimetre cubes.

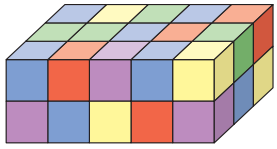
1. Make each object with centimetre cubes.
Find the volume of each object.
Order the objects from least to greatest volume.

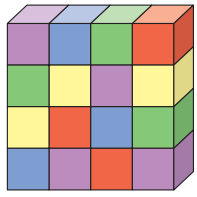
a) 

b) 

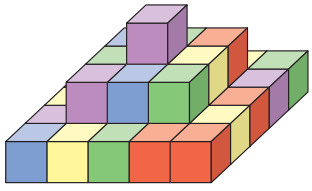
c) 

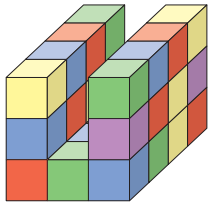
d) 

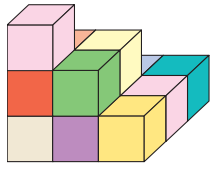
e) 

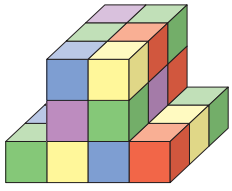
f) 

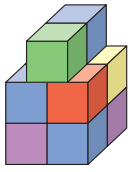
2. Make each object with centimetre cubes.
Find each volume.

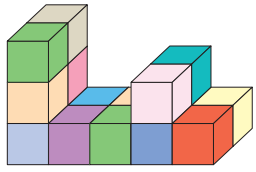
a) 

b) 

c) 

d) 

e) 

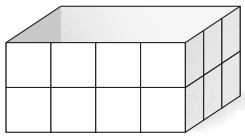
f) 

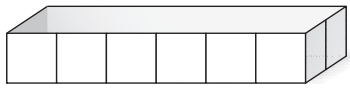
3. Look at the objects in question 2.
Order the objects from least to greatest volume.

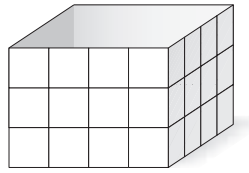
4. **a)** Name a referent for 1 cm^3. Explain your choice.
b) Find 3 small boxes.
Use your referent to estimate the volume of each box.
Explain how you did this.

5. Find a small box that you think has a volume of about 24 cm^3.
Determine the actual volume of the box.

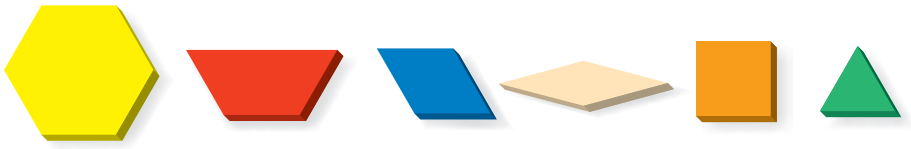
6. Each box below was made by folding 1-cm grid paper.
Find the volume of each box.
Explain how you found each volume.

a) 

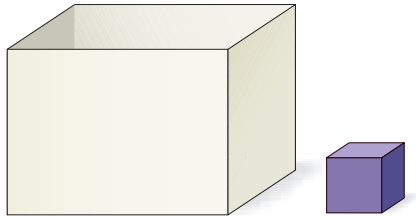
b) 

c) 

7. Each Pattern Block is 1 cm high. Use a referent for 1 cm^3 to estimate the volume of each Pattern Block. Explain how you did this.



8. Ogi says that he can find the volume of this box using only a few centimetre cubes.
How do you think Ogi will do this?



9. A box has a volume of 20 cm^3.
The box is 2 cm tall.

a) How many centimetre cubes will fit in one layer in the bottom of the box?
How do you know?

b) How long and how wide might the box be?
Try to give as many answers as possible.

10. Describe a strategy you could use to estimate, then find the volume of this textbook.
What problems might you have finding the volume?
Compare your strategy with that of a classmate.

11. Use a referent for 1 cm^3 to estimate the volume of a pen.
Explain how you did this.

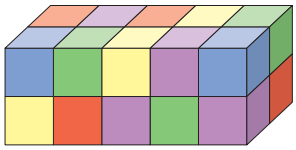
Reflect

Suppose you need to estimate the volume of a lunchbox.
Would you visualize centimetre cubes or your referent for 1 cm^3?
Explain your choice.

LESSON 7

Constructing Rectangular Prisms with a Given Volume

This rectangular prism is made with centimetre cubes.
What is its length? Width? Height?
What is the volume of the rectangular prism?



Length, width, and height are **dimensions** of the rectangular prism.

Explore

You will need centimetre cubes.

➤ Construct as many different rectangular prisms as you can, each with a volume of 24 cubic centimetres.

➤ Record your work in a table.

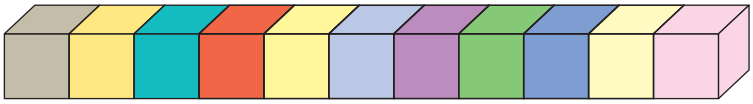
Length	Width	Height	Volume
24 cm	1 cm	1 cm	24 cm^3

Show *and* Share

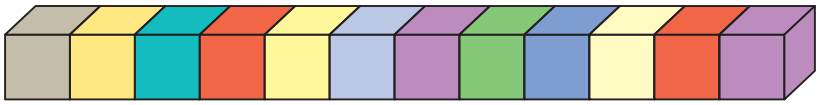
Share your work with another pair of students.
How do you know you have found all the possible rectangular prisms?

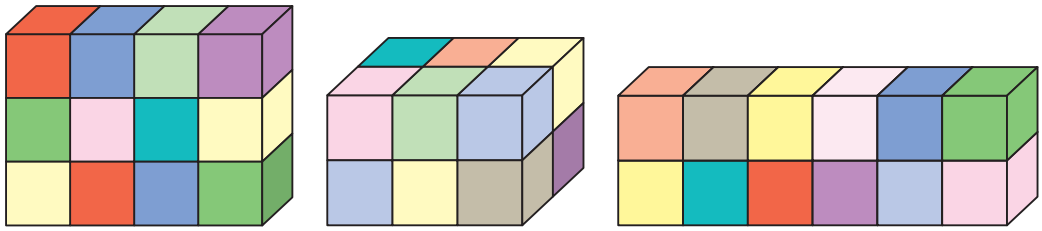
Connect

➤ Suppose you have 11 centimetre cubes.
You can make only 1 rectangular prism with all 11 cubes.
The volume of this rectangular prism is 11 cm^3.



➤ Suppose you have 12 centimetre cubes.
You can make 4 different rectangular prisms with 12 cubes.
The volume of each rectangular prism is 12 cm^3.



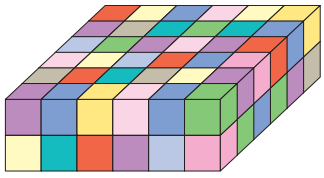


Practice

Use centimetre cubes.

1. These rectangular prisms are made with centimetre cubes.
Find the volume of each prism.

a)



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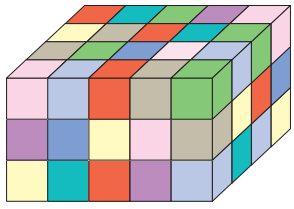

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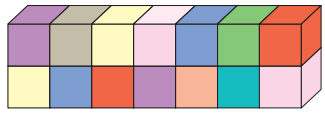


2. Build a rectangular prism with each volume.
Record your work in a table.

a) 9 cm^3 **b)** 36 cm^3
c) 13 cm^3 **d)** 15 cm^3

Volume	Length	Width	Height
9 cm^3			

3. Build all the possible rectangular prisms with a volume of 16 cm^3.
Record your work in a table.

4. Build a rectangular prism with each set of dimensions shown in the table.
Find the volume of each prism.

	Length (cm)	Width (cm)	Height (cm)	Volume (cm^3)
a)	8	3	2	
b)	3	4	2	
c)	7	3	1	

5. **a)** How many different rectangular prisms can be made with 18 centimetre cubes? Write the dimensions of each prism.
b) Suppose the number of centimetre cubes were doubled.
How many different prisms could be made?
Write their dimensions.

6. Suppose you have 100 centimetre cubes.
How many larger cubes can you make using any number of the centimetre cubes?
Record your work in a table.
What patterns do you see?

7. **a)** Anjana used centimetre cubes to build a rectangular prism with a volume of 26 cm^3.
What might the dimensions of Anjana's prism be?
Give as many answers as you can.
b) Build a rectangular prism with one-half the volume of Anjana's prism. Record its dimensions.
How many different prisms can you build? Explain.

8. Suppose you want to build a rectangular prism with 50 centimetre cubes. You put 10 cubes in the bottom layer.
a) How many layers of cubes will you need?
b) What are the dimensions of the prism?

Reflect

How can you tell if you can build only one rectangular prism with a given number of centimetre cubes?
Use examples to explain.

LESSON 8

Measuring Volume in Cubic Metres

Explore

You will need metre sticks, newspapers, tape, and a calculator.

➤ Create 12 rolled-up newspapers, each 1 m long.
Arrange 4 rolls to show a square metre.
Connect the remaining rolls to build a skeleton of a cube with an edge length of 1 m.

➤ Compare the size of the cube to the size of your classroom.
About how many of your cubes would it take to fill your classroom?

Show *and* Share

Share your estimate with another group of students.
Talk about the strategies you used to make your estimate.

Connect

The cube you built in *Explore* has edge lengths of 1 m.
The cube has a volume of one **cubic metre** (1 **m^3**).

We use cubic metres to measure the volumes of large objects.

➤ This stack of hay bales has bales with edge lengths of 1 m.
There are 2 layers of 6 bales, or 12 bales.
The stack has a volume of 12 m^3.

➤ This wooden crate has a volume of 1 m^3.

Six of these crates can fit in the back of this pick-up truck.
The back of the truck has a volume of 6 m^3.

Practice

1. **a)** Name a referent you could use for a volume of one cubic metre.
Explain your choice.

b) Use your referent to estimate the volume of each object.

- a telephone booth
- your bedroom
- an elevator

2. Which unit – cubic centimetre or cubic metre – is represented by each referent?

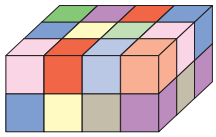
a) a sugar cube
b) a playpen
c) a Base Ten unit cube
d) a dog cage

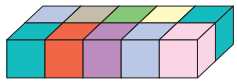
3. Suppose you have to measure the volume of each item below.
Would you use cubic centimetres or cubic metres?

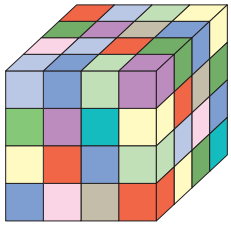
a) a refrigerator
b) the cargo space in a truck
c) a tissue box
d) the gym

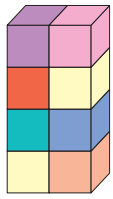
4. Each rectangular prism is built with 1-m cubes.
Find the volume of each prism.

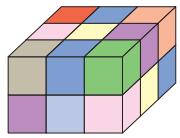
a) 

b) 

c) 

d) 

e) 

f) 

5. Marianne stacks crates.
Each crate has a volume of 1 m^3.
Marianne makes 4 layers, with 12 crates in each layer.

a) What is the volume of the stack of crates?

b) How many rows of crates could be in each layer?
How many crates could be in each row?

Reflect

Name 2 objects that might be measured in cubic metres.
Explain your choices.

LESSON 9

Exploring Capacity: The Litre

Camille carries a drinking bottle when she hikes.
The bottle holds one **litre** of water.
We use the symbol **L** for litres.

Explore

You will need some containers and sand.

- Look at the container that holds one litre.
  Choose another container.
  Estimate whether it holds
  less than one litre,
  more than one litre,
  or about one litre.
  Check your estimate.
  Record your work.
  Repeat this activity with other containers.

- Choose a large container.
  Estimate its capacity in litres.
  Record your estimate.
  Check your estimate.
  Record your work.

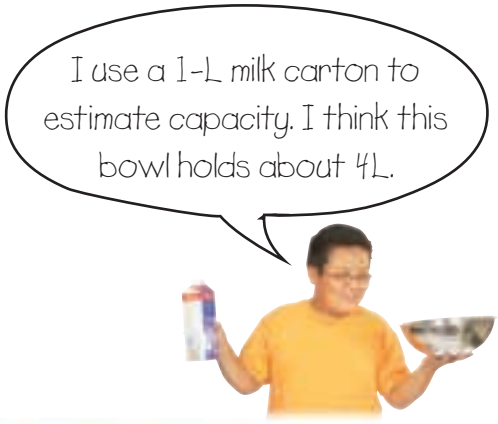
Show *and* Share

Discuss the strategies you used to make your estimates.
Can containers of different shapes hold about the same amount?
Do you drink more or less than one litre of liquids in a day?

Connect

When you fill a container with liquid to find out how much it holds, you measure its **capacity**.

This carton has a capacity of one litre.
You write: 1 L
The carton holds one litre of juice.
One litre fills about 4 glasses.



Here are some other things that are measured in litres.

Practice

1. Which containers hold less than one litre?

a) 

b) 

c) 

d) 

2. Choose the better estimate. How do you know?

a) 5 L or 210 L

b) 9 L or 1 L

c) 2 L or 26 L

d) 1 L or 17 L

e) 4 L or 25 L

f) 1 L or 6 L

3. Order these containers from least to greatest capacity.

4. **a)** Name a referent you could use for a capacity of one litre.
Explain your choice.
b) Find 3 containers that you think have capacities greater than one litre.
Use your referent to estimate the capacity of each container.
c) Find the capacity of each container. Explain your strategy.

5. Suppose you estimate that you made about 1 L of lemonade.
How can you check your estimate if you do not have a 1-L container?
Show your work.

6. Suppose you make 4 L of apple juice.
About how many glasses can you fill?
Explain how you know.

7. Each person at a barbecue was served 1 glass of juice.
Fifteen litres of juice were served.
About how many people were at the barbecue?
Explain how you got your answer.

8. The doctor told Jia she should drink
8 glasses of water a day.
About how many litres should Jia drink
in one week? Explain.

9. Raphie wants to give each of his
20 guests a glass of fruit punch.
How many litres of punch should he make?
How do you know?

Reflect

Use words, pictures, or numbers to explain what *capacity* means.

LESSON 10

Exploring Capacity: The Millilitre

This is Chef Alexia's favourite soup recipe.
She serves it piping hot with sour cream.
Each item in the recipe is measured in litres or **millilitres**.
We use the symbol **mL** for millilitres.

Explore

You will need some containers and water.

- Look at the measuring cups marked in millilitres.
  Choose a container.
  Use the measuring cups to estimate the capacity of the container in millilitres.
  Check your estimate.
  Record your work.
  Repeat this activity with other containers.

- Look at a 1-L container.
  Estimate how many millilitres it holds.
  Check your estimate.

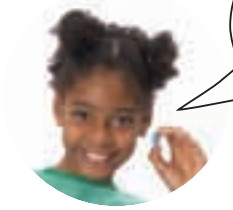
Show *and* Share

Compare your estimates with those of others in your group.
Explain your strategy for checking your estimates.
Tell what things are measured in millilitres.

Connect

The millilitre (mL) is a small unit of capacity.

This eyedropper has a capacity of 1 mL.
It holds about 10 drops.



A hollow centimetre cube holds 1 mL of liquid. I use this as a referent to estimate capacity in millilitres.

This measuring jug has a capacity of 500 mL.
It holds 500 mL of water.

It takes 2 of those measuring jugs to fill the one-litre mug.

But 500 mL + 500 mL = 1000 mL
so, I can say that 1 L = 1000 mL

Practice

Use measuring cups when they help.

1. **a)** Name a referent you could use for a capacity of one millilitre. Explain your choice.
b) Find 3 containers whose capacities you would measure in millilitres. Use your referent to estimate the capacity of each container.
c) Find the capacity of each container. Explain your strategy.

2. Choose the better estimate.

a) 5 mL or 100 mL

b) 15 mL or 250 mL

c) 20 mL or 300 mL

d) 75 mL or 15 mL

e) 250 mL or 900 mL

f) 10 mL or 500 mL

3. Choose the better estimate for each. Explain.

a) 4 mL or 4 L

b) 10 mL or 1 L

c) 100 mL or 2 L

d) 100 mL or 1 L

e) 6 mL or 6 L

f) 50 mL or 7 L

4. Which capacity unit – millilitre or litre – is represented by each referent?

a) an eyedropper **b)** a teaspoon **c)** a water bottle

5. Which unit would you use to measure each capacity: millilitre or litre? Explain your choice.

a) 

b) 

c) 

6. Which measure is closest to 1 L? How do you know?
400 mL 889 mL 799 mL 850 mL

7. Copy and complete.

a) 1 L = ☐ mL **b)** 2 L = ☐ mL **c)** 3 L = ☐ mL

d) 4000 mL = ☐ L **e)** 5000 mL = ☐ L **f)** 6000 mL = ☐ L

8. James drank 400 mL of water in the morning and 500 mL in the afternoon.
Did James drink more than or less than 1 L?
How do you know?

9. Alexis drank one-half of 1 L of water.
How many millilitres of water does Alexis have left?
How do you know?

Math Link

Science

The body of a human adult has about 5 L of blood. A mosquito's bite removes about $\frac{1}{200}$ of a millilitre of blood!

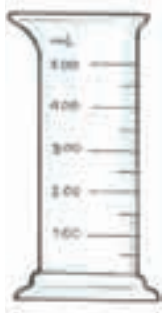
Reflect

You have learned two units for measuring capacity.
How do you know which unit to use when you measure the capacity of a container?

LESSON 11

Relating Capacity and Volume

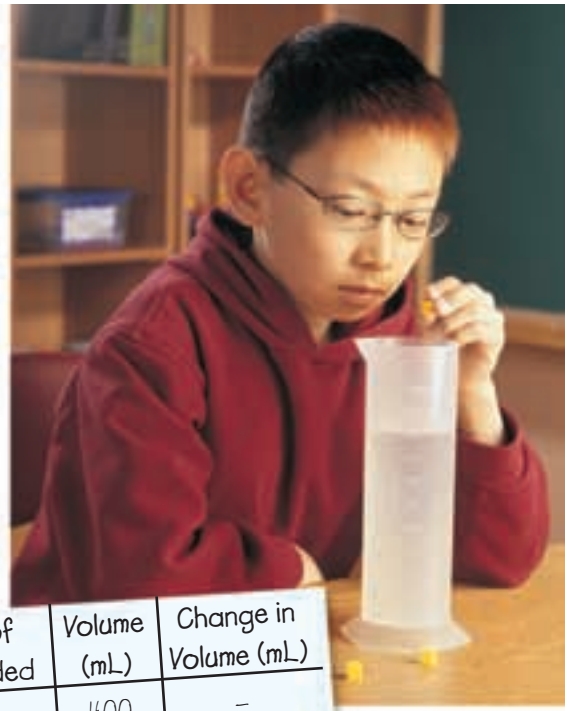
The capacity of this graduated cylinder is 500 mL.
If we pour in 400 mL of water,
we can say the volume of water is 400 mL.
That is, we can measure the volume of water
in millilitres.



Explore

You will need centimetre cubes, a 500-mL graduated cylinder, and water.

- Pour 400 mL of water into a 500-mL graduated cylinder.
  Record the volume of water in a table.
  Place 10 cubes in the cylinder.
  Record the number of cubes added and the new volume, in millilitres.
  Calculate and record the change in volume.
- Add 10 more cubes.
  Record the new volume.
  Continue to add groups of 10 cubes.
  Each time, record the volume and the change in volume.
- Describe any patterns you see in the table.
- Look at your results.
  When you added 10 cubes, how did the volume in the cylinder change?
  How many millilitres equal 10 cm^3?



Number of Cubes Added	Volume (mL)	Change in Volume (mL)
0	400	–
10		

Show *and* Share

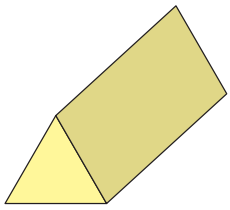
Share the patterns you found with another group of students.
How could you use water in a graduated cylinder to find the volume of a stone?

Connect

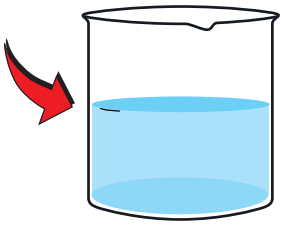
The volume of an object can be measured in cubic centimetres or millilitres.

$1\ cm^3 = 1\ mL$

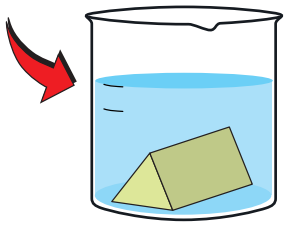
➤ Here is another way to find the volume of an object.
You can use **displacement** of water to find the volume of this triangular prism.



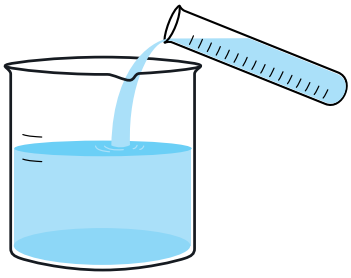
Mark the water level in a container.



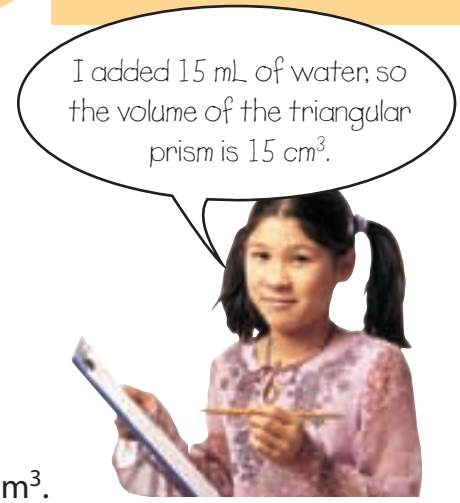
Totally submerge the prism. Mark the new water level.



Remove the prism.
Fill the container to the upper mark.
Record the volume of water added, in millilitres.



Convert the volume in millilitres to cubic centimetres.



The volume of the triangular prism is 15 cm^3.

Practice

You will need a container, water, and a graduated cylinder.

1. Collect 4 small solid objects.
   a) Estimate the volume of each object.
   b) Find each volume.
   c) Order the objects from least to greatest volume.

2. Use modelling clay to build a solid.
   Try to make a solid with a volume of 250 cm^3.
   a) Find the volume of your solid.
   b) How close is the volume to 250 cm^3?

3. Choose two different solids from the classroom.
   Look for solids with about the same volume.
   a) Explain why you chose the solids you did.
   b) Find the volume of each solid in cubic centimetres.

4. **a)** What is the volume of 100 centimetre cubes?
   b) Put 100 centimetre cubes into an empty graduated cylinder.
   Read the number of millilitres from the scale.
   c) Compare your answers to parts a and b.
   Explain any differences.

5. You will need 50 counters.
   a) Predict the volume of 50 counters in cubic centimetres.
   b) Find the volume of 50 counters.
   c) How does your estimate compare to the volume?

6. Describe how you could find each measure:
   a) the volume of one dime in cubic centimetres
   b) the volume of a toy car in millilitres

One dime is very small. Think how you could measure more than one dime.

Reflect

Explain how you can use displacement of water to measure the volume of an object.

Unit 4 Show What You Know

LESSON

1

1. Use a referent. Estimate the length, width, and height of your desk or table.
Record each estimate in millimetres, centimetres, and metres.

2. Use a ruler. Draw each item.

a) a stick 14 cm long **b)** a pin 15 mm long **c)** a pencil 16.2 cm long

3. Copy and complete.

a) 3 m = ☐ mm **b)** 4000 mm = ☐ m **c)** 2 m = ☐ mm

d) 5000 mm = ☐ m **e)** 10 m = ☐ mm **f)** 7000 mm = ☐ m

3
4

4. Use 1-cm grid paper.

a) Draw 3 different rectangles with perimeter 20 cm.

b) Draw 3 different rectangles with area 20 cm^2.

5. Use 1-cm grid paper.
Draw a rectangle with area 36 cm^2 and perimeter 30 cm.

6. The area of a rectangular garden is 48 m^2.

a) What is the greatest perimeter the garden could have?

b) What shape would the garden with the least perimeter have? Explain.

c) Why might a person choose to build the garden with the least perimeter?

5

7. Find a small container in the classroom.
Choose some identical items that will fill the container.

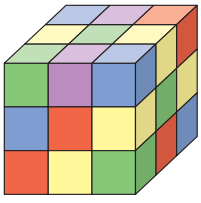
a) Estimate how many items will fill the container.

b) Measure the volume of the container with the items you chose.

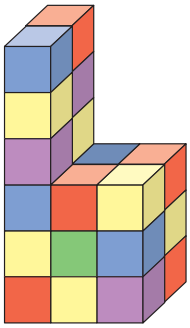
6

8. Use centimetre cubes to make each object below.
Find the volume of each object.
Which object has the greatest volume?

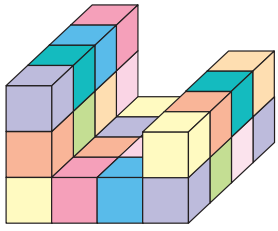
a)



b)

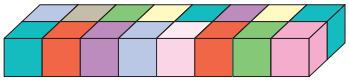


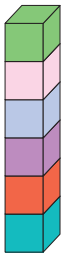
c)

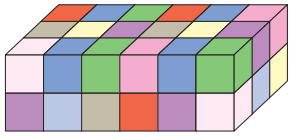


LESSON

9. Make each rectangular prism with centimetre cubes.
Find the volume of each prism.

a) 

b) 

c) 

7

10. Use centimetre cubes.
Build a rectangular prism with each volume.
Record the dimensions of each prism in a table.
a) 12 cm^3 **b)** 24 cm^3 **c)** 11 cm^3

11. Use centimetre cubes.
Build all the possible rectangular prisms with volume 18 cm^3.
Record the dimensions of each prism in a table.

8

12. Describe a referent for one cubic metre.
Name 2 objects that might be
measured in cubic metres.
Explain how you could use your referent to estimate each volume.

9
10

13. Choose the better estimate for each capacity.
a) 15 mL or 500 mL **b)** 10 L or 1000 mL

c) 400 mL or 2 L **d)** 2000 mL or 200 L

14. Order these capacities from greatest to least:
2 L 1500 mL 4 L 1980 mL

11

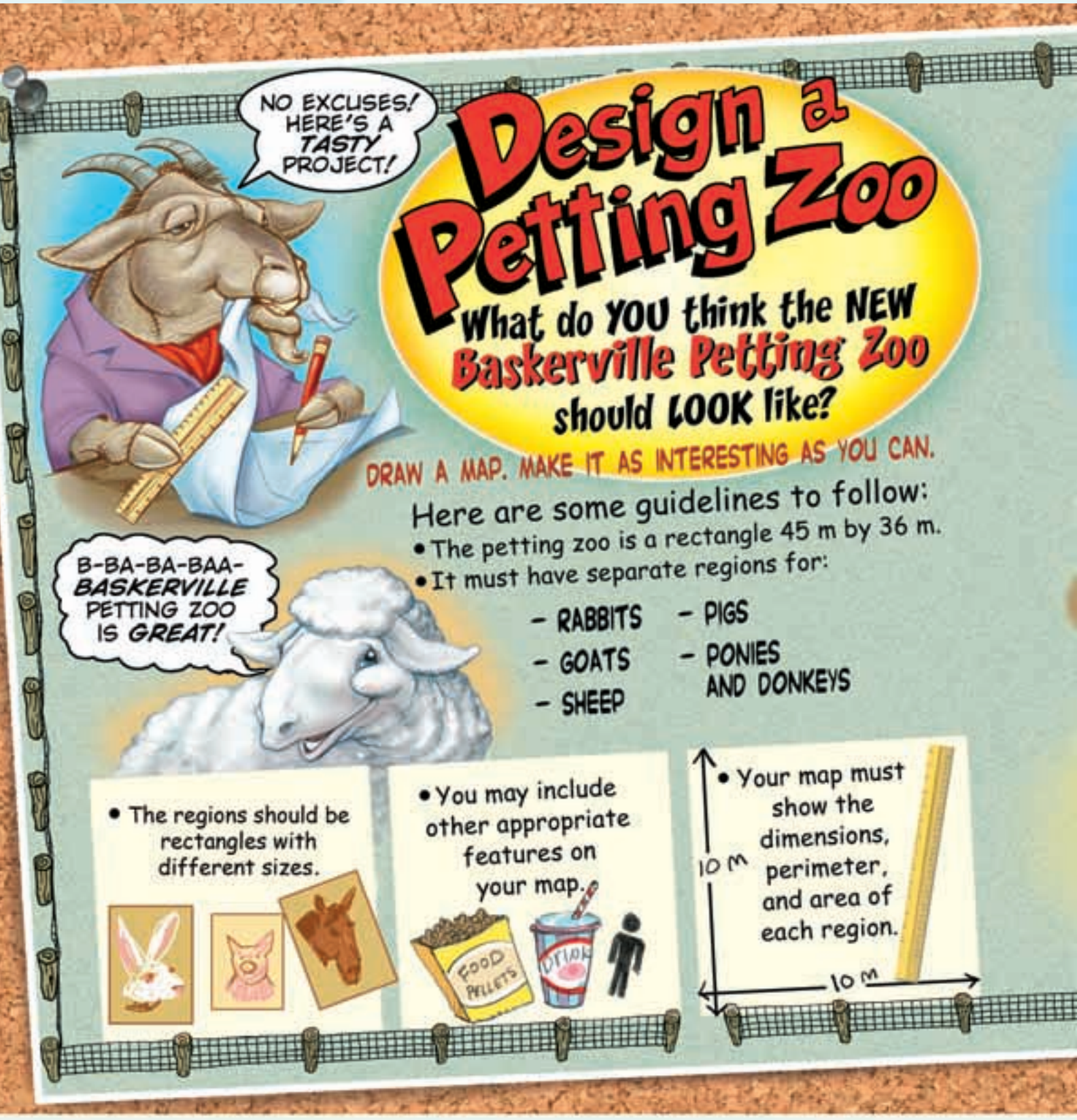
15. How could you find the volume of a lacrosse ball?
Use pictures and words to explain.

UNIT 4 Learning Goals

- measure length in millimetres
- select referents for units of measure
- relate units of measure
- draw different rectangles for a given perimeter or area
- estimate and measure volume
- estimate and measure capacity

Unit Problem

At the Zoo



Check List

Your work should show

- ☑ a map of the petting zoo on grid paper, with each section outlined and labelled
- ☑ the dimensions, perimeter, and area of each section and how you found them
- ☑ a different rectangle for each region
- ☑ that the size of a region reflects the size of the animal

Reflect on Your Learning

You have learned about units of measure for dimensions, perimeter, area, volume, and capacity.
Write a sentence to describe where you could use each unit outside the classroom.

Investigation

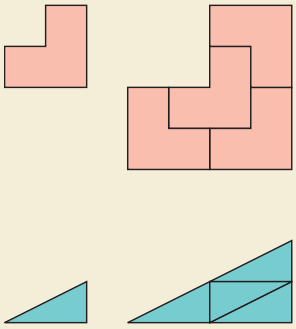
Rep-Tiles

You will need Pattern Blocks.

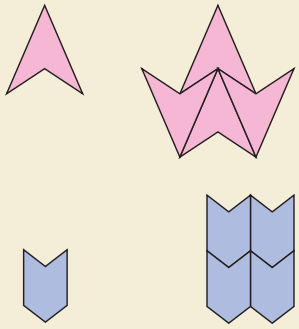
Part 1

A **rep-tile** is a polygon that can be copied and arranged to form a larger polygon with the same shape.

These are rep-tiles:



These are not rep-tiles:



➤ Which Pattern Blocks are rep-tiles?
How did you find out?

Part 2

Choose a block that is a rep-tile.
Do not use orange or green blocks.
Build an increasing pattern.
Record the pattern.

➤ Choose one Pattern Block that is a rep-tile.
This is Frame 1.

➤ Now take several of the same type of block.
Arrange the blocks to form a polygon with the same shape.
This is Frame 2.

➤ Continue to arrange blocks to make larger polygons with the same shape. The next largest polygon is Frame 3.

➤ Suppose the side length of the green Pattern Block is 1 unit. Find the perimeter of each polygon.

➤ Suppose the area of the green Pattern Block is 1 square unit. Find the area of each polygon.

Copy and complete the table.

Frame	Number of Blocks	Perimeter	Area
1	1		
2			

Part 3

➤ What patterns can you find in the table?

➤ How many blocks would you need to build Frame 7? How do you know?

➤ Predict the area and the perimeter of the polygon in Frame 9. How did you make your prediction?

Display Your Work

Record your work.
Describe the patterns you found.

Take It Further

Draw a large polygon you think is a rep-tile.
Trace several copies.
Cut them out.
Try to arrange the copies to make a larger polygon with the same shape.
If your polygon is a rep-tile, explain why it works.
If it is not, describe how you could change it to make it work.