GRADE 5 MATHEMATICS

Shape and Space

Grade 5: Shape and Space (Measurement) (5.SS.1)

Enduring Understandings:

There is no direct relationship between perimeter and area.

General Outcome:

Use direct or indirect measurement to solve problems.

Specific Learning Outcome(s):	Achievement Indicators:
5.SS.1 Design and construct different rectangles, given either perimeter or area, or both (whole numbers), and draw conclusions. [C, CN, PS, R, V]	➢ Construct or draw two or more rectangles for a given perimeter in a problem-solving context. ➢ Construct or draw two or more rectangles for a given area in a problem-solving context. ➢ Illustrate that for any perimeter, the square or shape closest to a square will result in the greatest area. ➢ Illustrate that for any perimeter, the rectangle with the smallest possible width will result in the least area. ➢ Provide a real-life context for when it is important to consider the relationship between area and perimeter.

Prior Knowledge

Students may have had experience with the following:

- Estimating, measuring, and recording the length, width, and height of objects to the nearest metre and centimetre
- Estimating, measuring, and recording the perimeter of regular and irregular shapes
- Constructing shapes with a given perimeter
- Estimating, measuring, and recording the area of regular and irregular shapes with a given perimeter
- Estimating, measuring, and recording the area of regular and irregular shapes
- Constructing shapes with a given area
- Distinguishing between perimeter and area
- Identifying and describing patterns found in tables and charts
- Identifying polygons

Students may also have had experience with the following:

- Perimeter is the distance around a shape
- Area is the amount of surface within a region

Related Knowledge

Students should be introduced to the following:

- Demonstrating an understanding of measuring length in millimetres, and distinguish rectangles from other quadrilaterals
- Recognizing that all squares are rectangles

Background Information

Perimeter is the distance around a shape. Students often confuse this concept with **area**, the amount of surface a shape covers. Involving students in actual measuring experiences can help them distinguish between these two concepts. For example, activities that have students completely covering shapes with square units can help them understand the meaning of area.

Moreover, students often have misconceptions about the relationship between perimeter and area. Two of the most common are the following:

1. the longer the perimeter, the larger the area
2. perimeter and area increase at the same rate

For example, some students have the mistaken belief that if the perimeter is doubled, the area will double. Therefore, the intent of the learning experiences in this section is to help students overcome their misconceptions by having them explore the perimeter and area of rectangles. The learning experiences are also designed to help students recognize at least five generalizations about the relationship between these two measurements:

- If only the perimeter (area) of a rectangle is given, its area (perimeter) cannot be determined.
- Increasing the perimeter (area) of a rectangle does not necessarily increase the area (perimeter) of the rectangle.
- If the length (width) of a rectangle is fixed, then increasing its perimeter will increase its area.
- The square has the largest area among rectangles that have the same perimeter.
- The square has the smallest perimeter among rectangles that have the same area.

Mathematical Language

Area

Length

Perimeter

Polygon

Rectangle

Square

Width

Assessing Prior Knowledge

Materials: Centimetre grid paper (BLM 5–8.9)

Organization: Individual

Procedure:

a) Ask students to use the centimetre grid paper to draw the following:
   - A polygon with a perimeter of 10 cm
   - A polygon with a perimeter greater than 15 cm
   - A polygon with an area of 12 cm^2
   - A polygon whose area is greater than 15 cm^2 and less than 25 cm^2

   Inside of each shape that they draw, have students write the name of the polygon and its perimeter or area measurement.

b) Present the students with the following problems:
   - Kelly wants to make a wooden frame for the picture his aunt drew for him. Does Kelly need to measure the perimeter or the area of the picture to find out how much wood he needs? What unit of measurement do you think he should use? Explain your answers.
   - Mr. Lien wants to cover the bulletin board in his classroom with a piece of paper. Does he need to measure the perimeter or the area of the bulletin board to find out how much paper he needs? What unit of measurement do you think he should use? Explain your answers.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ construct a polygon with a given perimeter
- ❏ construct a polygon with a given area
- ❏ distinguish between perimeter and area
- ❏ understand that perimeter is the distance around a shape
- ❏ understand that area is the amount of surface inside a region
- ❏ name polygons according to the number of sides that they have
- ❏ know that perimeter is measured in linear units and that area is measured in square units
- ❏ justify their selection of a unit of measurement

- **Construct or draw two or more rectangles for a given perimeter in a problem-solving context.**
- **Illustrate that for any perimeter, the square or shape closest to a square will result in the greatest area.**
- **Illustrate that for any perimeter, the rectangle with the smallest possible width will result in the least area.**

Materials: Square tiles, centimetre grid paper (BLM 5–8.9), and recording sheet (BLM 5.SS.1.1)

Organization: Small group/Whole class

Procedure:

a) Present students with the following problem:
   - Mrs. Zahn and Mr. Stewart have gardens that are rectangular in shape. The perimeter of Mrs. Zahn's garden is 16 metres and the perimeter of Mr. Stewart's garden is 20 metres. Is Mr. Stewart's garden larger than Mrs. Zahn's?

   Make sure students understand the problem by asking:
   - "What do you know about Mrs. Zahn's garden?"
   - "What do you know about Mr. Stewart's garden?"
   - "What question do you need to answer?"

b) Have students write down what they think the answer is, and then share it with the other members of their group.

c) Next, have students draw rectangles on the centimetre grid paper to show why they think their answer is correct, and then share their drawings with the other members of their group.

d) Challenge students by asking: "Are there other rectangles that have perimeters of 16 metres? Are there other rectangles that have perimeters of 20 metres? What are their areas?" Have students in each group use the square tiles or centimetre grid paper to find other rectangles that have perimeters of 16 metres and 20 metres.

e) Encourage students to organize their work by having them record their findings in the table provided (see BLM 5.SS.1.1).

f) Have students in each group analyze their tables and record any patterns or relationships that they find.

g) Ask each group to present its findings to the other members of the class, as well as its conclusion regarding whose garden—Mrs. Zahn's or Mr. Stewart's—is larger.

Observation Checklist

Check students' work to determine whether they can do the following:

- ❑ construct or draw two or more rectangles for a given perimeter in a problem-solving context
- ❑ recognize that they cannot tell for sure whether Mr. Stewart's garden is larger than Mrs. Zahn's—that is, if only the perimeter of a rectangle is given, its area cannot be determined
- ❑ recognize patterns and relationships, such as
  - the square has the largest area among rectangles with the same perimeter
  - the rectangle with the smallest width has the least area
  - increasing the perimeter does not necessarily increase the area
  - if the length of a rectangle is fixed, increasing its perimeter increases its area

Materials: Square tiles, centimetre grid paper (BLM 5–8.9), and recording sheet (BLM 5.SS.1.1)

Organization: Small group/Whole class

Procedure:

a) Present students with the following problem:
   - A farmer has 36 metres of fencing material. He is planning to use all of the fencing material to make a rectangular pen for his sheep. What is the largest pen he can make for his sheep?

   Make sure students understand the problem by asking:
   - "What does the farmer want to do?"
   - "How much fencing material does he have?"
   - "What do you need to find out?"

b) Have students write down what they think the answer to the problem is and share their answer with the other members of their group.

c) Next, ask, "How many different rectangular pens can the farmer make with 36 metres of fencing material?"

d) Have students in each group use the square tiles or centimetre grid paper to find all the rectangles that have a perimeter of 36 units. Have students record their findings in the table provided (see BLM 5.SS.1.1).

e) Have students analyze their findings and record any patterns and relationships that they find.

f) Have each group share with the other members of the class its solution to the problem and any other patterns that it finds.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ construct or draw two or more rectangles with a given perimeter in a problem-solving context
- ❑ recognize that the pen with the largest area is a square with sides six metres in length—that is, the square has the largest area among rectangles with the same perimeter
- ❑ recognize patterns and relationships, such as
  - the rectangle with the smallest width has the least area
  - the closer the rectangle is to a square, the closer the area is to the maximum area

- **Construct or draw two or more rectangles for a given area in a problem-solving context.**
- **Illustrate that for any perimeter, the square or shape closest to a square will result in the greatest area.**
- **Illustrate that for any perimeter, the rectangle with the smallest possible width will result in the least area.**
- **Provide a real-life context for when it is important to consider the relationship between area and perimeter.**

Materials: *Spaghetti and Meatballs for All* by Marilyn Burns, square tiles, and recording table (BLM 5.SS.1.1)

Organization: Whole class/Small group

Procedure:

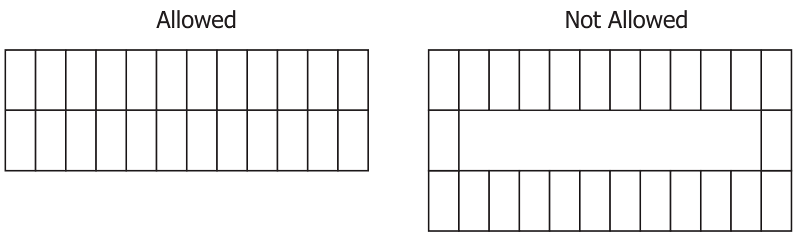
a) Read *Spaghetti and Meatballs for All*. As you read the story, have the students use the square tiles to model what is happening with the tables.

b) Have students discuss the problem with the table arrangements. Begin the discussion by asking, "Why does Mrs. Comfort keep saying the table arrangements won't work?" Have students work with their partner to find different ways of arranging eight tables. Have them decide which arrangement is the best.

c) Pose the problem: "Mrs. Comfort has 24 square tables. If she pushes the tables together to form a rectangle, what is the highest number of people she can sit around the rectangle?"

d) Make sure the students understand the problem by asking them the following questions:

- "How many square tables does Mrs. Comfort have?"
- "What does Mrs. Comfort do with the tables?"
- "What do you need to find out?"
- "What is one way that Mrs. Comfort can push the tables together to form a rectangle?" (Make sure the students recognize that the rectangular arrangements cannot have any spaces in the middle.)



- "How many people can Mrs. Comfort sit around the table?"

e) Explain that the number of tables pushed together represents the area and the number of people who can sit around the table represents the perimeter. Then, ask, "Are there other rectangles that Mrs. Comfort can make that have an area of 24 square units? Can she seat the same number of people around each rectangle?"

f) Have the students work with their partners to determine all the rectangles that can be made with 24 tiles. Encourage students to record their findings in the table provided (see BLM 5.SS.1.1).

g) Have students analyze their findings and record any patterns and relationships that they find.

h) Ask students to share their findings and their conclusion as to which rectangle Mrs. Comfort should make if she wants to seat the most people with the rest of the class.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ construct or draw two or more rectangles for a given area in a problem-solving context
- ❑ recognize that Mrs. Comfort can seat the most people around a 1 x 24 rectangle—that is, among rectangles with the same area, the one with the smallest width has the greatest perimeter
- ❑ recognize patterns and relationships, such as the following:
  - The closer the rectangle is to a square, the smaller its perimeter.
  - If two rectangles have the same area, they do not necessarily have the same perimeter.
  - If only the area of a rectangle is given, its perimeter cannot be determined.

- **Construct or draw two or more rectangles for a given area in a problem-solving context.**
- **Illustrate that for any perimeter, the square or shape closest to a square will result in the greatest area.**

Materials: Math journals, square tiles, and square centimetre paper (BLM 5–8.9)

Organization: Individual/Large group

Procedure:

a) Pose the following problem:
   - Mr. Santos is making a rectangular flower garden in his backyard. If the area of the garden is 36 m^2, what is the least amount of fencing that he needs to enclose the garden?

b) Make sure the students understand the problem by asking them the following questions:
   - "What is Mr. Santos making?"
   - "How big is the garden?"
   - "What do you need to find out?"

c) Tell students that they can use the square tiles or the centimetre grid paper to help them solve the problem. Have the students record their solutions in their math journals.

d) Have students share their answers and the strategies they used to solve the problem.

Observation Checklist

Check students' work to determine whether they can do the following:

- ❑ recognize that different rectangles can have the same area
- ❑ recognize that the least amount of fencing that is needed is 24 metres

Putting the Pieces Together

Design a Clubhouse

Purpose:

The purpose of this investigation is to have students apply the concepts of perimeter and area to a problem-solving situation. In particular, it is designed to enhance students' ability to

- differentiate between perimeter and area
- construct rectangles with a given perimeter or area
- maximize or minimize the area of a rectangle with a fixed perimeter
- maximize or minimize the perimeter of a rectangle with a fixed area

In addition, the investigation is designed to enhance students' ability to

- communicate mathematically
- connect mathematics to real-world situations
- solve problems
- reason mathematically

Materials/Resources: Centimetre grid paper (BLM 5–8.9), coloured centimetre grid paper, square tiles, scissors, and glue

Organization: Whole class/Small groups

Procedure:

a) Present students with the following situation:

You and your friends have decided to build a rectangular clubhouse. You plan to build your clubhouse in a section of the schoolyard with an area of 200 m^2. You have decided that your clubhouse must have the following:

- The largest possible floor space
- Two rugs (One rug must have a perimeter of 24 m and cover the largest possible area, and the other rug must have a perimeter of 16 m that covers the least possible area.)
- At least two doors with a width of one metre

- A play area that takes up at least ¼ of the floor space. No furniture can be placed in the play area
- A rectangular seating area with a perimeter of 12 m
- A rectangular table with an area of 4 m^2

You also decide that the clubhouse can have other items as long as they are not placed in the play area.

b) Explain that each group must draw up a plan for the clubhouse that includes the dimensions of each item in the list of specifications. Tell students that they can draw their plan for the clubhouse on the white centimetre grid paper and use the colour centimetre paper to indicate the furniture and the rugs. They should let each square centimetre on the grid paper represent one square metre.

c) Help students develop the criteria for assessing their plans for a clubhouse.

d) Have students work on their plans for a clubhouse.

e) Have each group present its design for a clubhouse to the other members of the class. Encourage students to describe the dimensions of each item in their clubhouse and how they determined its size.

Observation Checklist

❑ Use the rubric provided and the student-developed criteria to assess students' attainment of outcome 5.SS.1 during the completion of the project.

	3	2	1
Distinguishes between perimeter and area	Determines the perimeter of a rectangle by finding the distance around it. Determines the area of a rectangle by finding the number of square units it covers.	Determines the perimeter of a rectangle ***or*** the area of a rectangle.	Is not able to determine the perimeter of a rectangle.
Constructs rectangles with a given perimeter	Constructs a rectangle with a given perimeter.	Constructs a rectangle with a given perimeter with support.	Is not able to construct a rectangle with a given perimeter.
Recognizes relationships	Recognizes that a square has the largest area among rectangles that have the same perimeter. Recognizes that, among rectangles that have the same perimeter, the one with the smallest width has the least area. Recognizes that a square has the smallest perimeter among rectangles with the same area.	Recognizes that a square has the largest area among rectangles with the same perimeter with support. Recognizes that, among rectangles that have the same perimeter, the one with the smallest width has the least area with support. Recognizes that a square has the smallest perimeter among rectangles with the same area with support.	Does not recognize that a square has the largest area among rectangles with the same perimeter. Does not recognize that, among rectangles that have the same perimeter, the one with the smallest width has the least area. Does not recognize that a square has the smallest perimeter among rectangles with the same area.

Grade 5: Shape and Space (Measurement) (5.SS.2)

Enduring Understandings:

All measurements are comparisons.

Length, area, volume, capacity, and mass are measurable properties of objects.

The unit of measure must be of the same nature as the property being measured.

General Outcome:

Use direct or indirect measurement to solve problems.

Specific Learning Outcome(s):	Achievement Indicators:
5.SS.2 Demonstrate an understanding of measuring length (mm) by ■ selecting and justifying referents for the unit mm ■ modelling and describing the relationship between mm and cm units, and between mm and m units [C, CN, ME, PS, R, V]	➛ Provide a referent for one millimetre and explain the choice. ➛ Provide a referent for one centimetre and explain the choice. ➛ Provide a referent for one metre and explain the choice. ➛ Show that 10 millimetres is equivalent to 1 centimetre using concrete materials (e.g., ruler). ➛ Show that 1000 millimetres is equivalent to 1 metre using concrete materials (e.g., metre stick). ➛ Provide examples of when millimetres are used as the unit of measure.

Prior Knowledge

Students may have had experience with the following:

- Estimating, measuring, and recording the length, width, and height of objects to the nearest metre or centimetre
- Describing the relationship between a metre and a centimetre
- Identifying referents for a cm and a m
- Demonstrating an understanding of fractions less than one

Students may also have had experience with the terms *length*, *width*, *height*, and *perimeter*.

Related Knowledge

Students should be introduced to the following:

- Multiplying and dividing whole numbers by 10s, 100s, and 1000s
- Reading, writing, interpreting, and using decimal notation for 10ths, 100ths, and 1000ths
- Relating fractions to decimals
- Describing orally and in writing the rule for a pattern

Background Information

Measurement is the process of comparing a unit of measure with a measurable property of an object or phenomenon. The process consists of the following:

1. Identifying the property to be measured
2. Selecting an appropriate unit of measure
3. Repeatedly matching the unit with the property or phenomena being measured
4. Counting the number of units

By the end of the 18th century, units of measure varied greatly within and between countries. The lack of standard units made trading with other cultures difficult to carry out. To remedy this situation, the French National Assembly in 1790 asked the Academy of Science to develop a common system of measurement. The system it developed is known as the metric system. The units of measure developed by the academy have evolved into the Système International d'Unités (abbreviated SI), which was established in 1960. The SI is governed by the General Conference on Weights and Measures, which makes changes in the system to reflect the latest advances in science and technology. Even though there are differences between the two systems, SI is still referred to as the metric system.

Because of its simplicity, all but a few countries have adopted the metric system. Its simplicity arises from its use of the following:

1. A small number of base units
2. The decimal system
3. A uniform set of prefixes that apply to each area of measurement

These prefixes—the most common of which are shown below—indicate multiples or subdivisions of the base units.

Prefix	Meaning
kilo (k)	1000 units
hecto (h)	100 units
deka (da)	10 units
deci (d)	0.1 unit
centi (c)	0.01 unit
milli (m)	0.001 unit

In the Early and Middle Years, students are introduced to length, area, volume, capacity, and mass. Their measurement of these properties involves the units listed in the chart below, and can be either direct or indirect. **Direct measurements** involve selecting a unit and comparing it directly with the object (e.g., using a metre stick to measure the height of a table). **Indirect measurements** are made when a unit cannot be placed directly on the object (e.g., finding the height of a flagpole or the area of a country). Often, objects can be measured indirectly by comparing them with things that can be measured (e.g., finding the height of a tree by measuring its shadow).

Quantity	Units	Symbol
Length	kilometre metre centimetre millimetre	km m cm mm
Area	square metre square centimetre	m^2 cm^2
Volume	cubic metre cubic centimetre	m^3 cm^3
Capacity	litre millilitre	L mL
Mass	kilogram gram	kg g

Learning experiences that require students to use measuring instruments in realistic situations are key ingredients in helping them understand the concepts and skills involved in measurement systems. In particular, these experiences can help students understand the following:

- The measure of a unit is always 1
- The unit must be of the same nature as the property that is being measured
- The unit must be repeatedly matched with the property being measured without any gaps or overlaps (This process is known as **unit iteration**.)
- One unit may be more appropriate than another to measure the property of an object
- There is an inverse relationship between the number of units and the size of the unit
- A smaller unit gives a more exact measurement
- A measurement must include both a number and a unit
- When the same units are used, measurements can be easily compared

Estimating—that is, making a reasonable judgment about the approximate amount of a quantity—also plays an important role in the development of students' understanding of measurement systems. A focus on estimating enables students to create a mental frame of reference for the size of units and their relationships to each other. It also helps them judge the reasonableness of their measurements.

Mathematical Language

Centimetre

Estimate

Height

Length

Measurement

Metre

Millimetre

Referent

Width

Learning Experiences

Assessing Prior Knowledge

Materials: Assessment activity sheet (BLM 5.SS.2.1) and cm rulers

Organization: Individual

Procedure:

Have students complete the assessment activity sheet (BLM 5.SS.2.1).

- **Provide a referent for one millimetre and explain the choice.**
- **Show that 10 millimetres is equivalent to 1 centimetre using concrete materials (e.g., ruler).**
- **Provide examples of when millimetres are used as the unit of measure.**

Materials: cm rulers with mm marked on them, a cm ruler that can be projected on the overhead or an overhead of a cm ruler, toothpicks, safety pins, index cards, crayons, math scribblers, soda straws, and the activity sheet (BLM 5.SS.2.2)

Organization: Whole class/Individual

Procedure:

a) Ask students to draw a metre stick and make sure that they include all the markings. When students finish their drawings, have them share their pictures and explain what the markings on their metre sticks mean. Use the discussion to determine what the students already know about mm so you can clear up any misconceptions that they may have.

b) Tell students that they will be learning about a new unit of linear measure called a millimetre. Place a cm ruler on the overhead and point out that there are 10 spaces between consecutive centimetres. Tell students that each space represents 1 millimetre. Write the word *millimetre* on the board or overhead, and show students the symbol for the unit.

c) Have students take out their cm rulers. Ask them to find the number of millimetres between

   - the 1 cm mark and the 2 cm mark
   - the 10 cm mark and the 11 cm mark
   - the 15 cm mark and the 17 cm mark
   - the 20 cm mark and the 23 cm mark

d) Have students show these points on their rulers:
   - 20 mm
   - 45 mm
   - 85 mm
   - 120 mm

e) Tell students that millimetres are used to measure the lengths of small objects. Have them identify objects that they would measure with this unit.

f) Have students complete the activity sheet (BLM 5.SS.2.2). Remind students of the symbol for millimetre.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ make reasonable estimates
- ❏ read and use their cm rulers correctly to determine the lengths of objects
- ❏ record measurements correctly (e.g., recorded measurements include both a number and the unit)
- ❏ recognize when it's appropriate to use mm as a unit of measure (Note: Many of the objects that students name could also be measured in cm or m.)

- **Provide a referent for one millimetre and explain the choice.**
- **Provide a referent for one centimetre and explain the choice.**
- **Provide a referent for one metre and explain the choice.**

Materials: Metre sticks and cm rulers

Organization: Whole class/Partners

Procedure

a) Discuss the importance of estimation in measurement. For example, talk about how good estimating skills can help an individual recognize when an error in measurement is made and the consequences of using an incorrect measurement.

b) Have students identify examples of situations when estimating the lengths of objects would be beneficial. For example:
   - "We need to wrap a gift. Do we have enough ribbon to wrap the package?"
   - "We want to put a new shelving unit in the room. Is the room high enough for the shelving unit?"
   - "We want to store some books. Is the box we have wide enough?"

c) Ask students to estimate the length of the room to the nearest metre. Record their responses on the board. Have students share their strategies for estimating the length of the room and discuss why their estimates varied.

d) Discuss the importance of personal referents in the estimating process. Explain that a personal referent is a familiar object, one that they see or use regularly whose measure is known. They can think of this object when they are estimating the length of an unknown object (e.g., the length of a baseball bat is approximately 1 metre). When estimating the length of an unknown object, they can think of a bat and visualize how may "bats long" the object is.

e) Have the students work with a partner to find five common objects that are approximately
   - 1 mm in length, width, or height
   - 1 cm in length, width, or height
   - 1 m in length, width, or height

f) Have students share their referents for each unit with the rest of the class.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ provide reasons why estimating is an important skill
- ❑ give examples of situations in which estimating would be beneficial
- ❑ identify appropriate referents for 1 mm, 1 cm, and 1 m

Materials: Decks of 20 cards (one side of each card should have a letter on it; the other side should have a line segment drawn on it [BLM 5.SS.2.3]), an answer sheet listing the length of the line segment on each card

Organization: Pairs

Procedure:

a) Tell students that they will be playing an estimating game called "Metric 210" with their partner. Explain how the game is played.

   1. Shuffle the cards and lay them face down on the playing surface.
   2. Players take turns taking a card from the top of the pile until one of them estimates that he or she has a total length of 210 mm and stops the game by saying "I have the line." This player may get rid of any one card that pushes the total over 210 mm. The player then states an estimate for the total length of the remaining cards.
   3. The player uses the answer sheet to determine his or her score. The player's score is determined by adding the difference between the estimate and the actual length to the difference between the actual length and 210.
   4. The winner is the player with the lowest total score after five rounds of the game.

b) Demonstrate how the game is played and answer any questions students might have. Have students play the game.

c) Vary the game by having students estimate the lengths of the line segments in cm. A round of the game is over when a student thinks he or she has reached a length of 21 cm.

Observation Checklist

Observe students to determine whether they can do the following:

- ❑ understand the rules for playing the game
- ❑ give reasonable estimates of the lengths of the line segments
- ❑ calculate the total length of the lines correctly
- ❑ calculate their scores correctly

Materials: A deck of measurement cards (BLM 5.SS.2.4), straight edges, a centimetre ruler, and a piece of paper for each player

Organization: Pairs

Procedure:

a) Tell students that they will be playing a variation of the game Metric 210. Explain how the new version of the game is played.

1. Shuffle the cards and place them face down on the playing surface.
2. Each card in the deck represents a mm length.
3. The first player turns over a card and uses a straight edge to draw a line segment he or she estimates to be the same length as the number of mm on the card (e.g., if the player turns over a 30, he or she draws, without measuring, a line segment that he or she thinks is 30 mm in length and records the length above the line segment).
4. The second player turns over a card and uses a straight edge to draw a line segment he or she estimates to be the same length as the number of mm on the card. The second player then records the length above the line segment.
5. The first player turns over a line card, and extends, without measuring, his or her line segment the number of mm shown on the card. The first player then records the length above the line segment. For example, if the first player draws a 30 and then a 50, his or her paper would look like this:

6. Play continues in this fashion until one player has a line segment he or she estimates is 210 mm in length and stops the game by saying, “I have the line.” If the player thinks the last extension of his or her line segment pushes the total length beyond 210 mm, he or she can state an estimate greater than 210 mm.
7. The player measures the line segment to determine his or her score. The player’s score is determined by adding the difference between the actual length and the estimated length to the difference between the actual length and 210 mm.
8. The winner is the player who has the lowest score after five rounds of the game.

b) Demonstrate how the game is played and answer any questions students might have. Have students play the game.

c) Vary the game by changing mm to cm (BLM 5.SS.2.4). A round of the game is over when a student draws a line segment he or she estimates is 21 cm in length.

Observation Checklist

Observe students to determine whether they can do the following:

- ❏ understand the rules of the game
- ❏ make reasonable estimates
- ❏ determine the length of the line segments by using and reading their rulers correctly
- ❏ record measurements correctly (e.g., recorded measurements include both the number and the unit)
- ❏ calculate their scores correctly

Materials: Metre sticks, cm rulers, table to record their findings (BLM 5.SS.2.5)

Organization: Small groups

Procedure

a) Tell students that they will be playing an estimating and measuring game with the members of their group. Explain how to play the game.

   1. Players take turns naming a unit of measure (m, cm, mm) and an object that everyone can see.
   2. Everyone records an estimate of the length of the object in the stated unit.
   3. The player who named the object measures it. The player whose estimate is the closest to the actual measurement gets one point. If there is a tie, all players with the best estimate get one point.
   4. The winner of the game is the first person to get five points.

b) Have students record in the table provided their choice of objects, their estimates, and the actual measurements (5.SS.2.5).

c) Demonstrate how the game is played and answer any question students might have. Have students play the game.

Observation Checklist

Observe students to determine whether they can do the following:

- ❏ understand the rules of the game
- ❏ determine the lengths of objects by using and reading a metre stick or cm ruler correctly
- ❏ record measurements correctly (e.g., recorded measurements include both a number and the unit of measure)
- ❏ make reasonable estimates
- ❏ select an appropriate unit of measure

- **Show that 10 millimetres is equivalent to 1 centimetre using concrete materials (e.g., ruler).**
- **Show that 1000 millimetres is equivalent to 1 metre using concrete materials (e.g., metre stick).**

Materials: cm rulers and line segments (BLM 5.SS.2.6)

Organization: Individual

Procedure:

a) Give students a copy of BLM 5.SS.2.6, and tell them that they should measure each line segment twice: The first time, they should measure the line segment to the nearest cm; the second time, they should measure the line segment to the nearest mm.

b) Encourage students to record their findings in the table provided in BLM 5.SS.2.6.

c) Ask students to study their tables and record any patterns they see.

d) Have students share their findings with the other members of the class. Encourage students to state a rule that describes the relationship between cm and mm.

e) Check students' understanding of the relationship between cm and mm by asking:
   - "How many mm are in 1 cm? 2 cm? 3 cm? 4 cm? 8 cm? 15 cm? 50 cm? n?"
   - "If the length of an object is given in cm, how can you find how long it is in mm without measuring?"
   - "If 1 cm = 10 mm, what part of a cm is 1 mm? 2 mm? 4 mm? 8 mm? 10 mm?"
   - "If an object is 7 mm long, how long is it in cm?"
   - "If an object is 35 mm long, how long is it in cm?"
   - "If an object is 83 mm long, how long is it in cm?"
   - "If the length of an object is given in mm, how can you find how long it is in cm without measuring?"

f) Show students how to record the relationship between mm and cm.
   - 1 cm = 10 mm
   - 1 mm = 0.1 cm

g) Help students understand the relationship between m and mm by asking:
   - "How many cm are in 1 metre?"
   - "How many mm are in 1 cm?"
   - "If there are 10 mm in 1 cm and 100 cm in 1 metre, how many mm are in 1 metre?"

   Have students use a metre stick to show why their answers are correct.

h) Check students' understanding of the relationship between mm and m by asking:

- "How many mm are in 1 m? 2 m? 3 m? 5 m? 8 m? 10 m?"
- "If the length of an object is given in m, how can you find how long it is in mm without measuring?"
- "If there are 1000 mm in one m, what part of a m is 1 mm? 2 mm? 10 mm? 25 mm? 100 mm?"
- "If an object is 1000 mm long, how long is it in m?"
- "If an object is 3000 mm long, how long is it in m?"
- "If an object is 6000 mm long, how long is it in m?"
- "If the length of an object is given in mm, how can you find how long it is in m without measuring?"

i) Show students how to record the relationship between m and cm.

- 1 m = 1000 mm
- 1 mm = 0.001 m

Emphasize that "milli" means thousandths so 1 mm means 1 thousandth of a metre.

Observation Checklist

Observe students to determine whether they can do the following:

- ❑ find the lengths of line segments by using and reading their cm rulers correctly
- ❑ record measurements correctly (e.g., recorded measurements include both a number and the unit)
- ❑ recognize the relationship between mm and cm
- ❑ recognize the relationship between mm and m
- ❑ convert cm to mm and vice versa
- ❑ convert mm to m and vice versa

Materials: *I have, who has…?* cards (BLM 5.SS.7)

Organization: Whole class

Procedure:

a) Tell students that they will be playing a metric version of the game "I have, who has…?". Explain that each student will get one card (some students may get two cards if there are fewer than 30 students in the class). One student will start the game by reading his or her card, and the person who has the answer to the question posed by this student reads his or her card. Play continues in this fashion until it gets back to the person who started the game.

b) After the students have played the game several times, have them make their own metric conversion *I have, who has…?* game and play it with the other members of the class.

Variation: Have students work in groups of 2 or 3, giving them several of the cards. Play the game as a class as you would in (a) and (b) above. This gives students the opportunity to engage with more than one card.

Observation Checklist

Monitor students' responses to determine whether they

- ❑ multiply or divide by tens, hundreds, or thousands
- ❑ add, subtract, multiply, or divide numbers other than powers of 10
- ❑ know the relationship between m, cm, and mm

Materials: cm rulers, stir sticks, books, erasers, soda cans, and pencil cases

Organization: Pairs/Whole class

Procedure:

a) Present the following problem to students:

- Martin drew a line that was 64 mm long. His friend Zack measured the line segment and said that it was 6.4 cm long. Is Zack right? How do you know?

b) Make sure students understand the problem by asking:

- "How long is the line that Martin drew?"
- "What else do you know?"
- "What do you need to find out?"

c) Have students work with their partner to solve the problem. When they finish, have them share their solutions with the other members of the class, and discuss why the two measurements are the same.

Note: Some students will be able to solve the problem by reasoning while others will need to use their cm rulers and draw the line.

d) Check students' understanding of how to express measurements to the nearest tenth of a cm by asking:

- "What is 37 mm expressed in cm?"
- "What is 93 mm expressed in cm?"
- "What is 58 mm expressed in cm?"
- "What is 116 mm expressed in cm?"

Have students use their cm rulers to justify their answers.

e) Have students make and complete the following table:

Object	Estimated Length	Length to Nearest Tenth of a cm	Length to Nearest mm
A stir stick			
Thickness of a book			
An eraser			
Distance around a can of soda			
Width of a pencil case			

f) Have students express each of the following measurements in mm:

- 25.1 cm
- 85.6 cm
- 37.9 cm
- 12.2 cm

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ record a measurement to the nearest tenth of a cm
- ❑ convert mm to the nearest tenth of a cm and vice versa
- ❑ understand that 10 mm is the same as 1 cm
- ❑ read and interpret measurements expressed in decimals
- ❑ make reasonable estimates

Caution: In some communities, playing cards are seen as a form of gambling and discouraged. Please be aware of local sensitivities before introducing this activity.

Materials: Deck of cards for each group

Organization: Small groups of 2 to 4 students

Procedure:

a) Tell students they will be playing the *Metric Convert* game, and explain how it is played.

   1. Shuffle the cards and place them face down on the playing area.
   2. The numbers on the cards represent mm. Let aces = 1 mm, jacks = 11 mm, queens = 12 mm, and kings = 13 mm.
   3. One player turns over a card and places it in the centre of the playing area so everyone can see it.
   4. The first player to convert mm to cm correctly takes the card (e.g., if an 8 is turned over, the first player to say 0.8 [8 tenths] cm wins the card).
   5. If there is a tie or an error is made, the card is put back into the deck and the cards are reshuffled.
   6. The person who wins the cards turns over the next card.
   7. The game proceeds in this fashion until there are no cards.
   8. The person with the most cards is the winner.

b) Demonstrate how the game is played and answer any questions students might have. Have students play the game.

c) Vary the game by having the students convert from

   - cm to mm
   - m to cm
   - m to mm
   - mm to m

Observation Checklist

Observe students to determine whether they

❏ know the relationships between mm, cm, and m

❏ calculate correctly

NOTES

Grade 5: Shape and Space (Measurement) (5.SS.3)

Enduring Understandings:

All measurements are comparisons.

Length, area, volume, capacity, and mass are measurable properties of objects.

The unit of measure must be of the same nature as the property of the object being measured.

General Outcome:

Use direct or indirect measurement to solve problems.

Specific Learning Outcome(s):	Achievement Indicators:
5.SS.3 Demonstrate an understanding of volume by ■ selecting and justifying referents for cm^3 or m^3 units ■ estimating volume by using referents for cm^3 and m^3 ■ measuring and recording volume (cm^3 or m^3) ■ constructing rectangular prisms for a given volume [C, CN, ME, PS, R, V]	➛ Identify the cube as the most efficient unit for measuring volume and explain why. ➛ Provide a referent for a cubic centimetre and explain the choice. ➛ Provide a referent for a cubic metre and explain the choice. ➛ Determine which standard cubic unit is represented by a given referent. ➛ Estimate the volume of a 3-D object using personal referents. ➛ Determine the volume of a 3-D object using manipulatives and explain the strategy. ➛ Construct a rectangular prism for a given volume. ➛ Explain that many rectangular prisms are possible for a given volume by constructing more than one rectangular prism for the same volume.

Prior Knowledge

Students may have had experience with the following:

- Using direct comparison to compare the volume of two objects
- Identifying attributes of objects that can be compared
- Demonstrating an understanding of measurement as a process of comparing by filling
- Describing and constructing rectangular prisms
- Measuring the lengths of objects in m or cm

Background Information

The terms *volume* and *capacity* are often used interchangeably. For the purposes of the learning experiences in this section and the section that follows, a distinction will be made. Volume is the amount of space an object occupies or, if the object is hollow, the amount of space inside the object. Volume is measured in cubic centimetres (cm^3) or cubic metres (m^3).

Capacity is the maximum amount of liquid a container can hold. Capacity is measured in litres (L) and millilitres (mL).

Mathematical Language

Cubic unit (centimetre and metre)

Dimension

Rectangular prism

Length (width, height)

Less (least) volume

More (greatest) volume

Same volume

Volume

Learning Experiences

- **Identify the cube as the most efficient unit for measuring volume and explain why.**
- **Determine the volume of a 3-D object using manipulatives and explain the strategy.**

Materials: A variety of small boxes, cubes, marbles, other 3-D shapes such as a triangular prism or pyramid, and sand

Organization: Whole class/Small group

Procedure:

a) Show students the insides of two empty boxes. Ask, “Which box has more space inside? How can we tell for sure?”

b) Explain that volume is the amount of space inside a container or the number of units needed to fill the container. Ask, “What unit do you think we should use to measure volume?”

c) Give each group a box and three possible units: marbles, cubes, and triangular prisms (or any other shape). Tell students that their task is to determine which unit is best for measuring volume. Explain that they will be measuring the volume of their box three times. Each time they will completely fill the box with one of the units. Explain that when filling the box they should lay the units carefully on the bottom of the box, record the number used, and then fill the box layer by layer. Ask students to record the total number of units used as well as their observations on the appropriateness of the unit.

d) Have students share their observations about the different units. Help them recognize that the cube is the best unit to use because it is easy to stack and there are no gaps or overlaps when filling the containers (e.g., have students pour sand into a box filled with marbles to show them that there are gaps between the marbles).

Observation Checklist

Observe students to determine whether they can do the following:

- ❑ measure the volume of the box correctly (e.g., completely fill the box with a unit and count the number of units used)
- ❑ record both the number and the unit of measure
- ❑ recognize that the cube is the most efficient unit for measuring volume and explain why

- **Determine the volume of a 3-D object using manipulatives and explain the strategy.**

Materials: Small boxes and cubes

Organization: Pairs or small groups

Procedure:

a) Give each group four or five boxes. Have students label the boxes A, B, C, D….

b) Have students look at the labelled boxes, and decide which one they think has the smallest volume and which one has the largest volume. Ask them to put the boxes in order from the smallest volume to the largest volume and to record the order they have decided on.

c) Have students measure the volume of each box to the nearest whole unit and record their measurements in a table like the one shown below. Have students record the actual volume of the containers and compare it with their estimated volume.

Box	Estimated Volume	Actual Volume
A		
B		
C		
D		

d) Have each group share its findings with the rest of the class. Encourage students to discuss the strategies they used to determine the volume of the boxes, particularly when the number of cubes was not an exact fit (e.g., when there was some space around the layers).

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❏ compare and order containers according to their volume
- ❏ make reasonable estimates of the volume of containers
- ❏ determine the volume of an object using manipulatives and explain the strategy
- ❏ record measurements that include both a number and the unit
- ❏ use the terms more (greatest) volume, less (least) volume, and the same volume correctly

- **Identify the cube as the most efficient unit for measuring volume and explain why.**
- **Provide a referent for a cubic centimetre and explain the choice.**

Materials: Different sizes of boxes, different sizes of cubes, a white rod from a set of Cuisenaire rods, and centicubes

Organization: Small groups

Procedure:

a) Present students with the following situation:
   - A box Nicky measured has a volume of 18 cubic units. She gave the box to Cathy. When Cathy measured the volume of the box, she found it had a volume of 26 cubic units. Could both girls' measurements be correct? Why or why not?

b) Encourage students to devise and carry out a plan to prove their assertions about the situation.

c) Have students share their results and reasoning with the other members of the class. Encourage students to discuss the need for a standard unit of measure and the reasons why it is important to use common units (e.g., to facilitate communications, business, and trade).

d) Show students a white rod from the set of Cuisenaire rods or a centicube, and explain that in the metric system a cubic centimetre is one of the units used to determine the volume of an object. Show students the word and the symbol for the unit.

e) Tell students that they will be using the white rods (or centicubes) to complete the following activity:
   1. Find a container that has a volume that is
      - greater than 80 cm^3
      - less than 40 cm^3
      - between 50 and 60 cm^3
   2. Find as many objects as you can that have a volume of 1 cm^3.

f) Have students share their findings with the rest of the class. Encourage students to discuss the strategies they used to find the containers and the objects they found that are approximately 1 cm^3. Start a class list of objects that have a volume of 1 cm^3. Encourage students to look outside the classroom for objects that have a volume of approximately 1 cm^3 and add them to list.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ recognize the need for a standard unit
- ❏ determine the volume of an object using manipulatives and explain the strategy
- ❏ identify objects that have a volume of approximately 1 cm^3

- **Estimate the volume of a 3-D object using personal referents.**
- **Determine the volume of a 3-D object using manipulatives and explain the strategy.**
- **Construct a rectangular prism for a given volume.**
- **Explain that many rectangular prisms are possible for a given volume by constructing more than one rectangular prism for the same volume.**

Materials: Centimetre grid paper (BLM 5–8.9), centicubes, scissors; tape, copies of the instructions for the activity (BLM 5.SS.3.1), and observation form (BLM 5–8.1)

Organization: Small groups

Procedures:

a) Tell students that they will be using BLM 5.SS.3.1 to complete an investigation involving volume.

b) Help students determine what should be included in their reports and the criteria for evaluating them. Encourage students to consider such things as the accuracy of their measurements, the strategies they used to determine the volumes of the open boxes, and the clarity of their explanation of what happens to the volume as the dimensions of the open boxes change.

Observation Checklist

- ❏ Use the observation form (BLM 5–8.1) to observe how well students work together.

- **Estimate the volume of a 3-D object using personal referents.**
- **Determine the volume of a 3-D object using manipulatives and explain the strategy.**

Material: Centicubes, small boxes such as a shoebox or a cereal box, a list of the volumes of the boxes, and math journals

Organization: Small groups/Whole class

Procedure:

a) Give each group four or five small boxes and only enough centicubes to cover the bottom of each box separately, plus enough to make one stack the height of each box.

b) Ask students to estimate the volume of each box, and to record their estimates in their math journals. Explain that there are not enough centicubes to completely fill any box; however, they can use the centicubes that they have been given to help them make their estimates. When they finish estimating the volumes of the boxes, they should compare their estimates with the list of the volumes of the boxes that you have prepared.

c) Have students share the strategies they used to estimate the volumes of each box.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ explain the strategy they used to determine the volume of the boxes
- ❑ use a referent to make reasonable estimates of the volume of the boxes

- **Construct a rectangular prism for a given volume.**
- **Explain that many rectangular prisms are possible for a given volume by constructing more than one rectangular prism for the same volume.**

Materials: Centicubes, or the white rods from a set of Cuisenaire rods, or multilink cubes

Organization: Pairs

Procedure:

a) Tell students that they will be making rectangular prisms with their centicubes and determining their volumes. Show students a rectangular prism made with 10 cubes. Ask students what the volume of the prism is, and how they know.

b) Have students complete the following activity:

1. Construct a rectangular prism with a volume of
   - 12 cm^3
   - 16 cm^3

   Record the dimensions of the prisms you made.
2. Build two rectangular prisms, side by side, so that one prism has a volume of 6 cm^3 more than another. Record the dimensions of each prism.
3. Make two rectangular prisms with the same length, with one wider and shorter than the other, but with different volumes. Record the dimensions of each prism.
4. Make two rectangular prisms with the same length, with one wider and shorter than the other, but with the same volume. Record the dimensions of each prism.
5. Make as many rectangular prisms as you can that have a volume of 24 cm^3. Record the dimensions of each prism that you make.
6. Make three rectangular prisms with the following dimensions:
   - 6 cm x 6 cm x 6 cm
   - 3 cm x 12 cm x 6 cm
   - 3 cm x 9 cm x 8 cm

   Find the volume of each prism. Record the dimensions of each prism and its volume.
7. Think about the rectangular prisms that you made. What can you conclude about the volume of prisms? Record your observations.

When students finish each part of the activity, have them share their results with the other members of the class.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ construct a rectangular prism with a given volume
- ❑ recognize that different rectangular prisms are possible for a given volume
- ❑ recognize that rectangular prisms with different dimensions can have the same volume
- ❑ recognize that if one dimension of two rectangular prisms is the same, the volume of the prisms is not necessarily the same
- ❑ recognize that the volume of a rectangular prism is dependent on its dimensions

- **Provide a referent for a cubic metre and explain the choice.**
- **Determine which standard cubic unit is represented for a given referent.**

Materials: Metre sticks, plasticine, cardboard, scissors, and tape

Organization: Small groups/Whole class

Procedure:

a) Ask students to think of containers they see inside and outside of school whose volume should be measured in cm^3. Keep a list of their suggestions. Finish the discussion by asking, "Are there any containers or objects that are too large to be measured with a cm^3?"

b) Have each group develop a list of containers or objects that would require a larger unit of measure. When students finish, have them share their list with the other members of the class.

c) Explain that in the metric system the volumes of very large items or containers are measured in cubic metres. Ask students to show with their hands how large they think a cubic metre is.

d) Have each group make a model of a cubic metre. Some groups can make their cubic metre using 12 metre sticks (or wooden dowels 1 metre in length) joined with plasticine or masking tape, while other groups can draw and cut out six 1 metre squares from heavy cardboard and join the squares with masking tape.

e) Have students estimate how many students they think will fit into a cubic metre. Have them try it out and then discuss how their estimates compared with the actual number and the reasons why they may vary.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ identify containers or objects whose volumes should be measured in cubic centimetres
- ❏ identify containers or objects whose volumes should be measured with larger units
- ❏ make a cubic metre

- **Provide a referent for a cubic metre and explain the choice.**
- **Determine which standard cubic unit is represented for a given referent.**
- **Estimate the volume of a 3-D object using manipulatives and explain the strategy.**

Materials: Models of cubic metres

Organization: Whole class/Small groups

Procedure:

a) Have students refer to their models of a cubic metre to estimate whether the following objects have a volume greater than, less than, or about the same as a cubic metre:
   - their desk
   - a pop machine
   - a filing cabinet
   - a garbage can
   - a dump truck
   - a stove

   Encourage students to explain their reasons for their estimates.

b) Ask each group to make a list of items inside and outside of the classroom whose volume could be measured in cubic metres. Have the groups share their lists and explain the reasons for their choices.

c) Have each group refer to its model of a cubic metre to estimate the volume of
   - their classroom
   - the school gym
   - the principal's office

   Have the groups share their estimates and the strategies they used to determine the volumes of the rooms.

d) Have students discuss the question: "Does a cubic metre have to be a cube?"

   Note: Students should recognize from the previous activity that a cubic metre does not need to be a cube since prisms with different dimensions can have the same volume.

e) Have students collect and fill one of the cardboard cubic metres they made with an item they would like to give to charity (e.g., students could give a cubic metre of clothes that they have outgrown). Have students write a letter to the community and other classes in the school explaining what they are doing and inviting them to help collect the item they have chosen.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ identify objects or containers whose volume could be measured in cubic metres
- ❑ give reasonable estimates of containers or items whose volume could be measured in cubic centimetres
- ❑ explain the strategies they used to estimate the volumes of large containers and objects

NOTES

Grade 5: Shape and Space (Measurement) (5.SS.4)

Enduring Understandings:

All measurements are comparisons.

Length, area, volume, capacity, and mass are measurable properties of objects.

The unit of measure must be of the same nature as the property of the object being measured.

General Outcome:

Use direct or indirect measurement to solve problems.

SPECIFIC LEARNING OUTCOME(S):	ACHIEVEMENT INDICATORS:
5.SS.4 Demonstrate an understanding of capacity by ■ describing the relationship between mL and L ■ selecting and justifying referents for mL or L units ■ estimating capacity by using referents for mL or L ■ measuring and recording capacity (mL or L) [C, CN, ME, PS, R, V]	➛ Demonstrate that 1000 millilitres is equivalent to 1 litre by filling a 1-litre container using a combination of smaller containers. ➛ Provide a referent for a litre and explain the choice. ➛ Provide a referent for a millilitre and explain the choice. ➛ Determine which capacity unit (mL or L) is represented by a given referent. ➛ Estimate the capacity of a container using personal referents. ➛ Determine the capacity of a container using materials that take the shape of the inside of the container (e.g., a liquid, rice, sand, beads), and explain the strategy.

Prior Knowledge

Students may have had experience with the following:

- Identifying attributes of objects that can be measured
- Using direct comparison to compare the capacity of two objects
- Demonstrating an understanding of measurement as a process of comparing by filling
- Demonstrating an understanding of whole numbers less than 10 000
- Demonstrating an understanding of addition and subtraction of whole numbers with answers less than 10 000

Related Knowledge

Students should be introduced to the following:

- Providing a referent for one millimetre, one centimetre, and one metre

Background Information

The terms *volume* and *capacity* are often used interchangeably. For the purposes of the learning experiences in this section and the previous section, a distinction will be made. Volume is the amount of space an object occupies or, if the object is hollow, the amount of space inside the object. Volume is measured in cubic centimetres (cm^3) or cubic metres (m^3).

Capacity is the maximum amount of liquid a container can hold. Capacity is measured in litres (L) and millilitres (mL).

Mathematical Language

Capacity

More capacity

Less capacity

Same capacity

Estimate

Litre

Referent

Millilitre

- **Determine the capacity of a container using materials that take the shape of the inside of the container (e.g., a liquid, rice, sand, beads), and explain the strategy.**

Materials: A variety of containers (some of which should be transparent), funnels, water, sand (or any other material that will take the shape of containers), paper towels, sponges, and markers

Organization: Whole class/Small groups

Procedure:

a) Explain that we often hear expressions, such as the following:
   - "The room was filled to capacity."
   - "They played to a capacity crowd."

   Ask, "What does the word 'capacity' mean? How can we find the capacity of an object?"

b) Explain that in math we use the term *capacity* to describe how much liquid a container can hold, and to determine the capacity of a container we need a unit of measure.

c) Show students a transparent container. Show students how to measure the capacity of the container by using another smaller transparent container as the unit of measure. Repeat this activity two or three times to make sure students understand how to measure the capacity of a container.

d) Give each group four or five containers. Have students select one of their containers to be the unit of measure and label the other containers A, B, C, D….

e) Have students look at the labelled containers and decide which one they think has the smallest capacity and which one has the largest capacity. Ask them to put the containers in order from the smallest capacity to the largest capacity, and to record the order they have decided on.

f) Have students give their unit a name. Have them measure each container and record their measurements in a table like the one shown below. Have students record the actual order of the containers, and compare it with their estimated order.

Container	Estimated Capacity	Actual Capacity
A		
B		
C		
D		

g) Have each group share its findings with the rest of the class. Encourage them to describe how the real order of the containers compared with their estimated order.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ use the terms "more capacity," "less capacity," and "the same capacity" correctly
- ❑ measure correctly (students completely fill the unit over and over again until the container being measured is full)
- ❑ record their measurements correctly (includes both a number and the unit)
- ❑ give reasonable estimates of capacity
- ❑ compare and order containers according to their capacities

Materials: A wide variety of containers, masking tape, spoons, large plastic glasses or jars, water, markers, paper towels, sponges, and procedure steps (BLM 5.SS.4.1)

Organization: Pairs

Procedure:

a) Have students use the following procedure to make their own measuring device:
   1. Put a piece of masking tape down the side of a glass (or jar).
   2. Fill a small container with spoonfuls of water, keeping track of the number of spoonfuls needed to fill it.
   3. Empty the water in the small container into the glass.
   4. Mark the level of the water and the number of spoonfuls on the tape.
   5. Fill the small container again. Empty the water into the glass. Mark the level of the water and the total number of spoonfuls.
   6. Continue filling and marking the glass until the top is reached.

b) Make sure the students know how to read and use their measuring device. Have them use their measuring device to find the capacity of five different containers in two different ways. Have the students record their findings in the chart provided in BLM 5.SS.4.1.

c) Have students write a paragraph describing the two different ways they found the capacity of their containers. Have students share and discuss their methods with the other members of the class.

d) Have students exchange their containers with another group. Have them use their measuring device to determine the capacity of these containers and record their findings in a table.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ use the terms "more capacity," "less capacity," and "the same capacity" correctly
- ❑ determine the capacity of a container by filling it with water using their measuring device
- ❑ determine the capacity of a container by filling it, and then pouring its contents into the measuring device to see how much it holds
- ❑ measure correctly (e.g., completely fill the container)
- ❑ read their measuring devices correctly
- ❑ record their measurements correctly (include both the number and the unit)

- **Estimate the capacity of a container using personal referents.**
- **Determine the capacity of a container using materials that take the shape of the inside of the container (e.g., a liquid, rice, sand, beads), and explain the strategy.**

Materials: Containers (some containers should be greater than a litre, less than a litre, and equal to a litre), water, sand (and other material that takes the shape of a container), student-made measuring devices, litre measuring devices, masking tape, and markers

Organization: Small groups

Procedure:

a) Give each group the same two containers. Have some of the groups use their measuring devices to determine the capacity of the containers. Have other groups select another container to be their unit. Have these groups name their unit and find the capacity of their containers.

b) Have students share their measurements. List their measurements on the board and ask why they differ. Ask students what they could do so everyone would get the same measurement. Help students recognize the need for a standard unit of measure and the reasons why it's important to use standard units (e.g., the use of standard units facilitates business and trade).

c) Tell students that in the metric system the litre is the standard unit of measure for capacity. Show students an unmarked litre container and tell them that a litre is the amount of the liquid it can hold. Also, show students how to write the word and the symbol for the unit.

d) Give each group five or six containers. Have the students label the containers from A to F and then make a list in their math journal of the containers they think are less than a litre, the same as a litre, and larger than a litre.

e) Have students use the unmarked litre containers to measure the capacity of each container. Explain that they should not fill any container higher than the bottom part of the neck of the container. Ask students to write the letter of each container in their math journal, and record whether its capacity is greater than a litre, less than a litre, or the same as a litre.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ determine the capacity of a container using materials that take the shape of the container
- ❑ measure correctly (e.g., fill the litre-measuring container and the containers they are measuring to the right levels)
- ❑ record measurements properly (e.g., use the correct symbol for a litre)
- ❑ make reasonable estimates of capacity

Materials: Litre-measuring containers, a variety of containers, water, sand, or any other material that takes the shape of a container, a pitcher, a water pail, and a wastepaper basket

Organization: Whole class/Small groups

Procedure:

a) Have students provide examples of when they would need to estimate the capacity of a container, and discuss how they can ensure that their estimates are reasonable.

b) Ask each group to find two common containers they can use as a referent for a litre.

c) Have the groups share their referents with each other and keep a class list of referents for a litre.

d) Show students a large pitcher, a wastepaper basket, and an empty water pail. Ask them to think of their referent and then estimate the capacity of each container. Have the students check their estimates by measuring each item.

e) Ask students to estimate the capacity of a bathtub. Help them devise and carry out a plan to check their estimates.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ provide a referent for a litre and explain their choice
- ❑ make reasonable estimates of the capacities

- **Provide a referent for a millilitre and explain the choice.**
- **Estimate the capacity of a container using personal referents.**
- **Determine the capacity of a container using materials that take the shape of the inside of the container (e.g., a liquid, rice, sand, beads), and explain the strategy.**

Materials: Beakers calibrated in mL, graduated cylinders calibrated in mL, an eyedropper, baby food jars, tin cans, small milk cartons, small soda cans, pickle jars, ketchup bottles, water, paper towels, funnels, and sponges, capacity table (BLM 5.SS.4.1)

Organization: Whole class/Small group

Procedure:

a) Show students a small container, such as an empty tuna can or empty baby food jar, and ask them how they could find the capacity of the container.

b) Explain that to find the capacity of smaller containers, we need a new unit of measure. The unit that is commonly used is the millilitre. Tell students that the millilitre is a very small unit about the size of a drop from an eyedropper. Fill an eyedropper with water and show students several drops so they can begin to conceptualize how large the unit is.

c) Explain that because the unit is so small, we often use measuring devices that are marked off in millilitres. Show students different measuring devices that are calibrated in mL, and explain how they should use them to find the capacity of a container.

d) Have students measure the capacity of each object listed below in two different ways and record their results in the table from 5.SS.4.1.

- **Demonstrate that 1000 millilitres is equivalent to 1 litre by filling a 1-litre container using a combination of smaller containers.**

Materials: A 500 mL beaker, a 250 mL beaker, a 100 mL beaker, and a 50 mL beaker; unmarked litre containers, water, funnels, paper towels, and math journals

Organization: Small groups/Whole class

Procedure:

a) Show students the litre container and tell them that their job is to determine the number of mL in a litre.

b) Have students estimate the number of 50 mL beakers of water it will take to fill the litre container. Have them record their estimates in a table like the one shown below.

Beaker	Estimated Number of Beakers	Actual Number of Beakers	Total Number of mL
50 mL			
100 mL			
250 mL			
500 mL			

c) Have students check their estimates by filling the litre container with 50 mL beakers of water and record their results in the table.

d) Repeat the activity using the 100 mL beaker, the 250 mL beaker, and the 500 mL beaker.

e) Have students compare their results with another group. Ask them what they can conclude about the relationship between a mL and a litre.

f) Give students the following problem and have them record their solution in their math journals:

   - Jessi has a container that holds 1425 mL of liquid. Is Jessi's container smaller than or larger than a litre? How do you know? How much larger or smaller than a litre is Jessi's container?

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ demonstrate that there are 1000 mL in a litre using a variety of smaller containers
- ❑ measure correctly (fill the beakers properly)
- ❑ record the measurements correctly
- ❑ solve a problem involving the relationship between millilitres and litres

Materials: Cards numbered from 0 to 9 (BLM 5–8.5), paper and pencil

Organization: Small groups/Whole class

Procedure:

a) Tell students that they will be playing a game involving the relationship between a litre and a millilitre. Explain how the game is played

1. Players should make the following grid on their papers:

			mL	+				mL

2. Shuffle the cards and place them face down on the playing area.
3. Turn over one card. Players decide where they want to write that number on their grid. Once a number has been placed on the grid, it cannot be changed.
4. The next card is turned over and the players now place this number on their grids. Play continues until six numbers have been turned over and each player has placed the numbers on his or her grid.
5. The players add the millilitre quantities and the player or players closest to 1 litre receive one point.
6. Reshuffle the cards, make new grids, and play the game again.
7. Continue playing the game. The first player to reach 10 points is the winner.

b) Demonstrate how the game is played and answer any questions students might have. Have students play the game.

c) Vary the game so that the player with the sum closest to 500 mL wins a point.

Observation Checklist

Observe students to determine whether they

- ❏ know the relationship between mL and litres
- ❏ calculate correctly

Putting the Pieces Together

Planning a Healthy Meal

Purpose:

The purpose of this investigation is to have students apply their knowledge of capacity to a real-world situation. In particular, it is designed to reinforce students' abilities to

- measure the capacity of containers
- estimate the capacity of containers
- record the capacity of containers

The investigation is also designed to enhance students' abilities to

- communicate mathematically
- solve problems
- reason mathematically
- connect mathematics to real-world situations and other subject areas (PE/HE)

Materials/Resources

- Centimetre measuring cubes
- Assorted containers
- Food groups guide (can be found on the Internet)
- Water, sand, or other material that takes the shape of a container
- Cylinders or beakers calibrated in mL
- Paper towels
- Markers

Organization: Whole class/Small groups

Procedure:

a) Tell students that each group will be responsible for planning a healthy breakfast or lunch. Since the capacity of the human stomach is approximately 1 litre, the meal they planned should not contain more than 800 mL of food. In planning their meal, they should

- use the food guide to help them select foods from each food group
- include foods that are available locally
- indicate the quantity of each food in mL

b) Have students design their meals. When they finish planning their meal, have them find a container with the same capacity as each item on their menu. Have students label each container by indicating the item of food it represents and its capacity.

c) Have each group display its menu and corresponding containers. Have students explain why their meals are nutritious and how the capacities of the different items add up to an 800 mL meal.

Observation Checklist

Observe students' responses to determine whether they can do the following:

❑ plan a meal that meets the criteria specified in part (a)

❑ make reasonable estimates of the capacities of containers

❑ measure the capacity of containers correctly

❑ record the capacity of containers correctly

NOTES

Grade 5: Shape and Space (3-D Objects and 2-D Shapes) (5.SS.5)

Enduring Understandings:

Shapes are distinguished by their properties.

General Outcome:

Describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationship between them.

Specific Learning Outcome(s):	Achievement Indicators:
5.SS.5 Describe and provide examples of edges and faces of 3-D objects, and sides of 2-D shapes, that are ■ parallel ■ intersecting ■ perpendicular ■ vertical ■ horizontal [C, CN, R, T, V]	➛ Identify parallel, intersecting, perpendicular, vertical, and horizontal edges and faces on 3-D objects. ➛ Identify parallel, intersecting, perpendicular, vertical, and horizontal sides on 2-D shapes. ➛ Provide examples from the environment that show parallel, intersecting, perpendicular, vertical, and horizontal line segments. ➛ Find examples of edges, faces, and sides that are parallel, intersecting, perpendicular, vertical, and horizontal in print and electronic media, such as newspapers, magazines, and the Internet. ➛ Draw 2-D shapes or 3-D objects that have edges, faces, and sides that are parallel, intersecting, perpendicular, vertical, or horizontal. ➛ Describe the faces and edges of a given 3-D object using terms such as parallel, intersecting, perpendicular, vertical, or horizontal. ➛ Describe the sides of a 2-D shape using terms such as parallel, intersecting, perpendicular, vertical, or horizontal.

Prior Knowledge

Students may have had experience with the following:

- Identifying cubes, spheres, cones, cylinders, pyramids, triangular prisms, and rectangular prisms
- Identifying triangles, squares, rectangles, and circles
- Identifying the faces, edges, and vertices of 3-D objects
- Sorting regular and irregular polygons including triangles, quadrilaterals, pentagons, hexagons, and octagons according to the number of sides

Related Knowledge

Students should be introduced to the following:

- Identifying and sorting quadrilaterals

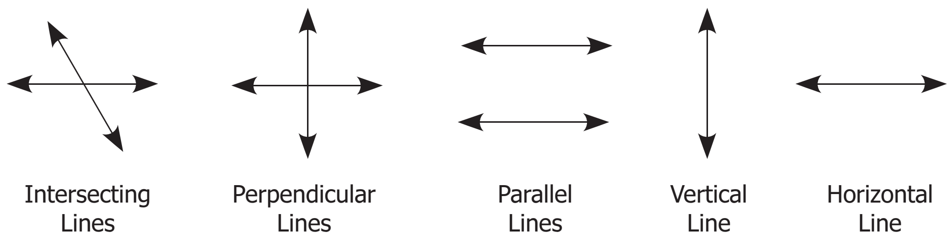
Background Information

Points, lines, and planes are the building blocks of geometry. These concepts are undefined and, like number, they are abstractions that cannot be seen or touched. Students' understanding of these concepts evolves from their experiences with physical objects (e.g., the tip of a pencil, the corner of a table or block, and the dot drawn on a piece of paper suggest the idea of a point to students).

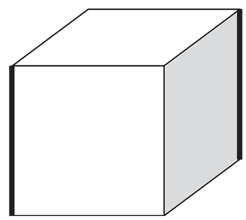
Lines are sometimes described as a set of points extending endlessly in two directions. They have length but no other dimension. Physical models, such as a rope stretched out, a wire held taut, and the centre line on a highway, can help students develop an understanding of this concept. A **line segment** is part of a line. It consists of two endpoints and all the points between them. Examples of line segments include the rungs of a ladder, the edges of a box, and the bars in a grill.

A **plane** is two-dimensional. Any smooth, flat surface, such as a tabletop, a floor, or a ceiling, can be thought of as a plane. However, each of these models is only a part of a plane because a plane extends infinitely in two directions.

Two lines in a plane can intersect or be parallel to each other. **Intersecting lines** have one point in common; **parallel lines** have no points in common. The distance between them is the same everywhere. Sometimes lines intersect at right angles. These lines are **perpendicular**. Because students are not introduced to angles until Grade 6, perpendicular lines are described as two lines that form "square" corners. In addition, lines can be either horizontal or vertical. A **horizontal line** is a line that is parallel to the horizon. A **vertical line** is a line that is at right angles to the horizon. Students usually describe horizontal lines as going across, and vertical lines as going up and down. However, their perception of whether a line is horizontal or vertical might differ according to their perspective.



When describing the edges of prisms, some students may think that any two line segments that do not intersect are parallel. For example, consider the cube shown below:



Some students may think the two dark edges are parallel since they do not intersect. However, these edges lie in different planes and therefore are not parallel.

Mathematical Language

Cone	Parallel lines
Cube	Perpendicular lines
Cylinder	Pyramid
Edge	Rectangular prism
Face	Sphere
Horizontal line	Triangular prism
Intersecting line	Vertex (Vertices)
Line	Vertical line
Line segment	

Assessing Prior Knowledge

Materials: A set of 3-D objects that includes a cone, sphere, cylinder, a pyramid, a cube, a rectangular prism, and a triangular prism

Organization: Whole class/Individual

Procedure:

a) Put the 3-D objects in a place where all students can see them. Tell the students that you will be asking them some questions about the shapes to find out what they already know about them.

b) Tell students they can look at the shapes to help them identify the 3-D objects or parts of objects that fit the following clues:

1. I have six faces all the same size and shape. (cube)
2. I am formed by the intersection of two faces. (edge)
3. Two of my faces are circular. (cylinder)
4. I am the point where three or more edges meet. (vertex)
5. I have six rectangular faces. (rectangular prism)
6. I have no flat faces. (sphere)
7. My shape is found on every pyramid. (triangle)
8. We are the faces found on a triangular prism. (triangle and rectangle)
9. I am one face of a cone. (circle)

Observation Checklist

- ❑ Use students' responses to the questions to determine whether further review on the identification and characteristics of 3-D objects and 2-D shapes is needed.

- **Provide examples from the environment that show parallel, intersecting, perpendicular, vertical, and horizontal line segments.**

Materials: Copies of the concept description sheet (BLM 5–8.2).

Organization: Individual/Whole class

Procedure:

a) Tell students that in the next few lessons they will be learning about lines and today they will be discussing what a line is. Before beginning the discussion, you want them to write down what they already know about lines.

b) Have students complete the concept description sheet. Let students know that it is alright if they cannot think of anything to put in a section. They will have another opportunity to complete the sheet when they learn more about lines.

c) When students finish, begin a discussion by asking, “What is a line? What are some examples of lines?” As the discussion progresses, clear up any misconceptions students may have about lines and make sure they see a variety of examples and non-examples.

d) Have students add to their concept description.

Observation Checklist

Monitor students’ responses to determine whether they can do the following:

- ❑ describe the characteristics of a line (e.g., it continues indefinitely in two directions)
- ❑ identify examples of a line
- ❑ identify non-examples of a line

Material: A long rope or a skein of yarn

Organization: Whole class

Procedure:

Note: This activity could be done in the gym or outside.

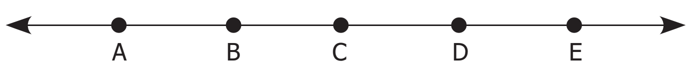
a) Take students outside to the playground. Stretch the rope across the playground. Have students hold onto the rope and hold it taut. Tell students that the rope represents a line that keeps going forever (e.g., if they were to tie another piece on the end and pull it taut, the line would continue). Have students discuss what things the line would go through as it goes beyond each end of the rope. Discuss how they think they could show that the rope/yarn would continue on.

b) Tell students that everyone holding onto the line is a point and the space between each pair of them is a line segment or part of a line. Name the line segments using the students' names (e.g., line segment Jack and Josie). Call out the names of several line segments. Each time you call out a line segment, have the named students hold on to the rope and the students between them let go to show how long the line segment is. Have students take turns naming line segments.

c) Ask students to remember who is standing on either side of them. Return to the classroom and draw an arrow on the chalkboard. Put an arrow on either end to indicate that the line goes on forever. Indicate points on the line and write the names of the students under them.

d) Have students discuss the differences between their experiences outdoors and the ideas represented by the line on the board. For example, students should note that the arrows on the line indicate that the line goes on forever, and the points where students' names appear show that a line segment has definite ends.

e) Explain that in math we use a double arrow to indicate a line and capital letters instead of students' names to indicate points on the line. Draw another line on the board. Name several line segments and have students identify where they are on the line.



Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ recognize that a line extends infinitely in two directions
- ❑ recognize that a line segment is part of a line
- ❑ name line segments correctly

- **Identify parallel, intersecting, perpendicular, vertical, and horizontal sides on 2-D shapes.**
- **Provide examples from the environment that show parallel, intersecting, perpendicular, vertical, and horizontal line segments.**
- **Draw 2-D shapes or 3-D objects that have edges, faces, and sides that are parallel, intersecting, perpendicular, vertical, or horizontal.**
- **Describe the faces and edges of a 3-D object using terms such as parallel, intersecting, perpendicular, vertical, or horizontal.**

Materials: Stir sticks or toothpicks, a mat or a rug

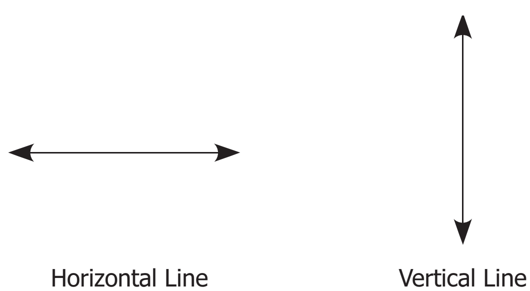
Organization: Whole class/Small group

Procedure:

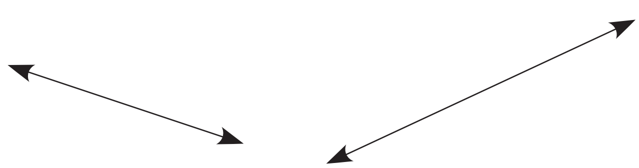
a) Have two or three students come to the front of the class. Ask them to lie down on the floor. Explain that when the students are lying on the floor they are horizontal. Now ask the students to stand up. Explain that when the students are standing up they are vertical.

b) Ask different students to either lie down or stand up. Have the other students indicate whether the students are horizontal or vertical.

c) Draw a horizontal and a vertical line on the board. Explain that, in math, lines can be horizontal or vertical. Lines that are lying down are horizontal and those that are standing up straight (go up and down on their paper) are vertical.



d) Draw several lines on the board like the ones shown below:



Ask, "Are these lines horizontal? Why or why not? Are the line segments vertical? Why or why not?"

e) Ask students to use the stir sticks to show the following:
   - A vertical line segment
   - A horizontal line segment
   - A line segment that is neither horizontal or vertical
   - A vertical line segment that crosses a horizontal line segment
   - A horizontal line segment that crosses a line segment that is not vertical
   - A horizontal line segment that crosses three vertical line segments
   - A vertical line segment that crosses two line segments that are neither horizontal nor vertical
   - Four horizontal line segments
   - Two vertical line segments and three horizontal line segments
   - A vertical line segment and two horizontal line segments and a line segment that is neither vertical nor horizontal

f) Have students identify whether the edge of their desk is a horizontal or a vertical line segment. Have them identify two or three other horizontal or vertical line segments in the room.

g) Ask each group to make a list of horizontal and vertical line segments that they see in the school. Have them share their lists with the other members of the class.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ use the terms "horizontal" and "vertical" correctly
- ❑ make vertical and horizontal line segments
- ❑ identify examples of horizontal and vertical line segments in the environment.
- ❑ identify line segments that are neither horizontal nor vertical

- Identify parallel, intersecting, perpendicular, vertical, and horizontal edges and faces on 3-D objects.
- Identify parallel, intersecting, perpendicular, vertical, and horizontal sides on 2-D shapes.
- Draw 2-D shapes or 3-D objects that have edges, faces, and sides that are parallel, intersecting, perpendicular, vertical, or horizontal.
- Describe faces and edges of a 3-D object using terms such as parallel, intersecting, perpendicular, vertical, or horizontal.
- Describe the sides of 2-D shapes using terms such as parallel, intersecting, perpendicular, vertical, or horizontal.

Materials: 20 stir sticks or toothpicks for each pair of students, cubes, rectangular prisms, pyramids, and triangular prisms

Organization: Pairs/Whole class

Procedure:

a) Show students a square made out of stir sticks. Have them identify the shape, as well as the horizontal and vertical line segments that form it.

b) Have students make as many shapes as they can with their stir sticks. Explain that a shape can be made with any number of stir sticks, but it must have only horizontal and vertical lines. Ask students to draw a picture of each shape they make. Tell students that they should write the name of each shape under it, and label the horizontal and vertical line segments.

c) Give a 3-D object to each pair of students. Ask students to discuss their shape with their partner, and then write a description of their shape in their math journal. Explain that they should write the name of the shape, and then use words and pictures to explain which edges and faces of their shape are horizontal and which are vertical.

Observation Checklist

Check students' work to determine whether they can do the following:

- ❑ construct 2-D shapes that have vertical and horizontal lines
- ❑ draw 2-D shapes that have vertical and horizontal lines
- ❑ identify the horizontal and vertical line segments on a 2-D shape
- ❑ identify the names of 2-D shapes
- ❑ identify the horizontal and vertical edges and faces of a 3-D object
- ❑ draw 3-D objects that have vertical and horizontal edges and faces

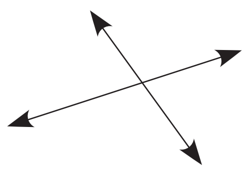
- **Identify parallel, intersecting, perpendicular, vertical, and horizontal edges and faces on 3-D objects.**
- **Identify parallel, intersecting, perpendicular, vertical, and horizontal sides on 2-D shapes.**
- **Provide examples from the environment that show parallel, intersecting, perpendicular, vertical, and horizontal line segments.**
- **Draw 2-D shapes or 3-D objects that have edges, faces, and sides that are parallel, intersecting, perpendicular, vertical, or horizontal.**

Materials: Stir sticks and orange pattern block squares

Organization: Small groups

Procedure:

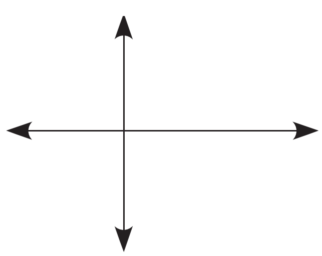
a) Draw the following line segments on the board or overhead. Explain that these lines are called intersecting lines because they cross each other.



Ask students to use their stir sticks to show

- three different pairs of intersecting line segments
- two line segments that do not intersect
- A line segment intersected by more than one line segment

b) Explain that sometimes lines intersect in a special way. Ask students what is special about how these two line segments intersect.



Explain that these lines are special because they form "square corners." Demonstrate this by placing the orange squares at the intersection of the lines.

Tell students that these lines are perpendicular.

Have students make three different pairs of perpendicular line segments with their stir sticks. Have them use the orange squares to show that each pair of lines forms a "square corner."

Ask students to make a pair of line segments that are not perpendicular and explain why they are not perpendicular.

c) Ask students what is special about this pair of lines (figure 1). Explain that lines that never meet are parallel. Demonstrate that the lines never meet by placing orange squares between the two lines (figure 2) and having students note that the distance between the two lines is the same everywhere.

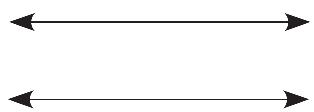


Figure 1

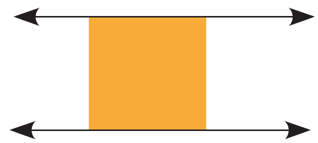


Figure 2

Ask students to make three different pairs of parallel line segments with their stir sticks. Have them demonstrate that the line segments are the same distance apart by using the orange squares or their rulers.

Have students make a pair of lines that are not parallel and explain why they are not parallel.

d) Ask each group to identify examples of parallel, intersecting, and perpendicular line segments inside and outside the classroom. Have them draw and label a diagram of each line segment pair, and list under each diagram real-world examples of the line segment pair.

e) Have each group share its examples of each type of line segment pair with the other members of the class.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ construct pairs of line segments that are parallel, perpendicular, and intersecting
- ❑ identify line segments that are not parallel
- ❑ identify line segments that are not intersecting
- ❑ identify line segments that are not perpendicular
- ❑ identify real-world examples of parallel, perpendicular, and intersecting line segments

- **Identify parallel, intersecting, perpendicular, vertical, and horizontal sides on 2-D shapes.**
- **Draw 2-D shapes or 3-D objects that have edges, faces, and sides that are parallel, intersecting, perpendicular, vertical, or horizontal.**

Materials: Paint or watercolours, black marker, and samples of Piet Mondrian artwork (can be found on the Internet)

Organization: Large group/Individual

Procedure:

a) Show students a picture of Piet Mondrian's artwork. Explain that Piet Mondrian was a Dutch painter who was famous for paintings that he called compositions.

b) Ask students to describe the picture. Encourage them to discuss the types of lines and shapes he used to create the picture.

c) Have students use black markers and watercolours to create a picture in the style of Piet Mondrian.

d) Display students' artwork on walls and conduct a gallery walk so students can look at each other's work.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ identify parallel, intersecting, perpendicular, vertical, and horizontal lines
- ❏ create a piece of artwork that is comprised of parallel, intersecting, perpendicular, vertical, and horizontal lines

Materials: Pattern blocks

Organization: Pairs

Procedure:

a) Ask students to use their pattern blocks to complete the following activity. Have them draw a sketch of each shape that they make.

1. Use two different blocks to make a shape with
   - exactly two pairs of parallel sides
   - exactly one pair of parallel sides
   - no parallel sides
2. Use three different blocks to make a shape with
   - exactly three pairs of parallel sides
   - exactly two pairs of parallel sides
   - exactly one pair of parallel sides
   - no parallel sides
3. What is the largest number of pairs of parallel sides of a shape you can make with
   - two pieces?
   - three pieces?
   - four pieces?
4. Can you use six different pattern blocks to make a shape with no parallel sides?

b) Have students share their shapes with the other members of the class. Encourage students to identify lines that are parallel, perpendicular, intersecting, vertical, and horizontal.

Observation Checklist

Monitor students' responses to determine whether they can do the following:

- ❑ identify parallel, intersecting, perpendicular, horizontal, and vertical line segments on 2-D shapes
- ❑ draw 2-D shapes with parallel, intersecting, perpendicular, horizontal, and vertical line segments

- **Identify parallel, intersecting, perpendicular, vertical, and horizontal edges and faces on 3-D objects.**
- **Describe the faces and edges of a 3-D object using terms such as parallel, intersecting, perpendicular, vertical, or horizontal.**

Materials: Cubes, rectangular prisms, square-based and triangular-based pyramids, and triangular prisms, cards with the names of the 3-D objects on them, one name per card (e.g., cube, rectangular prism, etc.), stir sticks or toothpicks, and plasticine

Organization: Small groups

Procedure:

a) Show students a triangular prism and ask them to describe it. Encourage students to identify the faces and edges that are parallel, intersecting, perpendicular, vertical, and horizontal.

b) Give each group a set of the 3-D objects. Have students take turns describing one of the shapes to the other members of their group. Encourage students to point out the faces and edges that are parallel, intersecting, perpendicular, vertical, and horizontal.

c) Give each student a card. Tell students you will be describing the characteristics of 3-D objects. If the shape on their card has that characteristic, they should stand up and show their card to the other members of the class. For example, if I say, "I am a 3-D object that has three pairs of parallel faces," then students who have cards with "cube" and "rectangular prism" written on them should stand up. The other members of the class have to check the cards to make sure that the right shapes have been identified.

d) Show students how to join toothpicks with plasticine to build a 3-D object. Have students use the materials to build 3-D objects that fit each set of characteristics.
   - Each edge is perpendicular to eight other edges. The edges are not all the same length. (rectangular prism)
   - There are six edges. No edges are perpendicular. (triangular pyramid)
   - The vertical edges are perpendicular to the horizontal edges. There are three vertical edges. (triangular prism)

e) Have students discuss questions like the following:
   - "Why are the roofs of most houses not parallel to the ground?"
   - "Why are the shelves of a bookcase parallel to the floor?"

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ identify faces of 3-D objects that are parallel, intersecting, perpendicular, horizontal, and vertical
- ❑ identify the edges of 3-D objects that are parallel, intersecting, perpendicular, horizontal, and vertical

Grade 5: Shape and Space (3-D Objects and 2-D Shapes) (5.SS.6)

Enduring Understandings:

Shapes are distinguished by their properties.

General Outcome:

Describe the characteristics of 3-D objects and 2-D shapes, and analyze the relationship between them.

SPECIFIC LEARNING OUTCOME(S):	ACHIEVEMENT INDICATORS:
5.SS.6 Identify and sort quadrilaterals, including ■ rectangles ■ squares ■ trapezoids ■ parallelograms ■ rhombuses according to their attributes. [C, R, V]	➛ Identify and describe the characteristics of a pre-sorted set of quadrilaterals. ➛ Sort a set of quadrilaterals and explain the sorting rule. ➛ Sort a set of quadrilaterals according to the lengths of the sides. ➛ Sort a set of quadrilaterals according to whether or not opposite sides are parallel.

PRIOR KNOWLEDGE

Students may have had experience with the following:

- Identifying quadrilaterals
- Identifying and explaining mathematical relationships using a Venn diagram

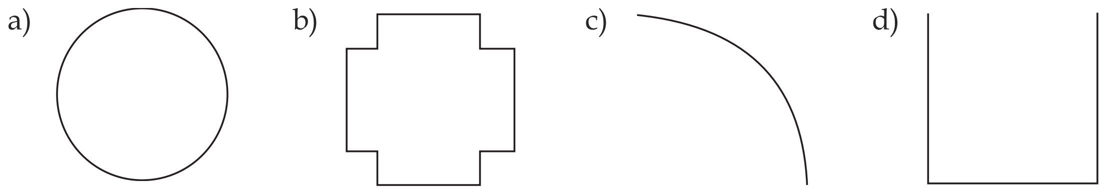
RELATED KNOWLEDGE

Students should be introduced to the following:

- Identifying parallel, perpendicular, horizontal, and intersecting line segments

Background Information

A simple closed curve is a curve that does not cross itself and can be drawn by starting and stopping at the same point (e.g., in the diagram below, figures (a) and (b) are simple closed curves while (c) and (d) are curves that are not closed).



Polygons are simple closed curves formed by the union of line segments. In the diagram above, (b) is the only polygon since it is both a simple closed curve and made up of line segments. The line segments that form the polygon are the **sides** of the polygon. A point where two sides meet is a vertex of the polygon.

Polygons can be classified according to the number of sides they have. The most common classifications are: **triangle** (three sides), **quadrilateral** (four sides), **pentagon** (five sides), **hexagon** (six sides), **heptagon** (7 sides), **octagon** (8 sides), **nonagon** (9 sides), **decagon** (10 sides), and **dodecagon** (12 sides). Other polygons are commonly referred to as *n*-gons, where *n* is the number of sides. For example, an eleven-sided polygon can be referred to as an 11-gon and a 14-sided polygon can be referred to as a 14-gon.

Quadrilaterals can be classified according to the number of parallel sides that they have. The definition of each type of quadrilateral is given below.

Trapezium—A quadrilateral with **no pairs** of parallel sides.

Trapezoid—A quadrilateral with **at least one pair** of parallel sides.

Some texts define a trapezoid as a quadrilateral with **exactly one pair** of parallel sides. If the support material you are using defines a quadrilateral in this way, students should be shown both definitions. This can help them understand that mathematics is not a rigid subject and that mathematicians do not always agree on the definition of a concept.

Parallelogram—A quadrilateral in which **each pair** of opposite sides is parallel. The opposite sides of parallelograms are also congruent (same length).

Rectangle—A parallelogram that has four right angles.

Rhombus—A parallelogram that has four congruent sides.

Square—A parallelogram that has four congruent sides and four right angles.

Students can be asked to examine how the different definitions affect their solutions to problems involving trapezoids. Even though the learning experiences focus on quadrilaterals that have parallel sides, some of the activities include quadrilaterals that have no parallel sides. This has been done to avoid giving students a flawed concept of a quadrilateral.

Mathematical Language

Congruent	Rhombus (Rhombuses or Rhombi)
Polygon	Set
Parallel	Side
Parallelogram	Square
Perpendicular	Square corner
Quadrilateral	Trapezoid
Rectangle	Vertex (Vertices)

Learning Experiences

Assessing Prior Knowledge

Materials: Concept description sheet (BLM 5–8.2).

Organization: Individual/Whole class

Procedure:

a) Tell students that they will be learning about a family of shapes called quadrilaterals, but before they begin you need to find out what they already know about this shape.

b) Have students complete the concept description sheet. Let students know that it is all right if they cannot think of anything to put in a section. They will have another opportunity to complete the sheet after they have learned more about the shape.

c) When students complete the sheet, begin a discussion of their responses by asking, “What is a quadrilateral? What does it look like?” As the discussion progresses, make sure students see a variety of examples and non-examples. In particular, students should see examples of quadrilaterals that have no parallel sides

Observation Checklist

When the discussion ends, have students add to the concept description sheet to determine whether they can do the following:

- ❏ recognize that a quadrilateral is a four-sided polygon
- ❏ give appropriate examples and non-examples of quadrilaterals

- **Identify and describe the characteristics of a pre-sorted set of quadrilaterals.**

Materials: Five envelopes (one labelled trapezoid, one labelled square, one labelled rectangle, one labelled parallelogram, and one labelled rhombus), three different cut-outs of each quadrilateral, one large sheet of paper, and one marker for each group

Organization: Small group/Large group

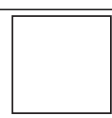
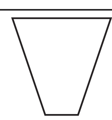
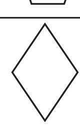
Procedure:

a) Place the cut-outs into the appropriate envelopes and then divide the class into five groups. Give each group a large sheet of paper, an envelope, and a marker.

b) Tell students that each group has a different type of quadrilateral and that their task is to teach the other groups about their quadrilateral. To do this, they need to look at the examples of the quadrilateral in their envelopes and determine its characteristics. Let students know that they should pay particular attention to the sides and vertices of their quadrilateral. Tell students that they should record the name of their quadrilateral and its characteristics on the large sheet of paper.

c) Have each group post their sheet of paper in the front of the room and tell the other members of the class about their quadrilateral. Help students identify any characteristics they might have missed.

d) Have students make a graphic organizer to help them learn the characteristics of the different quadrilaterals and their relationship to each other (e.g., students can make a chart like the one shown below).

Quadrilateral	Diagram	At least one pair of parallel sides	Two pairs of parallel sides	All sides congruent	Opposite sides congruent	All square corners
Parallelogram						
Square						
Rectangle						
Trapezoid						
Rhombus						

Observation Checklist

- ❏ Observe students' responses to make sure that for each quadrilateral they have correctly identified the characteristics shown in the chart.

Materials: Stir sticks or straws, and scissors

Organization: Whole class

Procedure:

a) Have the students use the stir sticks to make quadrilaterals
- whose opposite sides are congruent
- that is not a rhombus
- that has at least one pair of parallel sides
- that has no parallel sides
- that has four square corners
- that is neither a square nor a rectangle and has two pairs of parallel sides
- that has one square corner

b) When students finish making each shape, ask them:
- "What shape did you make?"
- "How do you know that it is a quadrilateral?"
- "Is there another shape that you could have made? What is it? How does it differ from the shape you made?"
- "What other characteristics does your shape have?"

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ construct and identify a quadrilateral with the given characteristic(s)
- ❏ describe the characteristics of each quadrilateral that they make
- ❏ identify other quadrilaterals that have the same characteristics as the one that was given
- ❏ describe how squares, rectangles, parallelograms, trapezoids, and rhombuses differ from each other
- ❏ recognize that there are other quadrilaterals besides squares, rectangles, trapezoids, parallelograms, and rhombuses

Materials: Tangrams

Organization: Individual

Procedure:

a) Have the students use the tangram pieces to make two different

- rectangles
- parallelograms
- trapezoids
- squares
- rhombuses

Let students know that they can use two or more of the tangram pieces to make each shape.

b) Have students place each shape they make on a piece of paper and trace around it. Ask them to write the name of the shape underneath their drawing and write a sentence stating which tangram pieces they used to make the shape.

Observation Checklist

Check students' work to see whether they can do the following:

❏ make two different rectangles, parallelograms, trapezoids, and squares

❏ correctly identify each quadrilateral that they made and the tangram pieces that they used to make it

❏ spell the names of the quadrilaterals correctly

Materials: Quadrilateral cards (BLM 5.SS.6.1)

Organization: Whole group

Procedure:

a) Give each student a card with a name of a quadrilateral on it.

b) Tell students that they are going to play a game called "Name that Quadrilateral." Explain that you will be describing a characteristic of a quadrilateral. Students who have a card with the name of a quadrilateral with that characteristic on it should stand up and show their card to the rest of the class (e.g., if I say, "I am a quadrilateral whose sides are all congruent, then students who have "square" or "rhombus" written on their card should stand up. The rest of the class checks to see whether students have identified the right quadrilaterals.).

c) Vary the game by selecting five students to be panel members. Give each panel member a card with a name of a quadrilateral on it and tell him or her to keep it hidden from the rest of the class. Tell students that everyone will have a chance to ask a panel member a question about his or her quadrilateral and the only question students can't ask is: "What is your quadrilateral?" The game is over when every student has had an opportunity to ask a question. The person who correctly identifies the quadrilateral on each panel member's card is the winner.

Observation Checklist

❑ Observe students' responses to determine whether they identify and describe the characteristics of the different quadrilaterals as shown in the chart.

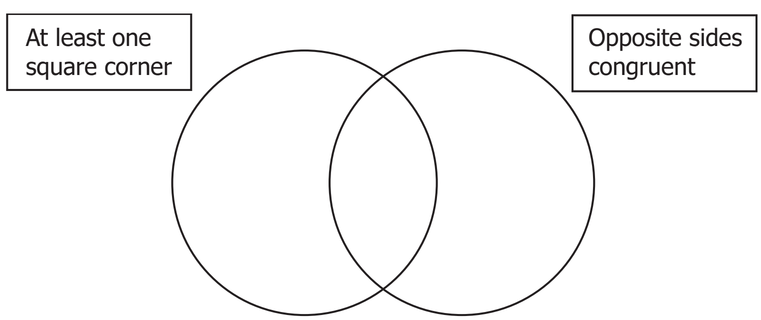
- **Sort a set of quadrilaterals and explain the sorting rule.**
- **Sort a set of quadrilaterals according to the lengths of the sides.**
- **Sort a set of quadrilaterals according to whether or not opposite sides are parallel.**

Materials: A set of quadrilateral cards and a set of rule cards for each pair of students (BLM 5.SS.6.2); two loops of string or yarn for each pair of students

Organization: Pairs

Procedure:

a) Have the students lay the string loops and the label cards "at least one square corner" and "opposite sides congruent" on their workspace, as shown below.



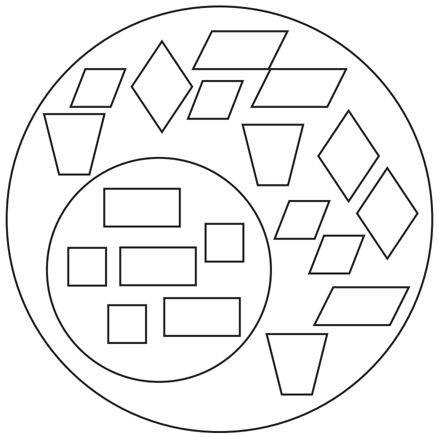
b) Have students sort their quadrilaterals into the appropriate sets. When students finish sorting the shapes, have them describe their solutions and explain how they knew where to place each quadrilateral.

c) Repeat the activity. Have the students sort the quadrilaterals into sets with

- at least one pair of parallel sides/ all sides congruent
- all square corners/two pairs of parallel sides
- no parallel sides/at least one pair of parallel sides

Have students make up their own rules for sorting the quadrilaterals.

d) Vary the activity by showing students pre-sorted sets and asking them to describe the rules that were used to sort the quadrilaterals. For example, show students the following set and ask them to identify the rule that was used to sort the quadrilaterals.



Observation Checklist

Observe students' responses to determine whether they can do the following:

❑ sort the set of quadrilaterals according to the stated rule

❑ explain how they knew where each quadrilateral belonged

❑ recognize the relationships among the quadrilaterals, such as

- all squares are rectangles
- all parallelograms are trapezoids, using the definition of trapezoids as quadrilaterals with **at least one pair** of parallel sides
- all rectangles, squares, and rhombuses are parallelograms
- all squares are rhombuses

- **Sort a set of quadrilaterals and explain the sorting rule.**

Materials: Quadrilateral activity sheet (BLM 5.SS.6.3)

Organization: Whole class/Individual

Procedure:

a) Ask students to complete the activity.

b) Have students share their responses with the other members of the class.

Observation Checklist

Check students' responses to the questions to determine whether they can do the following:

- ❑ recognize the characteristics of rectangles, squares, trapezoids, rhombuses, and parallelograms
- ❑ recognize the relationships among quadrilaterals, such as the following:
  - All squares are rectangles
  - All squares are rhombuses
  - All rectangles are parallelograms
  - All squares are parallelograms
  - All parallelograms, rectangles, squares, and rhombuses are trapezoids, using the definition of trapezoids as quadrilaterals with **at least one pair** of parallel sides
  - All rhombuses are parallelograms

A Parallel World

Purpose:

The purpose of this activity is to have students recognize real-world examples of lines and quadrilaterals. In particular, the investigation is designed to enable students to identify real-world examples of

- faces and edges of 3-D objects and sides of 2-D shapes that are examples of parallel, intersecting, perpendicular, vertical, and horizontal lines
- rectangles, squares, trapezoids, parallelograms, and rhombuses

In addition, the investigation is designed to enhance students' ability to

- communicate mathematically
- use technology
- connect mathematical concepts to each other and the real world

Materials/Resources:

- Digital camera or video camera*
- Computer

Organization: Large group/Small groups

Procedure:

a) Tell students that they will be creating a digital scrapbook (or a video recording). Explain that each group is responsible for taking pictures of examples of lines and quadrilaterals that they find either inside or outside of school. When they finish taking their pictures, they will create a digital scrapbook. Each picture in their scrapbook must include a description of the types of lines and quadrilaterals found in the picture.

b) Help students determine the guidelines they should follow when taking their pictures (e.g., students need to consider the amount of time needed to find and take the pictures, their conduct as they move within and outside the school, and the responsibilities of each group member).

c) Have students take their pictures and create their scrapbooks.

d) Have students choose a picture to present to the class. Ask them to explain why they chose the picture and where in the picture they see lines and quadrilaterals. Encourage them to identify the types of lines and quadrilaterals found in their picture.

* If digital cameras or computers are not available, have students find pictures of lines and quadrilaterals in magazines and newspapers.

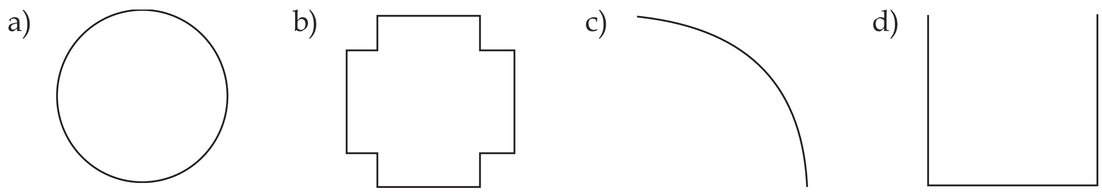
Observation Checklist

Use the following rubric to assess student mastery of learning outcomes *for* and *of* learning (during and at the completion of the activity).

3	2	1
Scrapbook includes: ▪ an example of each type of line ▪ an example of at least 3 different quadrilaterals	Scrapbook includes: ▪ an example of 3 or 4 types of lines ▪ an example of at least 2 different quadrilaterals	Scrapbook includes: ▪ examples of 1 or 2 types of lines ▪ an example of 1 type of quadrilateral
All lines are correctly identified.	Some lines are correctly identified.	A line is correctly identified.
All quadrilaterals are correctly identified.	Some quadrilaterals are correctly identified.	A quadrilateral is correctly identified.
Written description is clear. Mathematical terms are used correctly.	Written description is clear. Some mathematical terms are used correctly.	Written description is not clear. Some mathematical terms are used correctly.

Background Information

A simple closed curve is a curve that does not cross itself and can be drawn by starting and stopping at the same point (e.g., in the diagram below, figures (a) and (b) are simple closed curves while (c) and (d) are curves that are not closed).



Polygons are simple closed curves formed by the union of line segments. In the diagram above, (b) is the only polygon since it is both a simple closed curve and made up of line segments. The line segments that form the polygon are the **sides** of the polygon. A point where two sides meet is a vertex of the polygon.

Polygons are classified according to the number of sides they have. The most common classifications are: **triangle** (three sides), **quadrilateral** (four sides), **pentagon** (five sides), **hexagon** (six sides), **heptagon** (7 sides), **octagon** (8 sides), **nonagon** (9 sides), **decagon** (10 sides), and **dodecagon** (12 sides). Other polygons are commonly referred to as *n*-gons, where *n* is the number of sides. For example, an eleven-sided polygon can be referred to as an 11-gon and a 14-sided polygon can be referred to as a 14-gon.

Quadrilaterals can be classified according to the number of parallel sides that they have. The definition of each type of quadrilateral is given below.

Trapezium—A quadrilateral with **no pairs** of parallel sides.

Trapezoid—A quadrilateral with **at least one pair** of parallel sides.

Parallelogram—A quadrilateral in which **each pair** of opposite sides is parallel. The opposite sides of parallelograms are also congruent (same length).

Rectangle—A parallelogram that has four right angles.

Rhombus—A parallelogram that has four congruent sides.

Square—A parallelogram that has four congruent sides and four right angles.

Some texts define a trapezoid as a quadrilateral with exactly one pair of parallel sides. If the support material you are using defines a quadrilateral in this way, students should be shown both definitions. This can help them understand that mathematics is not a rigid subject and that mathematicians do not always agree on the definition of a concept. Students can also be asked to examine how the different definitions affect their solutions to problems involving trapezoids. Moreover, even though the learning experiences focus on quadrilaterals that have parallel sides, some of the activities include quadrilaterals that have no parallel sides. This has been done to avoid giving students a flawed concept of a quadrilateral.

Mathematical Language

Congruent	Rhombus (Rhombuses or Rhombi)
Polygon	Set
Parallel	Side
Parallelogram	Square
Perpendicular	Square corner
Quadrilateral	Trapezoid
Rectangle	Vertex (Vertices)

Learning Experiences

Assessing Prior Knowledge

Materials: Concept description sheet (BLM 5–8.2).

Organization: Individual/Whole class

Procedure:

a) Tell students that they will be learning about a family of shapes called quadrilaterals, but before they begin you need to find out what they already know about this shape.

b) Have students complete the concept description sheet. Let students know that it is all right if they cannot think of anything to put in a section. They will have another opportunity to complete the sheet after they have learned more about the shape.

c) When students complete the sheet, begin a discussion of their responses by asking, "What is a quadrilateral? What does it look like?" As the discussion progresses, make sure students see a variety of examples and non-examples. In particular, students should see examples of quadrilaterals that have no parallel sides

Observation Checklist

When the discussion ends, have students add to the concept description sheet to determine whether they can do the following:

- ❏ recognize that a quadrilateral is a four-sided polygon
- ❏ give appropriate examples and non-examples of quadrilaterals

- **Identify and describe the characteristics of a pre-sorted set of quadrilaterals.**

Materials: Five envelopes (one labelled trapezoid, one labelled square, one labelled rectangle, one labelled parallelogram, and one labelled rhombus), three different cut-outs of each quadrilateral, one large sheet of paper, and one marker for each group

Organization: Small group/Large group

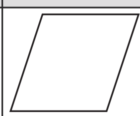
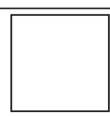
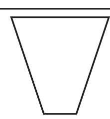
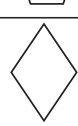
Procedure:

a) Place the cut-outs into the appropriate envelopes and then divide the class into five groups. Give each group a large sheet of paper, an envelope, and a marker.

b) Tell students that each group has a different type of quadrilateral and that their task is to teach the other groups about their quadrilateral. To do this, they need to look at the examples of the quadrilateral in their envelopes and determine its characteristics. Let students know that they should pay particular attention to the sides and "corners" of their quadrilateral. Tell students that they should record the name of their quadrilateral and its characteristics on the large sheet of paper.

c) Have each group post their sheet of paper in the front of the room and tell the other members of the class about their quadrilateral. Help students identify any characteristics they might have missed.

d) Have students make a graphic organizer to help them learn the characteristics of the different quadrilaterals and their relationship to each other (e.g., students can make a chart like the one shown below).

Quadrilateral	Diagram	At least one pair of parallel sides	Two pairs of parallel sides	All sides congruent	Opposite sides congruent	All square corners
Parallelogram						
Square						
Rectangle						
Trapezoid						
Rhombus						

Observation Checklist

- ❑ Observe students' responses to make sure that for each quadrilateral they have correctly identified the characteristics shown in the chart.

Materials: Stir sticks or straws

Organization: Whole class

Procedure:

a) Have the students use the stir sticks to make a quadrilateral
   - whose opposite sides are congruent
   - that is not a rhombus
   - that has at least one pair of parallel sides
   - that has no parallel sides
   - that has four square corners
   - that is neither a square nor a rectangle and has two pairs of parallel sides
   - that has one square corner

b) When students finish making each shape, ask them:
   - "What shape did you make?"
   - "How do you know that it is a quadrilateral?"
   - "Is there another shape that you could have made? What is it? How does it differ from the shape you made?"
   - "What other characteristics does your shape have?"

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ construct and identify a quadrilateral with the given characteristic(s)
- ❑ describe the characteristics of each quadrilateral that they make
- ❑ identify other quadrilaterals that have the same characteristics as the one that was given
- ❑ describe how squares, rectangles, parallelograms, trapezoids, and rhombuses differ from each other
- ❑ recognize that there are other quadrilaterals besides squares, rectangles, trapezoids, parallelograms, and rhombuses

Materials: Tangrams

Organization: Individual

Procedure:

a) Have the students use the tangram pieces to make two different

- rectangles
- parallelograms
- trapezoids
- squares
- rhombuses

Let students know that they can use two or more of the tangram pieces to make each shape.

b) Have students place each shape they make on a piece of paper and trace around it. Ask them to write the name of the shape underneath their drawing and write a sentence stating which tangram pieces they used to make the shape.

Observation Checklist

Check students' work to see whether they can do the following:

❑ make two different rectangles, parallelograms, trapezoids, and squares

❑ correctly identify each quadrilateral that they made and the tangram pieces that they used to make it

❑ spell the names of the quadrilaterals correctly

Materials: Quadrilateral cards (BLM 5.SS.6.1)

Organization: Whole group

Procedure:

a) Give each student a card with a name of a quadrilateral on it.

b) Tell students that they are going to play a game called "Name that Quadrilateral." Explain that you will be describing a characteristic of a quadrilateral. Students who have a card with the name of a quadrilateral with that characteristic on it should stand up and show their card to the rest of the class (e.g., if I say, "I am a quadrilateral whose sides are all congruent, then students who have "square" or "rhombus" written on their card should stand up. The rest of the class checks to see whether students have identified the right quadrilaterals.).

c) Vary the game by selecting five students to be panel members. Give each panel member a card with a name of a quadrilateral on it and tell him or her to keep it hidden from the rest of the class. Tell students that everyone will have a chance to ask a panel member a question about his or her quadrilateral and the only question students can't ask is: "What is your quadrilateral?" The game is over when every student has had an opportunity to ask a question. The person who correctly identifies the quadrilateral on each panel member's card is the winner.

Observation Checklist

- ❏ Observe students' responses to determine whether they identify and describe the characteristics of the different quadrilaterals as shown in the chart.

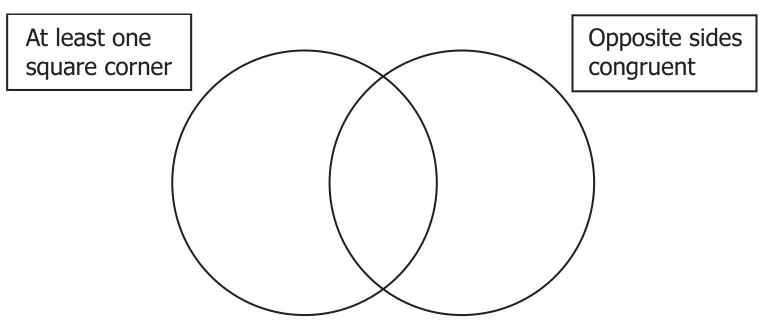
- **Sort a set of quadrilaterals and explain the sorting rule.**
- **Sort a set of quadrilaterals according to the lengths of the sides.**
- **Sort a set of quadrilaterals according to whether or not opposite sides are parallel.**

Materials: A set of quadrilateral cards and a set of rule cards for each pair of students (BLM 5.SS.6.2); two loops of string or yarn for each pair of students

Organization: Pairs

Procedure:

a) Have the students lay the string loops and the label cards "at least one square corner" and "opposite sides congruent" on their workspace, as shown below.



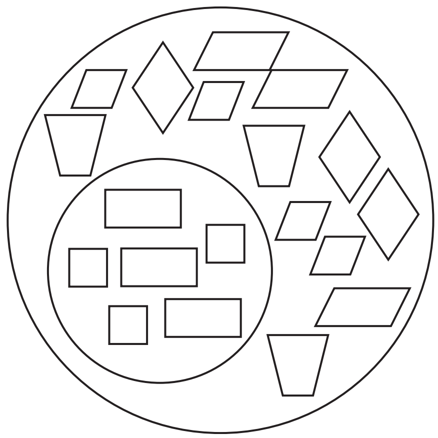
b) Have students sort their quadrilaterals into the appropriate sets. When students finish sorting the shapes, have them describe their solutions and explain how they knew where to place each quadrilateral.

c) Repeat the activity. Have the students sort the quadrilaterals into sets with

- at least one pair of parallel sides/ all sides congruent
- all square corners/two pairs of parallel sides
- no parallel sides/at least one pair of parallel sides

Have students make up their own rules for sorting the quadrilaterals.

d) Vary the activity by showing students pre-sorted sets and asking them to describe the rules that were used to sort the quadrilaterals. For example, show students the following set and ask them to identify the rule that was used to sort the quadrilaterals.



Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ sort the set of quadrilaterals according to the stated rule
- ❑ explain how they knew where each quadrilateral belonged
- ❑ recognize the relationships among the quadrilaterals, such as
  - all rectangles are squares
  - all parallelograms are trapezoids
  - all rectangles, squares, and rhombuses are parallelograms
  - all squares are rhombuses

- **Sort a set of quadrilaterals and explain the sorting rule.**

Materials: Quadrilateral activity sheet (BLM 5.SS.6.3)

Organization: Whole class/Individual

Procedure:

a) Ask students to complete the activity.

b) Have students share their responses with the other members of the class.

Observation Checklist

Check students' responses to the questions to determine whether they can do the following:

- ❏ recognize the characteristics of rectangles, squares, trapezoids, rhombuses, and parallelograms
- ❏ recognize the relationships among quadrilaterals, such as the following:
  - All squares are rectangles
  - All squares are rhombuses
  - All rectangles are parallelograms
  - All squares are parallelograms
  - All parallelograms, rectangles, squares, and rhombuses are trapezoids
  - All rhombuses are parallelograms

A Parallel World

Purpose:

The purpose of this activity is to have students recognize real-world examples of lines and quadrilaterals. In particular, the investigation is designed to enable students to identify real-world examples of

- faces and edges of 3-D objects and sides of 2-D shapes that are examples of parallel, intersecting, perpendicular, vertical, and horizontal lines
- rectangles, squares, trapezoids, parallelograms, and rhombuses

In addition, the investigation is designed to enhance students' ability to

- communicate mathematically
- use technology
- connect mathematical concepts to each other and the real world

Materials/Resources:

- Digital camera or video camera*
- Computer

Organization: Large group/Small groups

Procedure:

a) Tell students that they will be creating a digital scrapbook (or a video recording). Explain that each group is responsible for taking pictures of examples of lines and quadrilaterals that they find either inside or outside of school. When they finish taking their pictures, they will create a digital scrapbook. Each picture in their scrapbook must include a description of the types of lines and quadrilaterals found in the picture.

b) Help students determine the guidelines they should follow when taking their pictures (e.g., students need to consider the amount of time needed to find and take the pictures, their conduct as they move within and outside the school, and the responsibilities of each group member).

c) Have students take their pictures and create their scrapbooks.

d) Have students choose a picture to present to the class. Ask them to explain why they chose the picture and where in the picture they see lines and quadrilaterals. Encourage them to identify the types of lines and quadrilaterals found in their picture.

* If digital cameras or computers are not available, have students find pictures of lines and quadrilaterals in magazines and newspapers.

Observation Checklist

Use the following rubric to assess student mastery of learning outcomes *for* and *of* learning (during and at the completion of the activity).

3	2	1
Scrapbook includes: an example of each type of line an example of at least 3 different quadrilaterals	Scrapbook includes: an example of 3 or 4 types of lines an example of at least 2 different quadrilaterals	Scrapbook includes: examples of 1 or 2 types of lines an example of 1 type of quadrilateral
All lines are correctly identified.	Some lines are correctly identified.	Not all lines are correctly identified.
All quadrilaterals are correctly identified.	Some quadrilaterals are correctly identified.	Quadrilateral is incorrectly identified.
Written description is clear. Mathematical terms are used correctly.	Written description is clear. Some mathematical terms are used correctly.	Written description is not clear. Some mathematical terms are used correctly.

NOTES

Grade 5: Shape and Space (Transformations) (5.SS.7)

Enduring Understandings:

The position of shapes can be changed by translating, rotating, or reflecting them.

General Outcome:

Describe and analyze position and motion of objects and shapes.

Specific Learning Outcome(s):	Achievement Indicators:
5.SS.7 Perform a single transformation (translation, rotation, or reflection) of a 2-D shape and draw and describe the image. [C, CN, T, V]	➛ Translate a 2-D shape horizontally, vertically, or diagonally, and describe the position and orientation of the image. ➛ Rotate a 2-D shape about a point, and describe the position and orientation of the image. ➛ Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image. ➛ Perform a transformation of a 2-D shape by following instructions. ➛ Draw a 2-D shape, translate the shape, and record the translation by describing the direction and magnitude of the movement (e.g., the circle moved 3 cm to the left). ➛ Draw a 2-D shape, rotate the shape, and describe the direction of the turn (clockwise or counter-clockwise), the fraction of the turn, and point of rotation. ➛ Draw a 2-D shape, reflect the shape, and identify the line of reflection and the distance of the image from the line of reflection. ➛ Predict the result of a single transformation of a 2-D shape and verify the prediction.
5.SS.8 Identify a single transformation (translation, rotation, or reflection) of 2-D shapes. [C, T, V]	➛ Provide an example of a translation, a rotation, and a reflection. ➛ Identify a single transformation as a translation, rotation, or reflection. ➛ Describe a rotation by the direction of the turn (clockwise or counter-clockwise).

Prior Knowledge

Students may have had experience with the following:

- Identifying triangles, quadrilaterals, pentagons, hexagons, octagons, and circles

Related Knowledge

Students should be introduced to the following:

- Identifying vertical and horizontal lines
- Identifying rectangles, squares, trapezoids, rhombuses, and parallelograms
- Measuring the lengths of lines to the nearest cm or mm
- Identifying equivalent fractions

Background Information

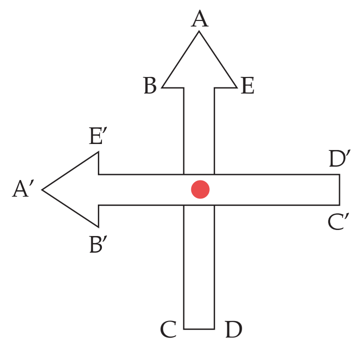
Transformations play an important role in the mathematics curriculum. In the Middle Years, the study of transformation can support students' work in patterning, algebra, problem solving, geometry, and statistics. In high school and beyond, the study of transformations helps students recognize the connections between algebra and geometry and enhances their understanding of other topics such as matrices, scaling, and complex numbers.

A **transformation** can be thought of as a change in the position, size, or shape of a figure. In the learning activities that follow, students are introduced to three transformations that change the position of a figure. Informally, these transformations are referred to as slides, flips, and turns. Formally, they are known as translations, reflections, and rotations. Students should know both the formal and informal terminology.

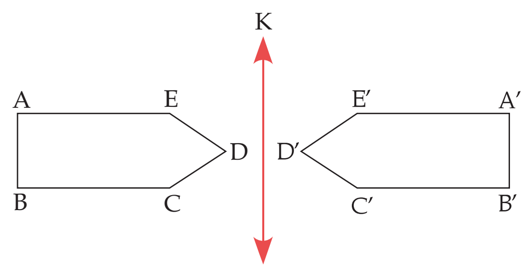
A **translation** "slides" a figure a fixed distance in a given direction. The figure and its translation are congruent (same size and shape) and face in the same direction. In the diagram shown below, square ABCD has been translated to a new position represented by square A′B′C′D′.

Note that Square A′B′C′D′, which is called the image of Square ABCD, is congruent to Square ABCD and faces in the same direction. The arrow indicates the distance and the direction of the translation.

A **rotation** "turns" a figure any number of degrees around a fixed point called the **centre of rotation**. The centre of rotation may be any point within or outside the figure. The figure and its **image** (the result of the transformation) are congruent but they may face in opposite directions (e.g., in the diagram below, the arrow ABCDE has been rotated 90° counter-clockwise about its midpoint). The image arrow A′B′C′D′E′ is congruent to Arrow ABCDE but faces in a different direction.



A **reflection** "flips" the figure over a line, creating a mirror image. The figure and its image are congruent but have different orientations. The line the figure is flipped over is called the **line of reflection** and it is the same distance from the figure as its image (e.g., in the diagram below, pentagon ABCDE has been flipped over line *k*).



Note that Pentagon A′B′C′D′E′ is congruent to Pentagon ABCDE but faces in the opposite direction. Line *k*, the line of reflection, is equidistant from the two pentagons.

Mathematical Language

Clockwise	Polygon
Counter-clockwise	Reflection (flip)
Congruent	Rotation (turn)
Diagonally	Transformation
Horizontal	Translation (slide)
Image	Vertical line
Line of reflection	

- **Translate a 2-D shape horizontally, vertically, or diagonally, and describe the position and orientation of the image.**
- **Rotate a 2-D shape about a point, and describe the position and orientation of the image.**
- **Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image.**
- **Perform a transformation of a 2-D shape by following instructions.**

Materials: Carpeted area or floor mats

Organization: Whole class

Procedure:

a) Have students lie down on a carpet or mat. Ask them to slide a short distance in one direction. Have them repeat the movement several times by asking them to slide up, down, and sideways. After each slide, ask, "What changed? What remained the same?" Emphasize that when a slide is made, the direction in which an object is pointing does not change.

b) Have students demonstrate flips. At the end of a flip, students should have changed from stomach to back or back to stomach. Discuss the different ways flips can be completed. For example, students may roll to the left or to the right, or over the feet or head. Have students try these different ways. After each flip, ask, "What changed? What remained the same?" Emphasize that when an object is flipped, its orientation changes. Ask students how this is different from looking at their reflection in the mirror. Emphasize that a true reflection of oneself would have exactly the same image, just in a different orientation.

c) Have students demonstrate turns. To perform a turn, students must keep either their feet or their heads (or belly button) at the same location for the duration of the turn. If the feet are the point (centre) of rotation, then the arms and head are used to move the body. If the head is the point (centre) of rotation, the feet are used to make the move. Have students turn all the way around or partway around. Have them turn in either a clockwise or counter-clockwise direction. After each turn, ask students, "What changed? What remained the same?" Discuss the fact that after a turn, the direction in which the head points is different, except when a complete turn is made.

d) Inform students that in the next few lessons they will be learning more about slides, flips, and turns.

Observation Checklist

- ❏ Observe students' responses to determine whether they are able to perform a slide, flip, and a turn.

- **Translate a 2-D shape horizontally, vertically, or diagonally, and describe the position and orientation of the image.**
- **Perform a transformation of a 2-D shape by following instructions.**

Materials: Grid paper and an overhead transparency of a grid

Organization: Whole class/Partners

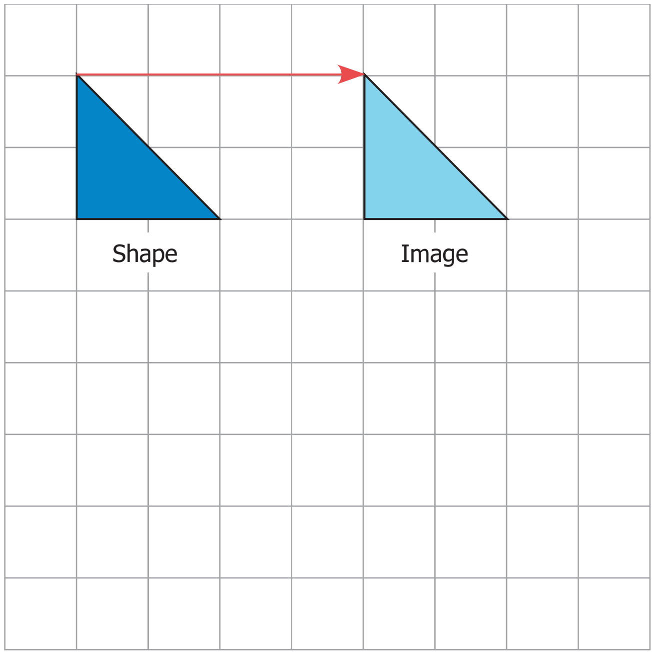
Procedure:

a) Remind students of the first activity by asking them to describe a slide. Discuss other objects in the environment that slide, such as drawers, sliding doors, and swings. Explain that to perform a slide, we need to know the distance and direction of the move.

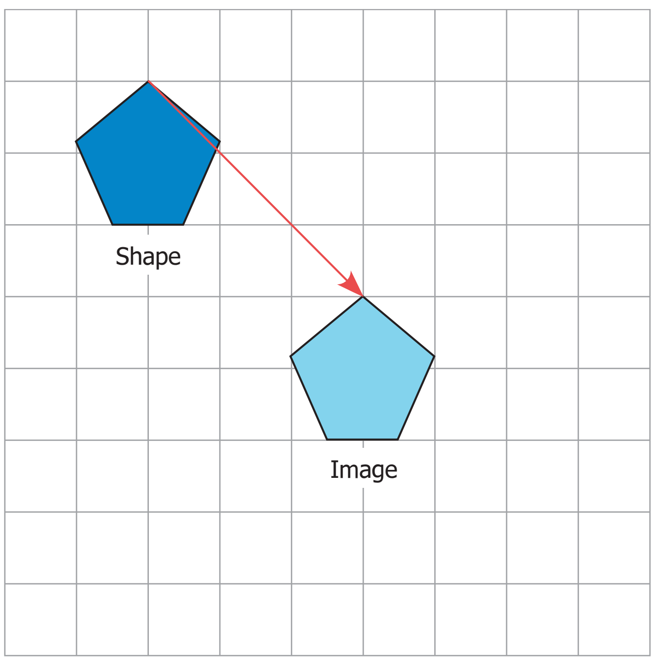
b) Tell students that they are going to perform a number of slides. Have them stand in a large open area or take them to the gym. Ask students to slide: one step to the right; one step up and two steps to the left; and three steps back and two steps to the right. After each slide, ask students, "What changed? What remained the same?"

c) Turn the activity into a game by playing "Simon Says." Tell students that if they move the wrong way or slide when Simon doesn't tell them to, they must take their seats. The last person standing is the winner.

d) Explain that another name for a slide is a translation. Draw a triangle on the overhead grid and show it to students. Tell students that to translate or slide the triangle, we need to know the distance and the direction of the move. Draw an arrow and explain that the arrow indicates the direction of the translation and its length describes the distance. Draw the image of the shape and explain that the original triangle has been translated horizontally four units to the right. Explain that the translated shape is called the image of the original shape. Ask, "How are the shape and its image alike? How do they differ?"



e) Do two or three more examples. Make sure you include an example where the shape is translated diagonally (e.g., in the figure shown below, the pentagon has been translated diagonally [on a slant] three units down and three units across).



f) Ask students to draw a shape on their grid paper and a slide arrow. Have them exchange papers with their partner. The partner must translate the shape according to the direction and length of the arrow. Have students repeat the activity several times.

g) Vary the activity by having students draw a shape and its image on grid paper, but not the slide arrow. Have them exchange papers with their partner. The partner must draw the slide arrow that corresponds to the translation. Have students repeat the activity several times.

Observation Checklist

Observe students' work to determine whether they can do the following:

- ❑ provide real-world examples of slides
- ❑ perform a transformation by following instructions
- ❑ translate a 2-D shape horizontally, vertically, and diagonally, and describe its position and orientation
- ❑ determine the direction and distance of a translation
- ❑ recognize that a shape and its image are congruent and face in the same direction
- ❑ draw a 2-D shape and translate the shape, and describe the distance and magnitude of the translation

- **Translate a 2-D shape horizontally, vertically, or diagonally, and describe the position and orientation of the image.**
- **Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image.**

Materials: Paint, paper, and black markers or crayons

Organization: Whole class/Individual

Procedure:

a) Remind students of the first activity by asking them to describe a flip. Explain that a flip is a mirror image. Tell students that they will be doing an activity that involves creating mirror images with their partners.

b) Have students stand up and face their partner. Ask students to: raise their right arm above their heads; bend their knees as if they were sitting; turn around and put their backs together; hold both arms straight out; and hop once on their left foot. Let one of the students be the leader and, without talking, make motions for the other students to follow. Then let another student be the leader.

c) Engage students in a discussion about their movements by asking them to describe how their movements were similar to and different from their partners. Explain that a mirror image or a flip is also called a reflection. Have students describe real-world occurrences of reflections, such as seeing one's reflection in a pool of water.

d) Give students a piece of paper and ask them to fold it in half vertically. Have students put dabs of different coloured paint on one side of the paper. Before the paint dries, have students fold the other half of the paper over the painted side and smooth it out. Have students open the picture to see the design.

e) Tell students that the fold in their paper is a line of reflection because it acts like a mirror. Have students draw a line segment along the fold line with a black marker or crayon and label the segment "reflection line."

f) Have students show their designs and their reflection to the entire class. Encourage students to describe why their pictures illustrate reflections. Display the designs in the classroom.

Observation Checklist

Observe students to determine whether they can do the following:

❏ provide real-world examples of reflections

❏ perform a transformation by following instructions

❏ reflect a 2-D shape over a line of reflection and describe its position and orientation

- **Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image.**
- **Perform a transformation of a 2-D shape by following instructions.**
- **Draw a 2-D shape, reflect the shape, and identify the line of reflection and the distance of the image from the line of reflection.**

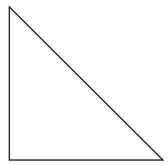
Materials: Miras or reflective plastic, copies of the activity sheet (BLM 5.SS.7&8.1), and rulers

Organization: Individual/Pairs

Procedure:

a) Show students how to use a Mira. Explain that the top and bottom of the Mira are different. The bottom of the Mira has a beveled drawing edge. When using the Mira to draw a figure, the beveled edge should always be facing the drawer.

b) Have students place a Mira on a piece of paper and draw a line along the drawing edge. Next, have students draw a triangle like the one shown below on the beveled side of the Mira. Have them look through the Mira and ask, “Do you see a reflection of the triangle you just drew?” Now have students reach around the Mira and draw the image of the triangle. Have students remove the Mira. Ask, “Does your drawing show a reflection? How do you know?”



c) Help students recognize that an object and its image are the same distance from the line of reflection by asking students to measure the distances from the vertices of the triangle (and its image) to the line of the reflection.

d) Have students repeat parts (b) and (c) several times using different shapes.

e) Give students a copy of the activity sheet (BLM 5.SS.7&8.1) and tell them to use their Miras to draw the line of reflection for each shape. After they draw the line of reflection, they should look through the Mira and draw the image of the shape.

f) Have students discuss the reflections. Encourage students to describe the distance the shape and its image are from the line of reflection and how the orientation of the image differs from the shape’s orientation.

Observation Checklist

Monitor students’ responses to determine whether they can do the following:

- ❏ draw a 2-D shape, reflect the shape, and identify the line of reflection and its distance from the shape and its image
- ❏ describe the orientation of the image
- ❏ recognize that the shape and its image are congruent
- ❏ perform a translation by following instructions

- **Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image.**
- **Perform a transformation of a 2-D shape by following instructions.**

Materials: Centimetre grid paper (BLM 5–8.9), Cuisenaire rods, mirrors, and black markers

Organization: Pairs or groups of four (if groups of four are used, divide each group into two teams of two)

Procedure:

a) Ask students to draw a black line horizontally across the middle of the grid paper. Tell them that the black line is the line of reflection.

b) Have one student in each pair arrange the Cuisenaire rods on the grid paper in some way on one side of the black line.

c) Have the other student in each pair build the reflection of the arrangement on the other side of the black line, and then use a Mira to check whether his or her arrangement is correct.

d) Have students continuing creating reflections, changing who "builds" and who "reflects."

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❏ recognize that an object and its reflection are the same distance from the line of reflection
- ❏ recognize that the orientation of the image is different from the orientation of the original shape
- ❏ recognize that the shape and its image are congruent
- ❏ translate the shape over a line of reflection, and describe its position and orientation

- **Perform a transformation of a 2-D shape by following instructions.**

Materials: None

Organization: Whole class

Procedure:

a) Remind students of the first activity by asking them to describe a turn. Encourage students to identify objects in their environment that turn, such as doorknobs, tires, and the hands on analog clocks. Explain that to turn a shape, we need to know how far and in what direction to turn it.

b) Have students stand up and face the front of the room. Have them turn around slowly until they see the front of the room again. Explain that they just made a full turn.

c) Ask students what they think they will see if they make a half-turn. Ask, “Will you be able to see me? What part of you will I be able to see?” Have students make a half-turn.

d) Ask students what they will see if they make a quarter-turn. Explain that what they see depends on the direction of their turn (e.g., if they turn counter-clockwise, they might see windows, and if they turn clockwise, they might see a bulletin board). Have students make: a quarter-turn clockwise; a three-quarter-turn counter-clockwise; a quarter-turn counter-clockwise, and a three-quarter-turn clockwise. Ask questions such as, “What are two ¼-turns clockwise equivalent to? What are three quarter-turns counter-clockwise equivalent to?” Have students perform the different turns to check their responses.

e) Have students practice making full-, quarter-, three-quarter-, and half-turns. Turn the activity into a game by playing “Simon Says.” Tell students that if they turn the wrong way or turn when Simon doesn’t tell them to, they must take their seats. The last person standing is the winner.

Observation Checklist

Observe students to determine whether they can do the following:

- ❏ understand the meaning of the terms clockwise and counter-clockwise
- ❏ make quarter-, half-, three-quarter-, and full turns in a clockwise direction
- ❏ make quarter-, half-, three-quarter-, and full turns in a counter-clockwise direction
- ❏ perform a transformation by following directions

- **Rotate a 2-D shape about a point, and describe the position and orientation of the image.**

Materials: Scissors, paper and pencil

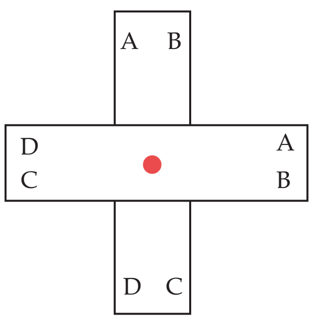
Organization: Individual

Procedure:

a) Ask students to draw a rectangle on a piece of paper. Have students label the vertices of their rectangle A, B, C, and D. Have them cut out another rectangle that is the same size as the rectangle that they drew on their paper, and label the vertices A, B, C, and D. Have students place the cut-out on their drawing so that the vertices of the two rectangles match.

b) Tell students another name for a turn is a rotation. Explain that to rotate the shape, we not only need to know the direction and how far to turn the shape, we also need to know the point (centre) of rotation. Any point on or off the shape can be used as the point (centre) of rotation.

c) Have students place the tip of a pencil on the centre of their rectangles and then have them rotate their rectangles a quarter-turn clockwise. Have students describe the position and orientation of the image.



Ask students to rotate their rectangles: ½-turn counter-clockwise; a ¾-turn clockwise, ¼-turn counter-clockwise; a ¾-turn counter-clockwise; and a ½-turn clockwise. After each rotation, have students describe the position and orientation of the rectangle. Have students discuss relationships, such as two ¼-turns is the same as a ½-turn; three ¼-turns is the same as a ¾-turn or a ½-turn plus a ¼-turn; and four ¼-turns is the same as a full turn.

d) Vary the activity by changing the point of rotation (e.g., let one of the vertices be the point of rotation, or select a point that is not on the rectangle as the point of rotation).

e) Repeat the activity using different shapes.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ understand the terms *clockwise* and *counter-clockwise*
- ❑ rotate a 2-D shape ¼-turn, ½-turn, ¾-turn, and a full turn, both clockwise and counter-clockwise, around any point in the interior or on the shape
- ❑ rotate a 2-D shape ¼-turn, ½- turn, ¾-turn, or a full turn from a point in the exterior of the shape
- ❑ describe the position and orientation of a 2-D shape after it has been rotated
- ❑ recognize that the shape and its image are congruent

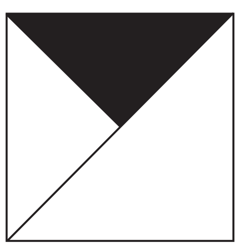
- **Rotate a 2-D shape about a point, and describe the position and orientation of the image.**
- **Perform a transformation of a 2-D shape by following instructions.**

Materials: Math journals

Organization: Individual

Procedure:

a) Have students draw in their math journals a square like the one shown below.



b) Ask students to draw a picture of how the square would look after it has been rotated around its centre point

- ¼-turn clockwise
- ½-turn clockwise
- ¾-turn clockwise

c) Ask students to write a paragraph describing the position and orientation of the image after each rotation.

Observation Checklist

Check to determine whether students:

- ❏ know the term *clockwise*
- ❏ can perform a transformation by following instructions
- ❏ can rotate a 2-D shape ¼-turn, ½-turn, and ¾-turn
- ❏ can describe the direction and the orientation of the image of a rotation

- **Translate a 2-D shape horizontally, vertically, or diagonally, and describe the position and orientation of the image.**
- **Rotate a 2-D shape about a point, and describe the position and orientation of the image.**
- **Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image.**

Materials: Pattern blocks, math journals

Organization: Pairs/Individual

Procedure:

a) Present students with the following situation:

- Michaela wants to use the same pattern block to show her cousin how to rotate, translate, and reflect a shape. She is not sure which pattern block she should use to show her cousin all three moves.

b) Tell students it is their job to help Michaela decide which block she should use. Explain that if a block looks the same after it has been transformed, it is not a good model. Help them understand what you mean by this by demonstrating why a circle is not a good model for illustrating a reflection.

c) Have students translate, rotate, and reflect each pattern block. Encourage them to record their findings in a table like the one shown below:

Shape	Translation	Rotation	Reflection
Orange Square			
Blue Rhombus			
Red Trapezoid			
Yellow Hexagon			
Green Triangle			
Tan Rhombus			

d) Have students write a paragraph in the math journal explaining which shape Michaela should use and the reasons for their choice.

Observation Checklist

Check students' responses to determine whether they can do the following:

- ❑ translate a given 2-D shape and describe the position and orientation of the transformed shape
- ❑ rotate a given 2-D shape and describe the position and orientation of the transformed shape
- ❑ reflect a given 2-D shape and describe the position and orientation of the transformed shape

Materials: Geoboards, elastics, dot paper, a set of cards (BLM 5.SS.7&8.2) for each group

Organization: Groups of four

Procedure:

a) Tell students that they will be doing an activity involving translations, reflections, and rotations. Explain that each group will get four cards. The cards should be placed face down on the work area and each student should draw one. The student with the card that says "Original Position" makes a shape on his or her geoboard. The student who has the card stating "Rotation" creates a rotation of the original shape on his or her geoboard. The student who has the card stating "Reflection" creates a reflection of the original shape on his or her geoboard, and the one who has the card stating "Translation" creates a translation of the original shape on his or her geoboard. Students should record the original shape on their dot paper and the transformation that they performed. Underneath the transformation, they should describe how the shape was transformed (e.g., vertical translation two units up) and how the position and orientation of the shape changed.

b) Tell students that they have to find a way to verify that they have successfully translated, rotated, and reflected the original shape. When they have verified their transformations, they should exchange cards and do the activity again. Each student should have the opportunity to create, translate, rotate, and reflect a shape.

Observation Checklist

Observe students' responses to determine whether they can do the following:

- ❑ translate a given shape horizontally, vertically, or diagonally, and describe the position and orientation of the image
- ❑ rotate a shape around a point and describe the position and orientation of the image
- ❑ reflect a shape across a line of reflection and describe the position and orientation of the image

- **Translate a 2-D shape horizontally, vertically, or diagonally, and describe the position and orientation of the image.**
- **Rotate a 2-D shape about a point, and describe the position and orientation of the image.**
- **Reflect a 2-D shape in a line of reflection, and describe the position and orientation of the image.**
- **Predict the result of a single transformation of a 2-D shape and verify the prediction.**
- **Identify a single transformation as a translation, rotation, or reflection.**
- **Describe a rotation by the direction of the turn (clockwise or counter-clockwise).**

Materials: A red trapezoid from the set of pattern blocks, a die, and math journals

Organization: Whole class

Procedure:

a) Tell students that they will be playing a game. Explain that you will be placing a trapezoid on the overhead and students will be taking turns rolling a die. After the die has been rolled, the overhead will be turned off and the student who rolled the die will transform the trapezoid according to the following rules:

   - If a 1 or 2 is rolled, the student will translate the trapezoid.
   - If a 3 or 4 is rolled, the student will reflect the trapezoid.
   - If a 5 or 6 is rolled, the student will rotate the trapezoid either clockwise or counter-clockwise.

   After the student has changed the position of the trapezoid, the overhead will be turned back on and the other members of the class must record in their math journals the transformation they think the student performed on the trapezoid.

b) Demonstrate the procedure for playing the game and answer any questions students may have.

c) Have students share their response to each round of the game. Encourage students to explain how the position and orientation of the trapezoid changed and why the transformation was a translation, rotation, or reflection.

Observation Checklist

Observe students’ responses to determine whether they can do the following:

- ❏ translate, rotate, and reflect a 2-D shape
- ❏ identify a transformation as a rotation, reflection, or translation
- ❏ describe a rotation by the direction of the turn (either clockwise or counter-clockwise)
- ❏ describe the position and orientation of a translated shape, a rotated shape, and a reflected shape

NOTES