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
• 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?
Estimate and measure in millimetres.

This ruler shows centimetres.

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

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How many millimetres are in 1 cm?

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.

<table>
<thead>
<tr>
<th>Given measurement</th>
<th>Object</th>
<th>Actual measurement</th>
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<tbody>
<tr>
<td>about 25 mm</td>
<td>an eraser</td>
<td>30 mm</td>
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</table>
**Show and Share**

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

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

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

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Centimetres and millimetres are related.

Metres and centimetres are related.

Metres and millimetres are related.

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You can use the thickness of a dime as a referent for 1 mm. A referent is used to estimate a measure.
Use a ruler or metre stick when it helps.

1. Copy and complete each table.

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</table>

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) \( 8 \text{ cm} = \square \text{ mm} \)  
   b) \( 20 \text{ cm} = \square \text{ mm} \)  
   c) \( 63 \text{ cm} = \square \text{ mm} \)

4. Copy and complete.
   a) \( 60 \text{ mm} = \square \text{ cm} \)  
   b) \( 40 \text{ mm} = \square \text{ cm} \)  
   c) \( 100 \text{ mm} = \square \text{ cm} \)

5. Copy and complete.
   a) \( 2000 \text{ mm} = \square \text{ m} \)  
   b) \( 6000 \text{ mm} = \square \text{ m} \)  
   c) \( 9000 \text{ mm} = \square \text{ m} \)
   d) \( 5 \text{ m} = \square \text{ mm} \)  
   e) \( 2 \text{ m} = \square \text{ mm} \)  
   f) \( 8 \text{ m} = \square \text{ mm} \)

6. Name another referent for each unit of measure. Explain each choice.
   a) \( 1 \text{ mm} \)  
   b) \( 1 \text{ cm} \)  
   c) \( 1 \text{ m} \)

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)  

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.
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.

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?

**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.

**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.
Record your list in the table.

<table>
<thead>
<tr>
<th></th>
<th>Length</th>
<th>Width</th>
<th>Perimeter</th>
<th>Area</th>
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<tbody>
<tr>
<td>Original Pen</td>
<td>2 m</td>
<td>1 m</td>
<td>6 m</td>
<td>2 m²</td>
</tr>
<tr>
<td>First Increase</td>
<td>4 m</td>
<td>2 m</td>
<td>12 m</td>
<td>8 m²</td>
</tr>
</tbody>
</table>

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?

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.

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

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

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

The rectangle with the least width has the least area.
The rectangle closest in shape to a square has the greatest area.

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) b) 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.
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.
Exploring Rectangles with Equal Areas

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.

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<tr>
<th>Length</th>
<th>Width</th>
<th>Perimeter</th>
<th>Area</th>
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<tbody>
<tr>
<td>36 units</td>
<td>1 unit</td>
<td>74 units</td>
<td>36 square units</td>
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</tbody>
</table>

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

Perimeter: 20 cm
Perimeter: 34 cm
Perimeter: 16 cm

The rectangle that is a square has the least perimeter.
The rectangle with the least width has the greatest perimeter.

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.

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<thead>
<tr>
<th>Length (units)</th>
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<th>Perimeter (units)</th>
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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 m².
   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 cm² and perimeter 18 cm 
   b) area 18 cm² and perimeter 22 cm 
   c) area 2 cm² and perimeter 6 cm 
   d) area 12 cm² and perimeter 26 cm 

5. Salvio wants to make a rectangular pumpkin patch with an area of 30 m².
   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.
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?
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.

➤ 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.

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

The sugar cubes fill the box without leaving any spaces.
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) Pencil Crayons 24
   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.
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.
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$^3$. 
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 cm³. 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 cm³.
   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.

![Boxes](image)

7. Each Pattern Block is 1 cm high. Use a referent for 1 cm³ to estimate the volume of each Pattern Block. Explain how you did this.

![Pattern Blocks](image)

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 cm³. 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 cm³ 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 cm³? 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?

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.

<table>
<thead>
<tr>
<th>Length</th>
<th>Width</th>
<th>Height</th>
<th>Volume</th>
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</thead>
<tbody>
<tr>
<td>24 cm</td>
<td>1 cm</td>
<td>1 cm</td>
<td>24 cm³</td>
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</table>

Show and Share

Share your work with another pair of students. How do you know you have found all the possible rectangular prisms?
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\(^3\).

Use centimetre cubes.

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

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\(^3\)

<table>
<thead>
<tr>
<th>Volume</th>
<th>Length</th>
<th>Width</th>
<th>Height</th>
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<tr>
<td>9 cm(^3)</td>
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</table>
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.

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<tr>
<th></th>
<th>Length (cm)</th>
<th>Width (cm)</th>
<th>Height (cm)</th>
<th>Volume (cm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>48</td>
</tr>
<tr>
<td>b)</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>24</td>
</tr>
<tr>
<td>c)</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>21</td>
</tr>
</tbody>
</table>

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

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\(^3\).
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) ![Prism a](image)
   - b) ![Prism b](image)
   - c) ![Prism c](image)
   - d) ![Prism d](image)
   - e) ![Prism e](image)
   - f) ![Prism f](image)

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.
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?
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.

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  

I use a 1-L milk carton to estimate capacity. I think this bowl holds about 4 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.
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.

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.

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.
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?

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?
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.

1. 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.
2. 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.
3. Describe any patterns you see in the table.
4. Look at your results. When you added 10 cubes, how did the volume in the cylinder change? How many millilitres equal 10 cm³?

<table>
<thead>
<tr>
<th>Number of Cubes Added</th>
<th>Volume (mL)</th>
<th>Change in Volume (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>400</td>
<td>–</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

➤ 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 cm³.

I can't use unit cubes to find the volume of this prism.

I added 15 mL of water, so the volume of the triangular prism is 15 cm³.

1 cm³ = 1 mL

The volume of the triangular prism is 15 cm³.
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.
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

4. Use 1-cm grid paper.
   a) Draw 3 different rectangles with perimeter 20 cm.
   b) Draw 3 different rectangles with area 20 cm².

5. Use 1-cm grid paper.
   Draw a rectangle with area 36 cm² and perimeter 30 cm.

6. The area of a rectangular garden is 48 m².
   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?

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.

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

   a)  
   b)  
   c)  

Show What You Know
9. Make each rectangular prism with centimetre cubes. Find the volume of each prism.
   a) b) c)

10. Use centimetre cubes. Build a rectangular prism with each volume. Record the dimensions of each prism in a table.
    a) 12 cm³  b) 24 cm³  c) 11 cm³

11. Use centimetre cubes. Build all the possible rectangular prisms with volume 18 cm³. Record the dimensions of each prism in a table.

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.

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

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

Design a Petting Zoo

What do you think the NEW Baskerville Petting Zoo should look like?

Draw a map. Make it as interesting as you can.

Here are some guidelines to follow:

- The petting zoo is a rectangle 45 m by 36 m.
- It must have separate regions for:
  - Rabbits
  - Pigs
  - Goats
  - Ponies
  - Sheep
  - And Donkeys

- The regions should be rectangles with different sizes.
- You may include other appropriate features on your map.
- Your map must show the dimensions, perimeter, and area of each region.
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

Check List

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.

Unit 4 161
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: ![Rep-tiles](image1)

These are not rep-tiles: ![Not rep-tiles](image2)

➤ 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.

<table>
<thead>
<tr>
<th>Frame</th>
<th>Number of Blocks</th>
<th>Perimeter</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.
UNIT 7

Statistics and

Weather Watch

Learning Goals

- understand the difference between first-hand data and second-hand data
- construct and interpret double bar graphs
- use the language of probability
- compare the likelihoods of outcomes
• How can we find out how much precipitation fell in one day?
• How can we find out the highest and lowest temperatures in one day?
• What types of weather are more likely in your area this week? How did you decide?
• Can we ever be certain about tomorrow’s weather? Why or why not?

Key Words

first-hand data
second-hand data
double bar graph
horizontal axis
vertical axis
legend
impossible
possible
certain
likely
unlikely
probable
improbable
probability
outcome
experiment
To find out what people like, do, think, or need, we ask questions. For example, how many bicycle stands will your class need?

Your teacher will draw this table on the board.

<table>
<thead>
<tr>
<th>Method of Travel</th>
<th>Tally</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Car</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Elementary school students across Canada answered the same question. Here are the results for 100 students.

- Why might someone need to know these data?
- Compare your data with the given data. How are the data the same? How are they different?

**Show and Share**

Work with another classmate.
Write a question you could answer using your data. Answer the question.
Write a question you could answer using the given data. Answer the question.
Data you collect yourself are called first-hand data.
Data collected by someone else are called second-hand data.

➤ Mrs. Rasoda’s class studied weather.
The students measured the rainfall for 5 days.
For Mrs. Rasoda’s class, these results are first-hand data.
For you, these results are second-hand data.

<table>
<thead>
<tr>
<th>Day</th>
<th>Rainfall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>5 mm</td>
</tr>
<tr>
<td>Tuesday</td>
<td>9 mm</td>
</tr>
<tr>
<td>Wednesday</td>
<td>0 mm</td>
</tr>
<tr>
<td>Thursday</td>
<td>12 mm</td>
</tr>
<tr>
<td>Friday</td>
<td>0 mm</td>
</tr>
</tbody>
</table>

During the 5 days that measurements were taken, we know that:
• More rain fell on Thursday than on any other day.
• There were 2 days when no rain fell.

➤ The students also looked at second-hand data from a government Web site.

<table>
<thead>
<tr>
<th>City</th>
<th>Annual Average Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winnipeg</td>
<td>504 mm</td>
</tr>
<tr>
<td>Regina</td>
<td>364 mm</td>
</tr>
<tr>
<td>Edmonton</td>
<td>461 mm</td>
</tr>
<tr>
<td>Calgary</td>
<td>399 mm</td>
</tr>
<tr>
<td>Vancouver</td>
<td>1167 mm</td>
</tr>
</tbody>
</table>

From these data, the students know that:
• Vancouver usually has more precipitation than any other 2 cities together.
• Regina has the least precipitation of the 5 cities.
1. Mathieu goes fishing at a lake near his home. He counts how many fish he catches in one hour. Are these first-hand or second-hand data? Explain.

2. Sylvie is interested in endangered animals. She wants to find out how many sea lions live off the west coast of B.C. Should Sylvie use first-hand or second-hand data? Why?

3. Tell whether you would use first-hand or second-hand data to answer each question. Explain your choices.
   a) Do your friends watch more English or French videos?
   b) Which foods contain the most vitamin C?
   c) How many people live in Canada?
   d) What are the favourite TV shows of students in your school?

4. Work with a partner to collect first-hand data.
   a) Think of one thing you would like to know about your classmates. What question will you ask?
   b) Conduct a survey. Tally your results.
   c) Display your findings in a table.
   d) What did you find out about your classmates?
   e) Tell why first-hand data were needed to answer your question.

5. Think of a question you could answer with second-hand data. Look for a table or graph that gives the information you need. Use newspapers, magazines, or the Internet. Why are second-hand data the better choice for this question?

**Science**
A marine biologist collects first-hand data when she observes whales in the ocean. The biologist uses second-hand data when she receives information on the Internet from other scientists around the world.

What is the difference between first-hand data and second-hand data? Include one example of each type of data in your answer.
Lyne surveyed her classmates to find out what they usually wear on their feet at home. She drew two bar graphs.

**Graph 1**

What We Wear At Home On Our Feet

<table>
<thead>
<tr>
<th>Types of Footwear</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoes</td>
<td>8</td>
</tr>
<tr>
<td>Socks</td>
<td>6</td>
</tr>
<tr>
<td>Slippers</td>
<td>4</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

**Graph 2**

What We Wear At Home On Our Feet

<table>
<thead>
<tr>
<th>Types of Footwear</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoes</td>
<td>6</td>
</tr>
<tr>
<td>Socks</td>
<td>4</td>
</tr>
<tr>
<td>Slippers</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
</tbody>
</table>

- How are the two graphs the same?
  - How are they different?
- What can you tell from one graph that you cannot tell from the other graph?

**Show and Share**

Work with another pair of classmates. Write a question you could answer using the first graph. Write a question you could answer using the second graph. Answer both questions.
What do you usually eat for breakfast? Students across Canada answered that question.

➤ Here are 2 bar graphs that show the typical answers of 100 boys and 100 girls.

From these graphs, we know that:
- More students eat grain products than any other food.
- Most students eat breakfast, but some do not.

➤ A **double bar graph** displays two sets of data at once. You can use the graph to make comparisons between the data sets.

The **title** tells what the graph is about.
The **horizontal axis** shows the breakfast foods.
The **vertical axis** shows how many students eat each food.
The **scale** is 1 square represents 10 students.
The double bar graph has a **legend** that tells what the 2 colours represent.
From the double bar graph, we know that:

- More boys than girls have meat for breakfast.
- More girls than boys have no breakfast.

Any bar graph may be drawn with its bars horizontal instead of vertical.

1. Look at these double bar graphs.
   a) What attributes does every graph have?
   b) How are the graphs different?

A. **Medals Won in the 2006 Arctic Winter Games**

B. **Thickness of Sea Ice**

C. **Category 4 and 5 Hurricanes in 30 Years**

D. **Some Languages Spoken by Aboriginal People, 2001**
2. Choose two graphs from question 1. For each graph:
   a) Write a question you could answer using the graph.
   b) Answer your question.
   c) Trade questions with a classmate.
      Answer your classmate’s question.

3. Kelly is in a combined Grades 4 and 5 class.
   She surveyed her classmates about their favourite recess activity.
   Kelly then drew this double bar graph.

   **Grades 4 and 5 Favourite Recess Activities**

   ![Double Bar Graph]

   a) What is the most popular activity for Grade 4 students?
      For Grade 5 students?
   b) How many students are in each grade?
   c) What else can you tell from the graph?

4. Suppose you are the manager of a new NHL hockey team.
   Which of these three hockey players would you pick:
   Jarome Iginla or Markus Naslund or Ryan Smyth?
   Use data from the double bar graph to explain your choice.

   **Hockey Players' Statistics**

   ![Double Bar Graph]
5. **a)** What does this double bar graph show?

Use the double bar graph to answer these questions.

**b)** Which fruit provides more vitamin C?

**c)** Which fruit provides more calcium?

**d)** An orange contains about 70 mg of vitamin C. How do apples and bananas compare to oranges for vitamin C?

**e)** Write a question about this graph. Answer your question.

6. Look at this double bar graph.

What could it represent?

Use a copy of the graph.

Write a title and legend for the graph.

Label each axis.

What is the scale?

**Reflect**

How are a bar graph and a double bar graph alike?

How are they different?

When would you use each graph?
The students in two Grade 5 classes were asked this question: “What is your favourite physical activity?”

The students’ responses are shown in the graph. What do you know from the graph?

Suppose you want to find which season the students in your class like best. Decide on a survey question. Collect data from equal numbers of boys and girls. Record the data in a table. Draw a double bar graph.

**Show and Share**

Share your graph with another pair of students. How are your graphs the same? Different? What conclusions can you make based on your graph? Suppose you had surveyed twice as many boys as girls. How might this have changed your conclusions?
The Grade 5 class sells snacks at morning and afternoon recesses.
This table shows one day’s sales.

David used a double bar graph to display these data.

➤ First, he drew and labelled 2 axes. Then, he chose a scale. One square represents $4.

➤ He drew two bars for each snack in the table. In each pair, he coloured the Morning bar red and the Afternoon bar green.

➤ He drew a legend to show what each colour of bar represents. Finally, David gave the graph a title.

The double bar graph shows how the data sets compare.

Look at the heights of pairs of bars:
• Fruit sales were a little higher in the morning than in the afternoon.
• Cereal bar sales were much higher in the morning than in the afternoon.
• Twice as much popcorn was sold in the afternoon than in the morning.
• Pretzels sales were the same at both recesses.

<table>
<thead>
<tr>
<th>Snack</th>
<th>Morning</th>
<th>Afternoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruit</td>
<td>$24</td>
<td>$20</td>
</tr>
<tr>
<td>Cereal Bars</td>
<td>$30</td>
<td>$12</td>
</tr>
<tr>
<td>Popcorn</td>
<td>$6</td>
<td>$12</td>
</tr>
<tr>
<td>Pretzels</td>
<td>$6</td>
<td>$6</td>
</tr>
</tbody>
</table>
1. **a)** Draw a double bar graph to display the data in the table.
   **b)** What conclusions can you draw from the graph?

2. Work with a partner.
   **a)** Each of you rolls a number cube 25 times.
       Record the results of each roll in a table.
   **b)** Draw a double bar graph to show your data and your partner’s data.
   **c)** Make comparisons between the data sets.

3. **a)** Draw a double bar graph to display the data in the table.
   **b)** Write a question about the graph.
       Answer the question.
   **c)** What else do you know from the graph?

4. Jonathan Cheechoo is a star hockey player and a member of the Cree First Nation.
   In 2005/2006, he scored more goals than any other player in the NHL. Here are Jonathan’s data for 4 months of that year.

   **Students’ Favourite Board Games**
<table>
<thead>
<tr>
<th>Game</th>
<th>Number of Girls</th>
<th>Number of Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monopoly</td>
<td>8</td>
<td>9</td>
</tr>
<tr>
<td>Scrabble</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>Life</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Clue</td>
<td>4</td>
<td>16</td>
</tr>
</tbody>
</table>

   **Precipitation**
<table>
<thead>
<tr>
<th>City</th>
<th>January</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlottetown</td>
<td>106 mm</td>
<td>86 mm</td>
</tr>
<tr>
<td>Fredericton</td>
<td>110 mm</td>
<td>87 mm</td>
</tr>
<tr>
<td>Halifax</td>
<td>134 mm</td>
<td>107 mm</td>
</tr>
<tr>
<td>St. John’s</td>
<td>150 mm</td>
<td>89 mm</td>
</tr>
</tbody>
</table>

   **Month**
<table>
<thead>
<tr>
<th>Goals</th>
<th>Assists</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>8</td>
</tr>
<tr>
<td>February</td>
<td>7</td>
</tr>
<tr>
<td>March</td>
<td>10</td>
</tr>
<tr>
<td>April</td>
<td>11</td>
</tr>
</tbody>
</table>

   **a)** Graph the data.
   **b)** In which month were Jonathan’s goals and assists equal?
       How does the graph show this?
   **c)** In which month did Jonathan score the fewest goals?
       How does the graph show this?
   **d)** Is Jonathan more likely to score a goal, or help another player score?
       Give reasons for your answer.
5. **a)** Draw a double bar graph to display these data.  
**b)** What do the table and graph show?  
**c)** Does every female grizzly bear have a mass of 200 kg? Explain your answer.  
**d)** Which has the greater mass: a male black bear or a female polar bear? How can you tell from the table? From the graph?  
**e)** Which bear has a mass that is one-half that of a male grizzly bear?  
**f)** Which bear has a mass that is three times that of a female grizzly bear?  
**g)** Write another question you can answer using the graph. Answer your question.

<table>
<thead>
<tr>
<th>Type of Bear</th>
<th>Mass of Female</th>
<th>Mass of Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Black bear</td>
<td>135 kg</td>
<td>275 kg</td>
</tr>
<tr>
<td>Grizzly bear</td>
<td>200 kg</td>
<td>400 kg</td>
</tr>
<tr>
<td>Polar bear</td>
<td>300 kg</td>
<td>600 kg</td>
</tr>
</tbody>
</table>

6. Do people with long arms also have long feet? Work with 3 classmates to complete part a. Complete parts b and c on your own.  
**a)** Measure each student’s arm length and foot length, to the nearest centimetre.  
**b)** Display the data on a double bar graph.  
**c)** Answer the question posed above. Use the graph to explain your answer. Show your work.

**When is it better to draw a double bar graph than two separate bar graphs?**

Find examples of double bar graphs in newspapers, magazines, and on the Internet. What is being compared in each graph? Why do you think a double bar graph was drawn?
How do you and your classmates compare to other students across Canada? You can find out on a Web site called *Census at School*. It provides data about students from age 8 to 18.

You can use questions from *Census at School* to collect first-hand data about your own classmates. Then, you can check the Web site for second-hand data about students from other parts of the country. You can even find out how students in other parts of the world answered the same questions.

Your teacher can register your class so you can complete a questionnaire online. The data from your class are then included with those already on the database.

Here are some of the questions you can answer.

- Do you have allergies?
- Which pets do you have?
- What is your favourite physical activity?
- How do you usually travel to school?
Suppose you select this question:
Are you right-handed, left-handed, or ambidextrous?
A table similar to that below appears.
From the table, we know that:
About 82 girls out of 100 girls in elementary school are right-handed.
About 12 boys out of 100 boys in elementary school are left-handed.

<table>
<thead>
<tr>
<th></th>
<th>Elementary</th>
<th>Secondary</th>
<th>All students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Girls</td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>Right-handed</td>
<td>82.12</td>
<td>75.47</td>
<td>83.25</td>
</tr>
<tr>
<td>Left-handed</td>
<td>7.55</td>
<td>11.81</td>
<td>8.17</td>
</tr>
<tr>
<td>Ambidextrous</td>
<td>10.33</td>
<td>12.72</td>
<td>8.58</td>
</tr>
</tbody>
</table>


- What else can you find out from this table?
- Draw a double bar graph to display the data for elementary school students. Remember to write each number to the closest whole number.

Visit the Census at School Web site.
- Select a topic that interests you. Print the data if you can.
- Write 3 questions you can answer using the data you find. Answer your questions.
- If the data are suitable, draw a double bar graph to display them. Write all that you know from the graph that you did not know from the table.
LESSON 4

The Language of Probability

Can you find a flower that talks? Is the month after June always July?

Some events are **impossible**. Some events are **certain**.

Events that could happen are **possible**.

---

**Explore**

Make a table with these headings.
Write 5 events under each heading.

<table>
<thead>
<tr>
<th>Impossible</th>
<th>Possible but Unlikely</th>
<th>Possible and Likely</th>
<th>Certain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Show and Share**

Share your events with another pair of students.
Do you agree about the likelihood of each event? Explain.
If an event is *likely* to happen, it is **probable**.
If an event is *unlikely* to happen, it is **improbable**.

Luis has these coins in his pocket.

<table>
<thead>
<tr>
<th>9 pennies</th>
<th>2 nickels</th>
<th>2 dimes</th>
</tr>
</thead>
</table>

One coin falls out.
How likely is it that this coin is:

- It is impossible for the coin to be a because Luis doesn’t have any quarters.
- It is likely that the coin is a because most of Luis’ coins are pennies.

The coin is *most likely* to be a .

- It is unlikely that the coin is a or a because Luis has only 2 of each coin.

The coin is *equally likely* to be a or a .

You can use a line to show how likely it is an event will happen.
1. Use the words “impossible,” “possible,” “certain,” “unlikely,” or “likely” to describe each event.

   a) It will snow tomorrow.
   b) You will have orange juice with your lunch today.
   c) You will see a whale next week.
   d) You will go camping in the spring.
   e) Tomorrow is Friday.
   f) The sun will rise tomorrow.

2. Describe each event.
   Use these words: impossible, unlikely, likely, certain
   a) Someone in your class will win a raffle.
   b) Someone in your class is 10 years old.
   c) It will rain tomorrow.
   d) You will attend the Carnaval de Québec next February.
   e) You will have math homework next Wednesday.

3. You will need a copy of this Venn diagram.
   a) Sort these events.
      A. A rock dropped into water will sink.
      B. You will be at school and at home at the same time.
      C. A bird will fly over your school today.
      D. An ice cube will be cold.
      E. A real goldfish will sing.
   b) Where did you put events that are impossible? Explain why.
   c) Write down 3 different events.
      Sort these events in the Venn diagram.
4. Roll a number cube until you get a 3.
   a) Keep a tally of how many rolls it takes.
   b) Which word describes how likely it is that a 3 will come up on the next roll: certain, possible, impossible? Explain.

5. Suppose you close your eyes, then pick one marble from this bag.
   Say which colour:
   a) You are likely to pick.
   b) You are unlikely to pick.
   c) You will never pick.

6. Draw a bag of marbles for which:
   a) Picking a pink marble is a likely event.
   b) Picking a green marble is an unlikely event.
   c) Picking an orange marble is possible.
   d) Picking a black marble is impossible.
   Explain how you chose the marbles you drew.

7. Suppose you put these counters in a bag.
   You take 1 counter from the bag without looking.
   Identify an event that is:
   a) possible   b) impossible   c) certain
   Explain how you identified each event.

Reflect

Which event is likely to happen at school today?
Which event is unlikely to happen at school today?
Explain your choices.

What are two likely events and two unlikely events that could happen at home this week?
How will you know what to wear when you leave the house tomorrow?

You cannot be certain of the weather. In each season, some weather conditions are more likely than others.

Your teacher will give you a spinner. Colour the spinner to match the colour name in each sector. You will need an open paper clip as a pointer, and a sharp pencil point to hold the pointer at the centre of the spinner.

When you spin the pointer, it will land on one of these sectors: blue, orange, pink, or green

➤ Which result is most likely?
➤ Which result is least likely?
➤ Are any results equally likely?

Spin the pointer 20 times. Record your results in a tally chart. How do your results compare with your predictions? If your results do not match your predictions, why do you think this happened?

**Show and Share**

Compare your results with those of another pair of students. Talk about your predictions and how you made them.
This spinner has 7 equal sectors. So, there are 7 possible outcomes when the pointer lands.

- One outcome that is *possible* is landing on 3.
  Other possible outcomes are landing on: 1, 2, 4, 5, 6, 7
- One outcome that is *impossible* is landing on 8.
  Other impossible outcomes are landing on: 9, 10, 11, 12, …

This spinner has 4 equal sectors.

The outcome that is *certain* is landing on 8.
There is no other possible outcome.

This spinner has 8 equal sectors.

- There are 2 sectors labelled A and 2 sectors labelled C.
  So, landing on A and landing on C are *equally likely*.
- There is 1 sector labelled D.
  So, landing on D is *less likely* than landing on A.
  Landing on D is also less likely than landing on B or on C.
- There are 3 sectors labelled B.
  So, landing on B is *more likely* than landing on C.
  Landing on B is also more likely than landing on A or on D.
1. This spinner is from a board game.
   The pointer is spun.
   a) Which colour is the pointer most likely to stop on?
      How do you know?
   b) It is equally likely that the pointer will stop on
      one of two colours.
      What are the two colours? How do you know?
   c) Write a statement about the pointer using
      the word “impossible.”

2. The pointer on each spinner is spun.
   How likely is the pointer to land on each colour:
   red, blue, green, orange, yellow?
   Use the words “less likely,” “equally likely,” or “more likely”.
   a) 
   b) 
   c) 

3. Your teacher will give you copies of blank spinners.
   Colour a spinner to match each statement below.
   a) landing on red is possible
   b) landing on blue is impossible
   c) landing on green is certain
   d) landing on green and landing on blue are equally likely
   e) landing on yellow is less likely than landing on pink
   f) landing on brown is more likely than landing on purple

4. Look at the spinners you coloured in question 3.
   Write another statement about one of the spinners that uses each word
   or phrase below.
   a) possible
   b) impossible
   c) less likely
   d) equally likely
   e) more likely
5. The pointer on this spinner is spun.
   a) What are the possible outcomes?
   b) Compare the likelihoods of the outcomes.
      Use the words “more likely,” “equally likely,” or “less likely.”

6. Alex and Rebecca spin the pointer on this spinner.
   Alex gets a point if the pointer lands on an even number.
   Rebecca gets a point if it lands on an odd number.
   Each person spins the pointer 20 times.
   The person with more points wins.
   Who is more likely to win? How do you know?

7. Anna and Nicolas disagree on the likelihoods of where the pointer will land.
   Anna thinks that the pointer landing on 2 is more likely because it has two spaces on the spinner.
   Nicolas thinks that the pointer landing on 1 is more likely than the pointer landing on any other number.
   Who is correct? Why?

Reflect

Suppose you have a spinner with equal sectors and different colours.
What do you know about the likelihood of landing on each colour?
Use words, pictures, or numbers to explain.
You will need a paper bag and counters. Put 1 yellow, 2 blue, 2 green, and 7 red counters in a bag.

➤ Suppose you took out 1 counter, without looking. Is each outcome below impossible, unlikely, likely, or certain? Explain. Which outcomes are equally likely? Explain.
A. The counter is blue.
B. The counter is green.
C. The counter is yellow.
D. The counter is red.
E. The counter is orange.

➤ Without looking, take 1 counter from the bag. Record the colour in a tally chart like this: Replace the counter and shake the bag. Do this 50 times. Explain your results.

Show and Share

Share your results with another pair of classmates. How do your results compare with theirs? Are the results the same? Should the results be the same? Explain.
Taking a counter from a bag is an experiment.

Suzanne and Marius conduct this experiment:
Suzanne puts these tiles in a paper bag:
6 red, 2 black, 1 yellow, and 1 blue
Without looking, Marius takes a tile from the bag.
Suzanne records the colour of the tile in a tally chart.
Marius returns the tile to the bag.
This experiment was conducted 100 times.

<table>
<thead>
<tr>
<th>Colour of Tile</th>
<th>Tally</th>
<th>Number of Tiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>■■■■■■■■■■</td>
<td>62</td>
</tr>
<tr>
<td>Black</td>
<td>■■■■■■</td>
<td>18</td>
</tr>
<tr>
<td>Yellow</td>
<td>■■■■■□□□□</td>
<td>9</td>
</tr>
<tr>
<td>Blue</td>
<td>■■■■■□□□□</td>
<td>11</td>
</tr>
</tbody>
</table>

- Six of the 10 tiles are red.
  So, it is more likely that a ■ is taken.
  The results show this.
  62 ■ were taken. Only 18 ■ were taken.
- Only 1 tile is yellow.
  So, it is less likely that a □ is taken.
  The results show this.
  Only 9 □ were taken compared with 62 ■ and 18 ■.
- There is 1 yellow tile and 1 blue tile.
  So, taking a □ and taking a □ are equally likely.
  The results show this.
  The numbers of □ and □ are very close: 9 and 11, respectively.
- All the tiles are coloured.
  So, it is certain that a coloured tile is taken.
  The results show this. All 100 tiles taken were coloured.
- There are no □ in the bag.
  So, it is impossible to take a □.
  The results show this.
  No green tiles were taken.
1. **a)** Suppose you toss a coin.  
Which outcome is more likely: heads or tails?  
**b)** Toss a coin 40 times. 
Record your results in a tally chart.  

<table>
<thead>
<tr>
<th></th>
<th>Tally</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tails</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

c) How do your results compare to your answer to part a? Explain.

2. Work with a partner.  
Roll a number cube 30 times.  
Record the result of each roll in a tally chart.  
Use your results and one of these words: likely, unlikely, impossible, certain  
Describe the likelihood of each event.  
**a)** rolling a 6  
**b)** rolling a 7  
**c)** rolling a number from 1 to 6  
**d)** rolling a number greater than 2

<table>
<thead>
<tr>
<th>Number</th>
<th>Tally</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. Work with a partner.  
Place 5 red tiles and 1 yellow tile in a paper bag.  
Take turns taking a tile from the bag and replacing it.  
Record your results.  
Do this 30 times.  
**a)** Which colour tile is more likely to be taken?  
Do your results match your answer? Explain.  
**b)** Which colour tile is less likely to be taken?  
Do your results match your answer? Explain.  
**c)** Which colour tile will never be taken?  
Explain how your results confirm your answer.
For each of questions 4 to 6, answer this question: 
Who is more likely to win the game? 
Use likelihoods to explain how you know.

4. The pointer is spun. 
   Player A gets a point if the pointer lands on an even number. 
   Player B gets a point if the pointer lands on an odd number.

5. The pointer is spun. 
   Player A gets a point if the pointer lands on $\bullet$. 
   Player B gets a point if the pointer lands on $\circ$.

6. A number cube labelled 1 to 6 is rolled. 
   Player A gets a point if 1 or 2 shows. 
   Player B gets a point if 3, 4, 5, or 6 shows.

7. Which spinner most likely has these results after 100 spins? 
   60 blue and 40 red 
   Explain your thinking.

Suppose you and a friend plan to toss a coin. 
Your friend says that she nearly always tosses heads. 
What would you say?
You will need an envelope, 10 red paper clips, and 10 green paper clips.

Take turns to design an experiment to get one of the results below. You have to decide how many paper clips of each colour to put in the envelope.

Result A: removing a $\text{red}$ is less likely than removing a $\text{green}$.
Result B: removing a $\text{red}$ is more likely than removing a $\text{green}$.
Result C: removing a $\text{red}$ and removing a $\text{green}$ are equally likely.

Conduct all three experiments. For each experiment, remove a paper clip from the envelope and replace it 20 times. Record your results.

Did each experiment turn out the way you expected? Explain.

**Show and Share**

Compare your experiments with those of another group of students. How are the experiments for Result A the same? How are they different? Repeat this comparison for Result B, then Result C. Suppose you conducted the other group’s experiments. Do you think your results would have been the same? Explain.
Sue and Tim were designing experiments with 2 colours of tiles in a paper bag. Sue designed an experiment where taking a blue tile was more likely than taking a red tile. Sue put 2 red tiles and 8 blue tiles in the bag.

Tim took a tile, recorded its colour, then returned the tile to the bag. Here are the results.

Tim took a blue tile more often than he took a red tile. The experiment turned out the way Sue expected.

---

1. Your teacher will give you 3 copies of a large spinner. Design, then colour each spinner so that:
   a) Landing on red is less likely than landing on green.
   b) Landing on red and landing on green are equally likely.
   c) Landing on red is more likely than landing on green.
   Explain why you coloured each spinner the way you did.

2. You will need an open paper clip as a pointer and a sharp pencil point to hold it in place. For each spinner in question 1, conduct an experiment to check that the spinner you coloured works the way you expected. How many times do you think you should spin each pointer? Explain your answer.

3. You will need coloured counters and a paper bag. Suppose you take one counter from the bag without looking. Design one experiment so that:
   • You are unlikely to take a green counter.
   • You are likely to take a blue counter.
   • Taking a red counter is impossible.
   a) How many counters of each colour did you put in the bag?
   b) Explain why you chose the counters you did.
4. Conduct the experiment you designed for question 3. Did the experiment give you the results you expected? Explain.

5. Suppose you have number cards from 1 to 20 and a paper bag. An experiment is taking a number from the bag without looking. Design each experiment:
   a) Taking an even number and taking an odd number are equally likely.
   b) Taking an odd number is more likely than taking an even number.
   c) Taking a number from 1 to 10 is more likely than taking a number from 11 to 20.
   d) Taking number 13 is impossible.
   Conduct each experiment to check that it works the way you expect. Write about how you designed each experiment and how well it worked.

6. Fatima is playing this game for the first time. She throws a dart at the target.
   a) Is it likely Fatima will hit the bull's-eye? Explain your answer.
   b) Explain why hitting white and hitting red are not equally likely.
   c) Design a target so that hitting red and hitting white are equally likely.

7. Design a spinner so that when the pointer is spun:
   • Landing on red is most likely.
   • Landing on blue is impossible.
   • Landing on green and landing on yellow are equally likely.
   • Landing on purple is least likely.
   Explain your work.

Reflect

Did your probability experiments always turn out the way you expected? Explain.
Include examples in your explanation.
You will need 2 number cubes each labelled 1 to 6.

➤ Take turns to roll the number cubes.

➤ Find the sum of the 2 numbers rolled.
   If the sum is even, you score a point.
   If the sum is odd, your partner scores a point.

➤ Record the results in a table.

➤ The first player to score 20 points wins.

➤ Who do you think will have more points after 36 turns?
   Explain.

➤ List the outcomes of the game.

➤ Which is more likely: an even sum or an odd sum?
   Or, are these sums equally likely?
   How do you know?
Arlo did an experiment. He used a spinner with green, yellow, red, and blue parts. Here are his results.

What might Arlo’s spinner look like?

**Show and Share**

Describe the strategy you used to solve this problem.

Jolanta did a spinner experiment. Here are her results. What might her spinner look like?

What do you know?
- The spinner has 2 colours: green and yellow.
- The pointer landed on green 18 times and yellow 12 times.

Think of a strategy to help you solve the problem.
- You could **work backward**.
- Use the results to draw the spinner.
How are the numbers in the tally chart related?
How many congruent parts of the spinner are yellow? How many are green?
Draw the spinner.

How many different spinners can you draw?

1. Sketch the spinner that likely gave each set of data.

   a) 
   
   b) 

2. The numbers 1, 2, 3, and 4 were written on the faces of an object.
The object was rolled 40 times.
The results are in the tally chart.
Name the object you think was used.
Explain your choice.

How does working backward help to solve a problem?
Use words and numbers to explain.
1. Tell whether you would use first-hand or second-hand data to answer the following questions:
   a) Do your friends prefer to read fiction or non-fiction books?
   b) Do more Canadians live in cities or outside cities?
   c) How many people in British Columbia speak Cantonese at home?
   d) How many people in Manitoba speak French?
   e) Which movies are most popular with the students in your class?

2. This table shows some students’ favourite hiking snacks.
   a) How many students were surveyed?
   b) Draw a double bar graph to display these data.
   c) Make comparisons between the data sets. Write as many as you can.
   d) What can you tell more easily from the graph than the table?

<table>
<thead>
<tr>
<th>Snack</th>
<th>Number of Grade 5 Students</th>
<th>Number of Grade 6 Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Granola bar</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Nuts</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>Pretzels</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Dried fruit</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

3. Use the words “likely,” “unlikely,” “impossible,” “possible,” or “certain” to describe each event.
   a) It will rain tomorrow.
   b) You will be in school this afternoon.
   c) You will go canoeing in January.
   d) You will travel to the moon in the future.

4. Each letter of the word PEPPER is written on a card. The cards are shuffled. One card is picked without looking.
   a) Which letter is most likely to be picked?
   b) Which letter is least likely to be picked?
   c) Which letter is impossible to pick?
   d) Are any two letters equally likely to be picked? How do you know?
5. The pointer on this spinner is spun. Compare the likelihoods of landing on the letters. Use any of the words: less likely, equally likely, more likely.

6. Suppose you took one marble from this bag without looking. Is each outcome below impossible, unlikely, likely, or certain?
   a) The marble is green.
   b) The marble is blue.
   c) The marble is red.
   d) The marble is yellow.

7. Work with a partner. Place tiles in a paper bag to match the marble colours in question 6. Take turns removing a tile from the bag and replacing it. Record your results. Do this 30 times. Do your results confirm your answers to question 6? Explain how you know.

8. Suppose you have a paper bag and coloured tiles. You take one tile from the bag without looking, then replace it. Design one experiment so that:
   • You are more likely to take a red tile than a yellow tile.
   • Taking a blue tile is impossible.
   • Taking a red tile and taking a green tile are equally likely.
   a) Tell how many tiles of each colour you would place in the bag.
   b) Explain why you chose the tiles you did.

9. Conduct the experiment you designed for question 8. Did the experiment give you the results you expected? Explain.
Look at this table of weather data. Are these first-hand or second-hand data?

<table>
<thead>
<tr>
<th>Precipitation</th>
<th>Iqaluit, Nunavut</th>
<th>Vancouver, B.C.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average January rainfall</td>
<td>0.1 mm</td>
<td>139.1 mm</td>
</tr>
<tr>
<td>Average January snowfall</td>
<td>228.0 mm</td>
<td>166.0 mm</td>
</tr>
<tr>
<td>Average July rainfall</td>
<td>59.2 mm</td>
<td>39.6 mm</td>
</tr>
<tr>
<td>Average July snowfall</td>
<td>1.0 mm</td>
<td>0</td>
</tr>
</tbody>
</table>

**Part A**

Use the data to draw a double bar graph on 1-cm grid paper. Your graph should compare Iqaluit and Vancouver. It should show the January rainfall, January snowfall, July rainfall, and July snowfall in each place.

Write each measurement to the closest millimetre before you graph the data.
Part B
Use your graph to help answer these questions.

- Is a rainy January day likely, unlikely, or impossible in Iqaluit? In Vancouver?
- Where are you more likely to have a rainy day in July?
- Where are you more likely to have a snowy day in July?
- Is a snowy July day in Vancouver impossible? Explain your answer.
- What else do you know from looking at your graph?

Part C
Find weather data for two other Canadian cities.
Repeat Parts A and B for the two cities.
Fold 2 pieces of paper into 4 sections.
For each city, draw a picture to show January and July weather that is likely and unlikely in each place.

Reflect on Your Learning
How does what you learned in this unit relate to your life outside school? Give examples.
Learning Goals

• translate, reflect, and rotate a shape
• draw and describe images after transformations
• identify a transformation
Look at the map of the amusement park.

• What rides do you see?
• How do people move on each ride?
• What is your favourite ride at an amusement park? How do you move on that ride?
Translations

You will need Pattern Blocks, dot paper, and a ruler.

➤ Choose a Pattern Block.
Place it on the dot paper.
Trace the block.
Slide the block in a straight line, in any direction.
Do not turn the block.
Use a ruler if it helps.
Trace the block in its new position.
How do the two positions of the block compare?

➤ Take turns to move a block and describe how its two positions compare.

Which other ways do people or objects slide?
**Show and Share**

Compare drawings with another pair of classmates.
How do the original shape and the shape in its new position compare?

When a shape moves along a straight line, without turning, it is *translated* from one position to another. The movement is a *translation* or a *slide*.

When we draw the shape in its new position, we draw a *translation image* of the shape.

The translation is described by the numbers of squares moved right or left and up or down. The translation below is:
5 squares right and 4 squares down.

If we cannot translate the shape, we trace the shape, then translate the tracing.

The *translation arrow* shows how the shape moved. The arrow joins matching points on the shape and its image.

A shape and its translation image have the same orientation; that is, they face the same way.
1. Copy each shape on grid paper. Use tracing paper. Translate the shape using the given translation. Draw the image and a translation arrow. Describe the position and orientation of the image.
   a) 7 squares left and 3 squares up
   b) 5 squares right and 4 squares down
   c) 3 squares left and 6 squares down

2. Does each picture show a translation? How do you know? If a picture does show a translation, describe it.
   a) 
   b) 
   c) 
   d) 

3. Write the translation that moved each shape to its image.
   a) 
   b) 
   c)
4. a) Draw this shape on grid paper.
   Predict where the image will be after this translation:
   3 squares left and 5 squares up
   Draw the image to check your prediction.

   b) Draw the shape again.
   Predict where the image will be after this translation:
   5 squares left and 3 squares up
   Draw the image to check your prediction.

5. Draw a shape on dot paper.
   Translate the shape in any direction.
   Draw its image.
   Record the translation.
   Describe the position and orientation of the image.

6. Draw two identical shapes in two different places on grid paper.
   Make sure the shapes have the same orientation.
   Label one shape “Image” and the other “Shape.”
   Which translation will move the shape to its image?

7. Copy these shapes on grid paper.

   a) Describe which translation moves Shape A to Shape B.
   b) Describe which translation moves Shape B to Shape A.

   **Reflect**

   Use grid paper.
   Draw a shape and its translation image.
   Explain how you know your picture shows a translation.
The hare and the tortoise had a race.
The race was 5 times around the running track.
The hare ran 4 times around in 1 h,
then stopped for a rest.
The tortoise did not stop.
She took 1 h to go once around the track.
The hare woke up after 4 h.
Who won the race?

Show and Share

Explain how you solved the problem.

A snail is at the bottom of a well.
It climbs 2 m every day, but it slides back 1 m at night.
The well is 6 m deep.
How many days does it take the snail to get out of the well?

What do you know?
- Each day, the snail climbs 2 m up the well.
- Each night, the snail slides back 1 m.
- The snail has to climb 6 m to get out.

Think of a strategy to help you solve the problem.
- You can draw a picture.
- Show where the snail is each day.

Strategies

- Make a table.
- Use a model.
- Draw a picture.
- Solve a simpler problem.
- Work backward.
- Guess and test.
- Make an organized list.
- Use a pattern.
Use grid paper to record how far the snail moves. Use a different colour for each day. Count the days when the snail reaches the top of the well. When does the snail get out of the well?

Write a similar problem. Have a classmate solve your problem.

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**Practice**

1. Shannon is shorter than Bruce. Olivia is shorter than Alex but taller than Bruce. Who is the tallest? Shortest?

2. Hannah and Liam are using a compass. They move 30 m north, then 30 m west, and then 30 m south. Which direction do Hannah and Liam go to get back to where they started? How far must they go?

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**Strategies**

Choose one of the

---

**Reflect**

How does drawing a picture help you to solve a problem?
A reflection can be used to make an interesting picture.
Is this person floating above the ground?
Where else do you see reflections?

You will need Pattern Blocks, dot paper, a ruler, and a Mira.

➤ Draw a line through the centre of the dot paper. Place a Mira on this line.

➤ Place a block on one side of the line. Your partner places her block on the image she sees in the Mira.

➤ Take turns to place one block, then another block on its image. Each time, describe the position and orientation of the image.
Take turns to draw around a block and its image.
Draw around blocks that touch the Mira line.
Draw around blocks that cross the Mira line.
In each case, how does the shape compare with its image?

Show and Share

Compare your pictures with those of another pair of classmates.
How is each shape and its image placed with respect to the Mira line?

When a shape is reflected in a mirror, we see a reflection image.
The line segment that joins a point to its image is perpendicular to the line of reflection.
A point and its image are the same distance from the line of reflection.
A shape and its reflection image have opposite orientations; that is, they face opposite ways.
A reflection is sometimes called a flip.
When a shape is reflected, it is flipped over.

Your World

Many patterns and designs show a shape and its reflection images.
Identify a shape and its reflection images in this design.
Where are the lines of reflection?
Use a Mira when it helps.

1. Copy each shape and line of reflection on grid paper.
   Draw each reflection image.
   Describe the position and orientation of the image.
   a)  
   ![Line of reflection](image)
   b)  
   ![Line of reflection](image)
   c)  
   ![Line of reflection](image)
   d)  
   ![Line of reflection](image)

2. Which pictures show a reflection? How do you know?
   Describe where the line of reflection is.
   a)  
   ![Image](image)
   b)  
   ![Image](image)
   c)  
   ![Image](image)

3. In question 2, do any pictures show a translation?
   If so, describe the translation.

4. Each picture shows a shape and its reflection image.
   a)  
   ![Image](image)
   b)  
   ![Image](image)

   Copy each picture on grid paper.
   Draw the line of reflection. Explain how you did this.
   How do you know the line of reflection is drawn correctly?
5. Copy each shape and line of reflection on dot paper. Predict where each reflection image will be. Draw each image to check your prediction.

a)

b)

6. Print the letters of the alphabet as capital letters.
   a) Draw a horizontal line above each letter. Place a Mira on the line. Which letters look the same in the Mira?
   b) Draw a vertical line beside each letter. Place a Mira on the line. Which letters look the same in the Mira?
   c) Create three words whose images read the same as the words when a Mira is placed above the letters.

7. Draw a shape on dot paper. Draw and label a line of reflection. Draw the image of the shape in the line of reflection.
   a) Use a ruler. Join two matching points on the shape and its image.
   b) Use a ruler. Measure the distance between each point and the line of reflection. What do you notice?
   c) What do you notice about the angle between the line you drew in part a and the line of reflection? Show your work. Explain your thinking.

Reflect

How are a translation and a reflection alike? Draw a shape and its image that could show both a reflection and a translation.
A bicycle wheel turns about the centre of the wheel.

What other examples are there of things that turn? Explain how they turn.

You will need several pieces of paper, tracing paper, a ruler, a compass, and scissors.

➤ Use a ruler.
   Draw a shape with straight sides in the centre of a piece of paper.

➤ Use tracing paper.
   Draw an identical shape on another piece of paper.
   Cut out this shape.
   Place it on top of the first shape you drew.

➤ Put your compass point at one vertex.
   Turn the shape to a new position.
   Draw the shape in its new position.
   Label this shape Image A.

➤ Return your shape to its original position.
   Turn the shape in the opposite direction.
   Draw the shape in its new position.
   Label this shape Image B.

➤ In each case, how do the positions of the original shape and its image compare?
Show and Share

Compare your picture and ideas with another pair of classmates. Did you have the same ideas about how a shape compares with its image after a rotation? Explain.

When a shape turns about a point, it is rotated from one position to another.

The movement is a rotation, or turn. When we draw the shape in its new position, we draw a rotation image of the shape.

After 1 complete turn, a shape is back to where it started.

When the minute hand on a clock moves from 12 to 3, it moves a quarter turn. When the minute hand moves from 12 to 6, it moves a half turn. When the minute hand moves from 12 to 9, it moves a three-quarter turn.

A shape can rotate clockwise about a vertex V:

A shape can rotate counterclockwise about a vertex V:
Any turn less than 1 complete turn is a fraction of a turn clockwise or counterclockwise.

This shape has rotated a $\frac{1}{4}$ turn clockwise, about vertex A. This point is called the point of rotation.

This shape has rotated a $\frac{1}{4}$ turn counterclockwise, about vertex B.

A rotation is described by:

- the direction of the turn (clockwise or counterclockwise),
- the fraction of the turn, and
- the point of rotation

A shape and its rotation image have different orientations. The shape and its image face different ways for any rotation that is less than 1 complete turn.

A reflection, a rotation, and a translation are transformations.

Practice

1. Copy each shape below on grid paper. For each shape:
   - Rotate the shape about vertex V, using the rotation given.
   - Draw the rotation image.
   - Describe the position and orientation of the image.
   a) a $\frac{1}{4}$ turn counterclockwise
   b) a $\frac{1}{2}$ turn clockwise
   c) a $\frac{3}{4}$ turn clockwise
2. Each picture below shows a shape and its rotation image. Describe the rotation. Include the direction of the turn.

a) ![Shape and Image Diagram]

b) ![Shape and Image Diagram]

3. Which pictures show a rotation? How do you know? Describe the rotation.

a) ![Shape and Image Diagram]

b) ![Shape and Image Diagram]

c) ![Shape and Image Diagram]

d) ![Shape and Image Diagram]

4. Did any of the pictures in question 3 show a translation? A reflection? If so, identify the picture and describe the transformation.

5. Copy this shape.
Trace the shape on tracing paper.
Use the tracing to rotate the shape.
Predict the position of the image after each rotation below.
Draw each image to check your prediction.

a) a $\frac{1}{4}$ turn clockwise about vertex A

b) a $\frac{3}{4}$ turn counterclockwise about vertex A
6. Copy this shape.
   Use tracing paper to rotate the shape:
   a) a \(\frac{1}{2}\) turn clockwise about vertex E
   b) a \(\frac{1}{2}\) turn counterclockwise about vertex E
What do you notice about the rotation images?

7. Copy this shape on grid paper.
   a) Rotate the shape about a vertex.
      Describe the direction of the turn, the fraction of the turn, and the point of rotation.
      Draw the image.
   b) Repeat part a for a different direction.
   c) Repeat part a for a different fraction.
   d) Repeat part a for a different point of rotation.
      Show your work.

8. Describe the transformation that moves the shape to each image.
   Can you describe any movements in more than one way? Explain.
   a) Image A
   b) Image B
   c) Image C
   d) Image D

---

Reflect

When you see a shape and its image, how do you know if they show a reflection, a rotation, or a translation?
Use diagrams to explain.

Look for an example of each transformation. Describe each transformation and explain how you identified it.
A shape can rotate about a point of rotation that is not on the shape.

**Explore**

You will need grid paper, Pattern Blocks, and a ruler.

- A blue Pattern Block was placed on grid paper and traced. The block was rotated about point O and traced again. Describe different ways the block could have moved. Tell about the fraction of the turn, the direction, and the point of rotation. How do the shape and its image compare?

- Trace the blue Pattern Block on grid paper as shown. Extend one side and mark this endpoint O. Use point O as the point of rotation. Choose clockwise or counterclockwise. Rotate the block a \( \frac{1}{2} \) turn about point O. Trace its new position.

**Show and Share**

Exchange your tracings with a pair of students who rotated their block in the direction opposite to yours. What do you notice? Explain.
We can use tracing paper to find the image when we rotate a shape.

• Place the tracing paper so the bottom right corner is on point P.
• Trace the shape.
• Hold the tracing paper in place with your pencil at point P. Rotate the tracing paper a $\frac{1}{4}$ turn clockwise.
• Note the position of the image of the shape.
• Lift the tracing paper and draw the image in place. Label the image.

We can predict the position of the image formed when we rotate a shape. Visualize the shape as a flag whose pole joins any vertex to the point of rotation. The pole rotates, but its length does not change.

Use tracing paper when needed.

1. Copy each rectangle and point P on grid paper.
   Draw each image after a $\frac{1}{4}$ turn clockwise about point P.

   a) 
   b)
2. Copy each trapezoid and point P on grid paper. Draw each image after a $\frac{1}{2}$ turn clockwise about P.

3. Describe each rotation. Include:
   - the fraction of the turn
   - the point of rotation
   - the direction

4. Copy this trapezoid and point O on grid paper.
   a) Draw the image after a $\frac{1}{4}$ turn clockwise about point O.
   b) Draw the image after a $\frac{1}{2}$ turn counterclockwise about point O.
   c) How can you tell if you have drawn the correct images?

5. Draw a quadrilateral on grid paper. Choose a point outside the quadrilateral. Rotate the quadrilateral about the point you chose. Draw its rotation image. Describe the rotation.

Reflect
When you see a shape and its rotation image, how can you tell if the point of rotation is on or off the shape?
Use dynamic geometry software.
Open a new sketch.
Check that the distance units are centimetres.
Display a grid.

**Translating a Shape**

Construct a rectangle. Select the rectangle.
Translate the rectangle 4 squares left and 2 squares down.
Print the rectangle and its translation image.

**Reflecting a Shape**

Construct a triangle.
Select one side of the triangle as the line of reflection.
Select the triangle. Reflect it in the line of reflection.
Print the triangle and its reflection image.

**Rotating a Shape**

Construct a parallelogram.
Select a vertex of the parallelogram as the point of rotation.
Select the parallelogram. Rotate it a \( \frac{1}{4} \) turn counterclockwise.
Print the parallelogram and its rotation image.

**Identifying Rotations**

Work with a partner. Take turns.

- Construct a shape on the grid.
  - Choose a rotation and construct the rotation image.
  - Print the picture.
  - Have your partner identify the rotation.
  - Remind her to include:
    - the point of rotation
    - the fraction of the turn
    - the direction of the turn

- Repeat the steps above for different points of rotation, different fractions of a turn, and different directions.

If you need help at any time, use the Help menu.
Predicting the Image

Work with a partner.
Take turns.

➤ Construct a shape on the grid.
  Print the shape.
  Choose a translation.
  Tell your partner what it is.
  Have your partner predict where
  the translation image will be.
  Translate the shape
  and draw its image.
  Print the shape and its image to verify
  your partner’s prediction.

➤ Repeat the steps above for a reflection.

➤ Repeat the steps above for a rotation.

Identifying a Transformation

Work with a partner.
Take turns.

➤ Choose a transformation.
  Construct a shape and its image.
  Have your partner look at the screen and
  identify the transformation.

➤ Repeat the steps above for different
  transformations and different shapes.

Reflect

How does each shape and its image compare?
Do the comparisons match those you made from pictures
you drew in earlier lessons? Explain your ideas.
1. Copy the shape on grid paper.
   a) Translate the shape in any direction you like.
      Draw its translation image.
   b) Draw a line of reflection.
      Draw the reflection image.
   c) Choose a point of rotation and a fraction of a turn.
      Rotate the shape and draw its rotation image.
   d) Describe the position and orientation of each image in parts a, b, and c.
      How does each description help you identify the transformation?

2. Draw a shape on grid paper.
   a) Translate the shape any way you like.
      Draw its translation image.
      Record the translation.
      Include each direction and the number of squares moved.
   b) Reflect the shape.
      Draw its reflection image.
      Label the line of reflection.
      Find how far the shape and its image are from this line.
   c) Rotate the shape.
      Draw its rotation image.
      Describe the rotation.
      Include the direction of the turn, the fraction of the turn, and the point of rotation.

3. Describe a transformation that would move shape A to each image.
   a) Image B  b) Image C  c) Image D  d) Image E
4. Describe the translation that moves:
   a) Shape B to Image A
   b) Shape D to Image C

5. In question 4, which other transformation would move each shape to its image?

6. Copy this shape on grid paper. Predict the position of the image after each transformation below. Draw each image to check your prediction.
   a) a reflection in the line of reflection
   b) a translation 3 squares right and 4 squares up
   c) a $\frac{1}{4}$ turn counterclockwise about O

7. Copy this triangle and point O on grid paper. Draw the image after a $\frac{1}{4}$ turn clockwise about O.

8. Describe the transformation that moves the shape to its image.
Design a ride for an amusement park.
The ride must move people in at least 2 different ways.
Your work should show
✓ how you designed a ride
✓ a clear presentation of your ride
✓ an explanation of how the ride moves
✓ how you used geometric language to describe your work

Check List

What did you learn about how shapes can move?
Use words and pictures to explain.

Think about how you will present your ride to the class.

Will you
– make a drawing?
– make a model?
– write about it?
– talk about it?

How does your ride move people in at least 2 different ways?

Moves up and down.
Part 1
Dinosaurs were first discovered in England in 1824. Since then, many dinosaur fossils have been found in Western Canada. Some dinosaurs, such as the Edmontosaurus and the Columbosaurus have been named after a Canadian city or province.

- Use books, magazines, or the Internet to learn which dinosaurs have been found in each province or territory of Canada. Record your findings in a table, chart, or on a map.

Great care is taken when fossils are excavated to avoid breaking the remains. The location of a fossil find is important, so a region is often searched systematically, using a grid.

Part 2
Play Dinomaze with a partner. This game uses dinosaurs as obstacles, and number cubes to determine a translation. You will need a copy of the game board, a red number cube and a green number cube, and 2 different coloured counters.
Rules:
• Each player rolls a number cube.
  The player who rolls the greater number starts.
• Take turns to roll both cubes.
  The green cube tells how many squares to move right or left.
  The red cube tells how many squares to move up or down.
• You must always move horizontally first, and then vertically.
• A dinosaur square is an obstacle.
  You cannot cross a dinosaur square, or land on it.
• If you cannot move in one direction, you must move in the opposite
direction if it is possible. If you cannot move, you miss that turn.
• Both players cannot be on the same square at the same time.
  The only exception to this is the START square.
• The winner is the first player to land on the END square.

Play the game several times.
• Which strategies did you use to help you win?
• Which series of translations would take you
to the END in 6 turns or fewer?
• Which series of translations would take you
to the END in the fewest turns?

Take It Further
Use grid paper.
Design your own Dinomaze game.
You may choose a different shaped game board,
or use spinners instead of number cubes.
1. Use a variable. Write an expression for each number pattern. Write the next 5 terms in each pattern. Explain how you know the expressions and terms are correct.

   a) 9, 10, 11, 12, 13, …
   b) 28, 27, 26, 25, 24, …

2. These data show how the population of Nunavut changed in 5 years. Use these data to predict the population of Nunavut in 2007. Explain your strategy for predicting. If possible, use the Internet to find the population of Nunavut in 2007. How close was your prediction?

<table>
<thead>
<tr>
<th>Year</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>28 700</td>
</tr>
<tr>
<td>2003</td>
<td>29 200</td>
</tr>
<tr>
<td>2004</td>
<td>29 600</td>
</tr>
<tr>
<td>2005</td>
<td>30 000</td>
</tr>
<tr>
<td>2006</td>
<td>30 800</td>
</tr>
</tbody>
</table>

3. How can you use multiplying by 10 to find $9 \times 8$?

4. Find each product or quotient. Which strategy did you use each time?
   a) $4 \times 600$
   b) $30 \times 20$
   c) $10 \times 300$
   d) $132 \div 3$
   e) $27 \times 68$
   f) $357 \div 8$
   g) $74 \times 55$
   h) $919 \div 7$

5. Give 3 examples of items you would measure in millimetres.

6. A rectangle has area 40 cm$^2$. Sketch and label all possible rectangles with side lengths that are whole numbers of centimetres. Describe the rectangle with the greatest perimeter. Describe the rectangle with the least perimeter.

7. Provide a referent for each unit of measure. Explain your choice.
   a) one cubic centimetre
   b) one cubic metre
   c) one litre
   d) one millilitre

8. Make the object at the right with centimetre cubes. Find its volume.

9. Use 36 centimetre cubes. How many different rectangular prisms can you make? How do you know you have made all possible prisms?
10. Use a number line to order these fractions from least to greatest.
\[
\frac{11}{12}, \quad \frac{1}{6}, \quad \frac{3}{4}, \quad \frac{7}{12}, \quad \frac{2}{3}
\]

11. Which other strategies could you have used to order the fractions in question 10? Use one of the strategies you name to check the order in question 10.

12. Write each decimal as a fraction.
   a) 0.3   b) 0.42   c) 0.535   d) 0.06

13. Write each fraction as a decimal.
   a) \(\frac{21}{100}\)   b) \(\frac{21}{1000}\)   c) \(\frac{9}{10}\)   d) \(\frac{90}{1000}\)

14. Order these decimals from greatest to least.
   1.325, 1.32, 1.235, 1.5, 1.253, 1.352
   Which strategy did you use?

15. a) Name as many shapes as you can that have some perpendicular sides.
    b) Use dot paper. Draw each shape you name.

   a) How are the quadrilaterals alike?
      How are they different?
   b) Choose a sorting rule. Sort the quadrilaterals.
      Record your sorting.
   c) Trade sortings with a classmate.
      List the attributes of each quadrilateral.
      Identify your classmate’s sorting rule.

17. Use triangular or square dot paper.
    Look at a rectangular prism.
    Draw the prism on dot paper.
    Label each vertex of the prism.
    Identify edges that:
   a) are parallel   b) intersect   c) are perpendicular
   d) are vertical   e) are horizontal
18. Look at the prism you drew in question 17. Identify faces that:
   a) are parallel  
   b) intersect  
   c) are perpendicular  
   d) are vertical  
   e) are horizontal

19. Tell whether you would use first-hand data or second-hand data to answer each question. Explain each choice.
   a) Which pop group or singer is the most popular with Grade 5 students in Canada?
   b) How tall is each member of your family?
   c) How many pets does each student in your class have?
   d) Which territory has the greatest area?

20. One hundred boys and 100 girls were asked: “What is your favourite subject?”
     The data are shown at the right.
     a) Draw a double bar graph.
     b) Write 3 questions you could answer using the graph.
     c) Trade questions with a classmate. Answer your classmate’s questions.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Number of Boys</th>
<th>Number of Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Computers</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>English</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>French</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Math</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>Music</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>PE</td>
<td>44</td>
<td>26</td>
</tr>
<tr>
<td>Science</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Social studies</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>6</td>
</tr>
</tbody>
</table>

21. The pointer on this spinner is spun.
   a) Which outcomes are equally likely?
   b) Name two outcomes where one outcome is more likely than the other. Name as many pairs of outcomes as you can.
   c) Name two outcomes where one outcome is less likely than the other. Name as many pairs of outcomes as you can.
22. Use the spinner in question 21.
   Name an outcome that is:
   a) possible  b) certain  c) impossible

23. Use dot paper.
   Draw a quadrilateral.
   a) Draw the translation image of the quadrilateral
     after the translation:
     7 squares left and 3 squares up
   b) Draw a slanted line of reflection.
     Draw the reflection image of the quadrilateral.
   c) Choose a vertex as the point of rotation.
     Draw the rotation image of the quadrilateral
     after a $\frac{1}{4}$-turn counterclockwise.
   d) Describe the position and orientation of each
     image in parts a to c.

24. You will need 3 pieces of grid paper.
   a) Copy the shape at the right.
      Choose a translation.
      Draw the translation image.
   b) Copy the shape at the right.
      Choose a line of reflection.
      Draw the reflection image.
   c) Copy the shape at the right.
      Choose a point of rotation,
      a fraction of a turn,
      and the direction for the rotation.
      Draw the rotation image.
   d) Make sure that only the original shape and its images
      appear on your drawings.
      Trade drawings with a classmate.
      Identify each transformation.
      Justify your answers.
a.m.: A time between midnight and just before noon.

Area: The amount of surface a shape or region covers. We measure area in square units, such as square centimetres or square metres.

Axis (plural: axes): A number line along the edge of a graph. We label each axis of a graph to tell what data it displays. The horizontal axis goes across the page. The vertical axis goes up the page.

Bar graph: Displays data by using bars of equal width on a grid. The bars may be vertical or horizontal.

Base: The face that names an object. For example, in this triangular prism, the bases are triangles.

Benchmark: Used for estimating by writing a number to its closest benchmark; for example,
1. For whole numbers: 47 532 is closer to the benchmark 47 500 than to the benchmark 47 600.
2. For fractions: \( \frac{1}{3} \) is closer to \( \frac{1}{2} \) than to 0 or to 1.
3. For decimals: 0.017 is closer to 0.020 than to 0.010.

Capacity: A measure of how much a container holds. We measure capacity in litres (L) or millilitres (mL).

Carroll diagram: A diagram used to sort numbers or attributes.

Centimetre: A unit used to measure length. We write one centimetre as 1 cm. 1 cm = 0.01 m 1 cm = 10 mm 100 cm = 1 m

Certain event: An event that always happens.

Clockwise: The hands on a clock turn in a clockwise direction.
Compatible numbers: Pairs of numbers that are easy to work with; for example,
1. The numbers 340 + 160 are compatible for adding because 40 + 60 = 100.
2. Multiples of 10 or 100 are compatible for estimating products because they are easy to multiply.

Compensation: A strategy for estimating; rounding one number up and rounding the other number down when the numbers are added.

Congruent shapes: Two shapes that match exactly.

Consecutive numbers: Numbers that follow in order; for example, 4, 5, 6, 7, …

Core: See Repeating pattern.

Counterclockwise: A turn in the opposite direction to the direction the hands on a clock turn.

Cube: An object with 6 faces that are congruent squares. Two faces meet at an edge. Three or more edges meet at a vertex.

Cubic centimetre (cm³): A unit to measure volume. A centimetre cube has a volume of one cubic centimetre. We write one cubic centimetre as 1 cm³.

Cubic metre: A unit to measure volume. One cubic metre is the volume of a cube with edge length 1 m. We write one cubic metre as 1 m³.

Data: Information collected from a survey or experiment.

Decagon: A polygon with 10 sides.

Decimal: A way to write a fraction. The fraction $\frac{2}{10}$ can be written as the decimal 0.2.

Decimal point: Separates the whole number part and the fraction part in a decimal. We read the decimal point as “and.” We say 3.2 as “three and two-tenths.”

Degree: A unit to measure temperature. We write one degree Celsius as 1°C.

Denominator: The part of a fraction that tells how many equal parts are in one whole. The denominator is the bottom number in a fraction.

Diagonal: A line segment that joins opposite vertices of a shape.
**Difference:** The result of a subtraction. The difference of 5 and 2 is 3: \(5 - 2 = 3\)

**Dimensions:** 1. The measurements of a shape or an object. A rectangle has 2 dimensions, length and width. A cube has 3 dimensions, length, width, and height.

2. For an array, the dimensions tell the number of rows and the number of columns.

**Displacement:** The volume of water moved or displaced by an object put in the water. The displacement of this cube is 50 mL or 50 cm\(^3\).

**Equally likely events:** Two or more events, each of which is as likely to happen as the other. For example, if you toss a coin, it is equally likely that the coin will land heads up as tails up.

**Equally probable:** See Equally likely events.

**Equation:** 1. Uses the = symbol to show two things that represent the same amount. \(5 + 2 = 7\) is an equation.

2. Uses the = symbol with a variable, an operation such as \(+, -, \times, \text{ or } \div\), and numbers to show two things that represent the same amount; for example, \(20 = p + 6\). See Solution of an equation.

**Equivalent decimals:** Decimals that name the same amount. 0.4, 0.40, and 0.400 are equivalent decimals.

**Equivalent fractions:** Name the same amount; for example, \(\frac{1}{2}\), \(\frac{2}{4}\), \(\frac{3}{6}\), \(\frac{9}{18}\), \(\frac{10}{20}\) are equivalent fractions.

**Estimate:** Close to an amount or value, but not exact.

**Event:** The outcomes or a set of outcomes from a probability experiment. For example, when a die labelled 1 to 6 is rolled, some events are: rolling a number greater than 3, rolling an even number, rolling a 6.

**Expanded form:** Shows a number as a sum of the values of its digits; for example,

1. For whole numbers:
   \[123456 = 100000 + 20000 + 3000 + 400 + 50 + 6\]

2. For decimals:
   \[5.713 = 5 + 0.7 + 0.01 + 0.003\]

**Experiment:** In probability, a test or trial used to investigate an idea.
Expression: Uses a variable and numbers to represent a pattern; for example, \(d + 2\) represents the number of dots on Figure \(d\) in the pattern shown in the table below.

<table>
<thead>
<tr>
<th>Figure Number</th>
<th>Number of Dots</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

Face: Part of an object. See also Cube, Prism, and Pyramid.

Factors: Numbers that are multiplied to get a product. In the multiplication sentence \(3 \times 7 = 21\), the factors of 21 are 3 and 7.

Fair game: A game where all players have the same chance of winning.

First-hand data: Data you collect yourself.

Front-end rounding: Using only the first digit of each number to get an estimate; for example,

1. For adding: \(23 \, 056 + 42 \, 982\) is about \(20 \, 000 + 40 \, 000 = 60 \, 000\)
2. For multiplying: \(72 \times 23\) is about \(70 \times 20 = 1400\)

Gram: A unit to measure mass. We write one gram as 1 g. 1000 g = 1 kg

Hexagon: A polygon with 6 sides.

Horizontal: A line that is parallel to the horizon.

Horizontal axis: See Axis.

Hundredth: A fraction that is one part of a whole when it is divided into 100 equal parts. We write one-hundredth as \(\frac{1}{100}\) or 0.01.

Image: The shape that is the result of a transformation. This is a rectangle and its image after a translation of 6 squares right and 1 square up.

Impossible event: An event that cannot happen.

Improbable event: An event that is unlikely to happen but not impossible.

Improper fraction: A fraction that shows an amount greater than one whole. The denominator is greater than the denominator. \(\frac{3}{2}\) is an improper fraction.

Increasing pattern: A pattern where each frame or term is greater than the previous frame or term.

Intersect: 1. For shapes, when two sides meet, they intersect in a point called the vertex.

2. For objects, when three or more edges meet, they intersect in a point called the vertex. When two faces meet, they intersect in an edge. See Cube.
**Irregular polygon:** A polygon that does not have all sides equal or all angles equal. Here are two irregular hexagons.

![Irregular hexagons](image)

**Key:** See Pictograph.

**Kilogram:** A unit to measure mass. We write one kilogram as 1 kg.  
1 kg = 1000 g

**Kilometre:** A unit to measure long distances. We write one kilometre as 1 km.  
1 km = 1000 m

**Kite:** A quadrilateral with two pairs of adjacent sides equal.

![Kite](image)

**Legend:** Tells the scale on a double bar graph and what each bar represents. See Double bar graph.

**Likely event:** An event that will probably happen.

**Line of reflection:** A line in which a shape is reflected. See Reflection.

![Line of reflection](image)

**Line of symmetry:** Divides a shape into two congruent parts. If we fold the shape along its line of symmetry, the parts match.

![Line of symmetry](image)

**Linear dimension:** Length, width, depth, height, thickness.

**Litre:** A unit to measure the capacity of a container. We write one litre as 1 L.  
1 L = 1000 mL

**Mass:** Measures how much matter is in an object. We measure mass in grams or kilograms.

**Metre:** A unit to measure length. We write one metre as 1 m.  
1 m = 100 cm  
1 m = 1000 mm

**Milligram:** A unit to measure mass. We write one milligram as 1 mg.  
1000 mg = 1 g

**Millilitre:** A unit to measure the capacity of a container. We write one millilitre as 1 mL.  
1000 mL = 1 L  
1 mL = 1 cm³

**Millimetre:** A unit to measure length. We write one millimetre as 1 mm. One millimetre is one-tenth of a centimetre: 1 mm = 0.1 cm  
10 mm = 1 cm  
One millimetre is one-thousandth of a metre: 1 mm = 0.001 m  
1000 mm = 1 m

**Multiple:** Start at a number, then count on by that number to get the multiples of that number. To get the multiples of 3, start at 3 and count on by 3:  
3, 6, 9, 12, 15, …

**Multiplication fact:** A sentence that relates factors to a product.  
3 × 7 = 21 is a multiplication fact.

**Net:** An arrangement that shows all the faces of an object, joined in one piece. It can be folded to form the object.

![Net](image)
**Number line:** Has numbers in order from least to greatest. The spaces between pairs of consecutive numbers are equal.

*Diagram:*

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
</table>

**Numerator:** The part of a fraction that tells how many equal parts to count. The numerator is the top number in a fraction. In the fraction $\frac{2}{3}$, the numerator is 2. We count 2 thirds of the whole.

**Object:** Has length, width, and height. Objects have faces, edges, vertices, and bases. We name some objects by the number and shape of their bases.

[Images: Pentagonal pyramid, Hexagonal prism]

**Octagon:** A polygon with 8 sides.

[Diagram: Octagon]

**Operation:** Something done to a number or quantity. Addition, subtraction, multiplication, and division are operations.

**Outcome:** One result of an event or experiment. Tossing a coin has two possible outcomes, heads or tails.

**p.m.:** A time between noon and just before midnight.

**Parallel:** 1. Two lines that are always the same distance apart are parallel.

[Diagram: Two parallel lines]

2. Two faces of an object that are always the same distance apart are parallel; for example, the shaded faces on the rectangular prism below are parallel.

[Diagram: Rectangular prism with shaded faces]

**Parallelogram:** A quadrilateral with 2 pairs of opposite sides parallel.

[Diagram: Parallelogram]

**Partial products:** Used as a strategy for multiplying 2-digit numbers; for example,

\[
42 \times 57 = (40 + 2) \times (50 \times 7)
\]

\[
= (40 \times 50) + (40 \times 7) + (2 \times 50) + (2 \times 7)
\]

\[
= 2000 + 280 + 100 + 14 = 2394
\]

There are 4 partial products.

**Pattern rule:** Describes how to make a pattern. For the pattern 1, 2, 4, 8, 16, ..., the pattern rule is: Start at 1. Multiply by 2 each time.

**Perimeter:** The distance around a shape. It is the sum of the side lengths.

The perimeter of this rectangle is:

\[
2 \text{ cm} + 4 \text{ cm} + 2 \text{ cm} + 4 \text{ cm} = 12 \text{ cm}
\]

[Diagram: Rectangle]
**Perpendicular:** 1. Two lines that intersect at a right angle are perpendicular.

![Perpendicular Lines]

2. Two faces that intersect on a rectangular prism or a cube are perpendicular.

![Rectangular Prism]

**Pictograph:** Uses pictures and symbols to display data. Each picture or symbol can represent more than one object. A key tells what each picture represents.

![Pictograph]

**Equipment Rentals for Week of July 2**

<table>
<thead>
<tr>
<th>Type of Equipment</th>
<th>Rollerblades</th>
<th>Bicycles</th>
<th>Skateboards</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="rollerblades.png" alt="" /></td>
<td><img src="bicycles.png" alt="" /></td>
<td><img src="skateboards.png" alt="" /></td>
</tr>
<tr>
<td></td>
<td>= 20 People</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Place-value chart:** It shows how the value of each digit in a number depends on its place in the number; see page 44 for whole numbers and page 184 for decimals.

**Placeholder:** A zero used to hold the place value of the digits in a number. For example, the number 603 has 0 tens. The digit 0 is a placeholder.

**Point of rotation:** The point about which a shape is rotated. See Rotation.

**Polygon:** A shape with three or more sides. We name a polygon by the number of its sides. For example, a five-sided polygon is a pentagon.

![Polygon]

**Possible event:** An event that may happen.

**Prediction:** You make a prediction when you decide how likely or unlikely it is that an event will happen.

**Prism:** An object with 2 bases.

![Prism]

**Probability:** Tells how likely it is that an event will occur.

**Probable event:** An event that is likely but not certain to happen.

**Product:** The result of a multiplication. The product of 5 and 2 is 10: \(5 \times 2 = 10\)

**Proper fraction:** Describes an amount less than one. A proper fraction has a numerator that is less than its denominator. \(\frac{5}{7}\) is a proper fraction.

**Pyramid:** An object with 1 base.

![Pyramid]
**Quotient:** The number obtained by dividing one number into another. In the division sentence $77 \div 11 = 7$, the quotient is 7.

**Quadrilateral:** A shape with 4 sides.

**Rectangle:** A quadrilateral, where 2 pairs of opposite sides are equal and each angle is a right angle.

**Rectangular prism:** See Prism.

**Rectangular pyramid:** See Pyramid.

**Referent:** Used to estimate a measure; for example, a referent for:
- a length of 1 mm is the thickness of a dime.
- a length of 1 m is the width of a doorway.
- a volume of 1 cm$^3$ is the tip of a finger.
- a volume of 1 m$^3$ is the space taken up by a playpen.
- a capacity of 1 L is a milk pitcher.
- a capacity of 1 mL is an eyedropper.

**Reflection:** Reflects a shape in a line of reflection to create a reflection image. See Line of reflection.

**Reflection image:** The shape that results from a reflection. See Reflection.

**Regular shape:** See Regular polygon.

**Regular polygon:** A regular polygon has all sides equal and all angles equal. Here is a regular hexagon.

**Related facts:** Sets of addition and subtraction facts or multiplication and division facts that have the same numbers. Here are two sets of related facts:

- $2 + 3 = 5 \quad 5 \times 6 = 30$
- $3 + 2 = 5 \quad 6 \times 5 = 30$
- $5 - 3 = 2 \quad 30 \div 6 = 5$
- $5 - 2 = 3 \quad 30 \div 5 = 6$

**Remainder:** What is left over when one number does not divide exactly into another number. For example, in the quotient $13 \div 5 = 2 R3$, the remainder is 3.

**Repeating pattern:** A pattern with a core that repeats. The core is the smallest part of the pattern that repeats. In the pattern: $1, 8, 2, 1, 8, 2, 1, 8, 2, \ldots$, the core is $1, 8, 2$.

**Rhombus:** A quadrilateral with all sides equal and 2 pairs of opposite sides parallel.

**Right angle:** Two lines that are perpendicular make a right angle.

**Rep-tile:** A polygon that can be copied and arranged to form a larger polygon that has the same shape.
**Rotation**: Turns a shape about a point of rotation in a given direction. This is a triangle and its image after a rotation of a $\frac{1}{4}$ turn counterclockwise about one vertex:

![Image of rotation](image.png)

**Rotation image**: The shape that results from a rotation. See **Rotation**.

**Scale**: The numbers on the axis of a graph show the scale.

**Second**: A small unit of time. There are 60 seconds in 1 minute. $60 \text{ s} = 1 \text{ min}$

**Second-hand data**: Data collected by someone else.

**Solution of an equation**: The value of a variable that makes the equation true; for example, $p = 14$ is the solution of the equation $20 = p + 6$.

**Speed**: A measure of how fast an object is moving.

**Square**: A quadrilateral with equal sides and 4 right angles.

![Square](image.png)

**Square centimetre**: A unit of area that is a square with 1-cm sides. We write one square centimetre as $1 \text{ cm}^2$.

**Square metre**: A unit of area that is a square with 1-m sides. We write one square metre as $1 \text{ m}^2$.

**Standard form**: The number 579 328 is in standard form; it has a space between the thousands digit and the hundreds digit. See **Place-value chart**.

**Standard units**: Metres, square metres, cubic metres, kilograms, and seconds are some standard units.

**Sum**: The result of addition. The sum of 5 and 2 is 7: $5 + 2 = 7$

**Survey**: Used to collect data. You can survey your classmates by asking them which is their favourite ice-cream flavour.

**Symmetrical**: A shape is symmetrical if it has one or more lines of symmetry.

**Tenth**: A fraction that is one part of a whole when it is divided into 10 equal parts. We write one-tenth as $\frac{1}{10}$ or as 0.1.

**Term**: One number in a number pattern. For example, the number 4 is the third term in the pattern $1, 2, 4, 8, 16, \ldots$

**Thousandth**: A fraction that is one part of a whole when it is divided into 1000 equal parts. We write one-thousandth as $\frac{1}{1000}$, or 0.001.

**Tonne**: A unit used to measure a very large mass. We write one tonne as $1 \text{ t}$. $1 \text{ t} = 1000 \text{ kg}$

**Transformation**: A translation (slide), a reflection (flip), and a rotation (turn) are transformations.
Translation: Slides a shape from one location to another. A translation arrow joins matching points on the shape and its image. This shape has been translated 6 squares left and 2 squares up.

Translation arrow: See Translation.

Translation image: The shape that results from a translation. See Translation.

Trapezoid: A quadrilateral with exactly 1 pair of sides parallel.

Triangular prism: See Prism.

Triangular pyramid: See Pyramid.

Unlikely event: An event that will probably not happen.

Variable: A letter, in italics, that is used to represent a number in an equation, or a set of numbers in a pattern. See Equation and Expression.

Vertex (plural: vertices): 1. The point where two sides of a shape meet. 2. The point where three or more edges of an object meet.

Vertical: A line that is perpendicular to the horizon.

Vertical axis: See Axis.

Volume: The amount of space occupied by an object or the amount of space inside an object. Volume can be measured in cubic centimetres or in cubic metres.
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