

# Unit 6 Geometry

Grade 7

## Lesson Outline

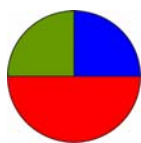
### BIG PICTURE

Students will:

- investigate geometric properties of triangles, quadrilaterals, and prisms;
- develop an understanding of similarity and congruence.

Day	Lesson Title	Math Learning Goals	Expectations
1	Measuring and Bisecting Angles	<ul style="list-style-type: none"> <li>• Construct acute, obtuse, right, and reflex angles.</li> <li>• Estimate angle sizes and measure with a protractor.</li> <li>• Bisect angles using a variety of methods, e.g., protractor, compass, paper folding, Mira.</li> </ul>	7m46, 7m48 CGE 2a, 2c, 3f, 5a
2	Investigating and Classifying Triangles	<ul style="list-style-type: none"> <li>• Classify triangles by their sides and angles (scalene, isosceles, equilateral, acute, obtuse, right)</li> <li>• Investigate triangle properties, e.g., the largest angle in a triangle lies across from the longest side.</li> <li>• Classify triangles by the number of lines of symmetry they possess.</li> </ul>	7m47 CGE 4c, 5b
3	Building and Classifying Quadrilaterals	<ul style="list-style-type: none"> <li>• Classify and name quadrilaterals and illustrate their characteristics.</li> <li>• Classify quadrilaterals based on geometric properties, e.g., symmetry, number of equal sides, number of equal angles...</li> </ul>	7m47 CGE 2b, 3c
4	Investigating Polygon and Quadrilateral Properties	<ul style="list-style-type: none"> <li>• Investigate the relationship between the number of sides in a regular polygon and the number of lines of symmetry it possesses.</li> <li>• Investigate the relationship in a quadrilateral between the number of lines of symmetry and if it has <math>180^\circ</math> or <math>90^\circ</math> rotational symmetry.</li> </ul>	7m47, 7m56 CGE 2b, 3c
5	Construct related lines <i>(lesson not included)</i>	<ul style="list-style-type: none"> <li>• Construct lines that intersect at <math>30^\circ</math>, <math>40^\circ</math>, and <math>60^\circ</math>, using a variety of tools and strategies.</li> </ul>	7m46 CGE 2c, 3c
6	Investigating Perpendicular Bisectors and Angle Bisectors	<ul style="list-style-type: none"> <li>• Construct perpendiculars and the perpendicular bisector of a line using a variety of tools and strategies.</li> <li>• Use appropriate symbols to mark <math>90^\circ</math> angles and equal line segments.</li> <li>• Investigate perpendicular bisectors and angle bisectors of triangles.</li> </ul>	7m46, 7m47, 7m48 CGE 2a, 2b, 2c, 3c, 3f
7	Investigating Parallel Lines	<ul style="list-style-type: none"> <li>• Construct parallel lines using a variety of tools.</li> <li>• Determine angle properties created by parallel lines.</li> <li>• Use angle properties to construct parallel lines.</li> <li>• Investigate angles in a parallelogram.</li> </ul>	7m46, 7m47 CGE 2c, 3c, 4c
8	Investigating Related Lines Using The Geometer's Sketchpad®4 <i>(lesson not included)</i>	<ul style="list-style-type: none"> <li>• Create basic constructions using The Geometer's Sketchpad®4</li> <li>• Review skills using dynamic geometry software (midpoints and the midpoint line, perpendicular lines and perpendicular bisectors, bisecting angles).</li> </ul>	7m46, 7m47, 7m48 CGE 4f

Day	Lesson Title	Math Learning Goals	Expectations
9	Investigating Quadrilaterals Using The Geometer's Sketchpad®4  <i>(lesson not included)</i>	<ul style="list-style-type: none"> <li>• Students use The Geometer's Sketchpad®4 to classify quadrilaterals based on their sides and angles.</li> <li>• Students make hypotheses related to triangles and quadrilaterals, investigate using tools and strategies, and support their findings with data or find a counter-example.</li> </ul>	7m47  CGE 3c, 4f
10	Examining Geometry Properties Using the Coordinate System	<ul style="list-style-type: none"> <li>• Plot points on the coordinate plane in the first quadrant.</li> <li>• Draw a triangle using ordered pairs in the first quadrant.</li> <li>• Distinguish between similar shapes and congruent shapes.</li> </ul>	7m48, 7m53, 7m54  CGE 2c, 2d

**Math Learning Goals**

- Construct acute, obtuse, right, and reflex angles.
- Estimate angle sizes and measure with a protractor.
- Bisect angles using a variety of methods, e.g., protractor, compass, paper folding, Mira.

**Materials**

- compasses
- protractors
- Miras
- BLM 6.1.1, 6.1.2, 6.1.3

**Assessment Opportunities****Minds On... Whole Class → Demonstration**

Develop four different ways to describe a straight angle using the headings: mathematical characteristics, everyday examples, diagram, and explanation. (See BLM 6.1.1 for sample responses.)

**Groups of 4 → Exploring Angles**

Post eight pieces of chart paper around the room. In groups of four, students focus on a specific angle, i.e., acute, right, obtuse, and reflex. Each angle is done twice. They define the angle and show examples, using available resources, books, Internet, etc.

Facilitate a class discussion using prompts such as:

- How did each group classify the angle? (by its degree range)
- Which angle(s) seems most common in the everyday world?
- Reflect on and explain why. (responses will vary)

**Action!****Groups of 4 → Practice**

Students complete Part A (BLM 6.1.2) and reflect after each measurement:

- Do we need to revise our estimates?
- Are our estimates within  $10^\circ$ ?

**Whole Class → Demonstration**

Demonstrate how to bisect using a Mira, a compass, paper folding, and a protractor and mark equal angles using proper notation. Students complete each bisection, marking equal angles on BLM 6.1.2, Part B.

**Individual → Reflection**

Students reflect, using guiding questions:

- What happened to the original angle? (bisected)
- What does *bisect* mean? (divides angle into two equal parts)
- How does this method compare to the others, i.e., compass, Mira, paper folding, and protractor? (responses will vary)

**Consolidate Debrief****Individual → Practice: Bisecting Angles**

Students complete BLM 6.1.3, Part C.

Ask:

- What do you notice about the two new angles created after bisecting the original angle? (They are equal.)
- What conclusions can you draw? (Bisecting an angle divides it into two new equal angles.)

**Curriculum Expectations/Observation/Mental Note:** Assess students' ability to bisect angles using at least two methods.

Demonstrate paper folding using a prepared angle on a piece of paper.

**Home Activity or Further Classroom Consolidation**

Using a protractor, a compass, and paper folding, complete the worksheet 6.1.3.

Alternatively, use the Frayer model (BLM 5.1.1).

It is important that all four angles are represented.

Word Wall

- bisect
- acute angle
- obtuse angle
- right angle
- reflex angle
- estimate

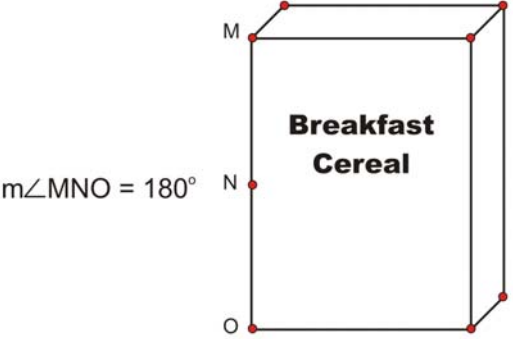
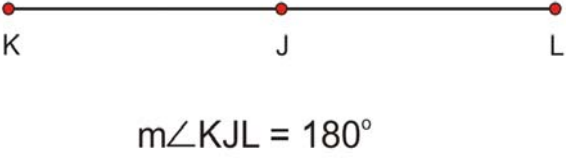
Lesson may vary depending on what protractors are available ( $360^\circ$  or  $180^\circ$ ).

Copy protractors on overhead acetates and cut up for Home Activity.

*Practice*

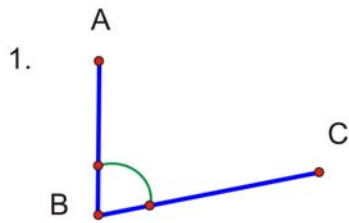
## 6.1.1: Straight Angles (Teacher)

### Angle Type: Straight

Mathematical Characteristics	Everyday Example
<p>Angle is composed of two rays that meet at a common end point (vertex). The straight angle always measures <math>180^\circ</math>.</p>	<p>Cereal Box</p>  <p><math>m\angle MNO = 180^\circ</math></p>
Diagram	Explanation
 <p><math>m\angle KJL = 180^\circ</math></p>	<p>A straight angle is <math>180^\circ</math>. It lies on any point along a straight line segment. Therefore any straight line has a straight angle.</p>

## 6.1.2: Estimating, Measuring, and Marking Angles

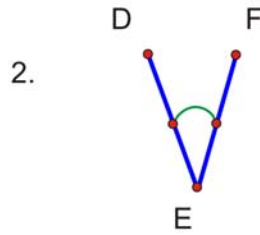
### Part A



Angle Type: \_\_\_\_\_

Estimate: \_\_\_\_\_

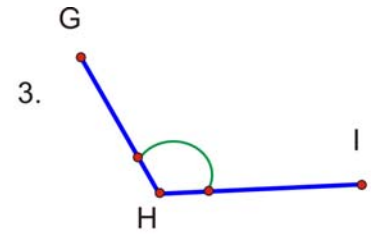
Actual: \_\_\_\_\_



Angle Type: \_\_\_\_\_

Estimate: \_\_\_\_\_

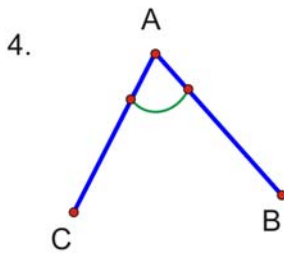
Actual: \_\_\_\_\_



Angle Type: \_\_\_\_\_

Estimate: \_\_\_\_\_

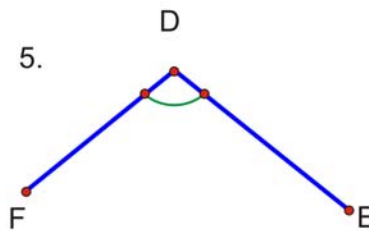
Actual: \_\_\_\_\_



Angle Type: \_\_\_\_\_

Estimate: \_\_\_\_\_

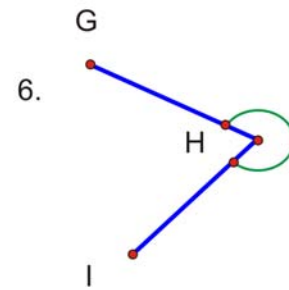
Actual: \_\_\_\_\_



Angle Type: \_\_\_\_\_

Estimate: \_\_\_\_\_

Actual: \_\_\_\_\_



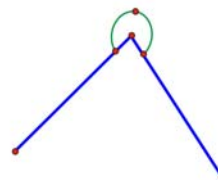
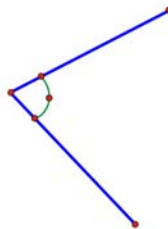
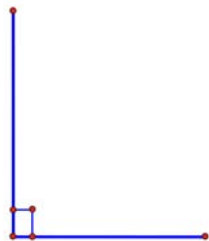
Angle Type: \_\_\_\_\_

Estimate: \_\_\_\_\_

Actual: \_\_\_\_\_

### Part B

#### Bisecting Angles

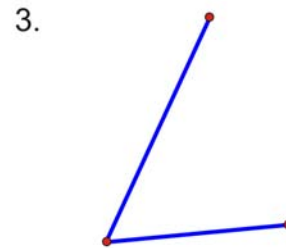
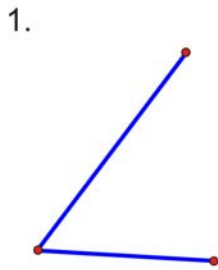
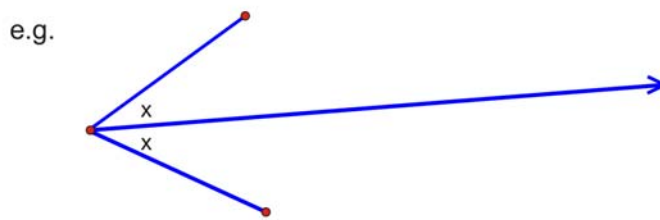


Bisect all angles in Part A, marking all equal angles, using a Mira for questions 1 and 4, compasses for questions 2 and 5, paper folding for question 3, and a protractor for question 6.

## 6.1.3: Bisecting Angles

### Part A

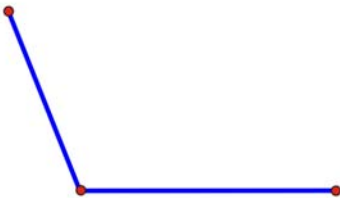
Use a compass to bisect and measure the following angles. Mark equal angles.



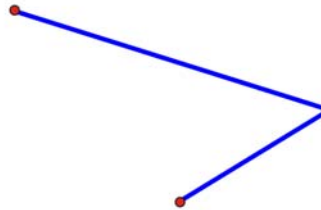
### Part B

Use a protractor to bisect and measure the following angles. Mark equal angles.

1.



2.



3.



### Part C

On the back of this sheet draw 3 different types of angles and bisect by folding paper. Mark equal angles.



**Math Learning Goals**

- Classify triangles by their sides and angles (scalene, isosceles, equilateral, acute, obtuse, right).
- Investigate triangle properties (e.g., the largest angle in a triangle lies across from the longest side).
- Classify triangles by the number of lines of symmetry they possess.

**Materials**

- geoboards
- straws
- paper strips
- protractor
- BLM 6.2.1

**Assessment Opportunities**

**Minds On... Pairs → Word and Picture Sort**

Students sort the set of cards into categories and explain their reasoning and criteria for the sort. Students then sort the cards in a different way, using different criteria (BLM 6.2.1).

**Whole Class → Discussion**

Discuss lines of symmetry and how this relates to the type of triangle.

**Action! Pairs → Investigation**

Students create a variety of triangles to determine the relationship between length of sides and angle sizes. Students can use geoboards, straws, paper strips, or GSP<sup>®</sup>4 to help them investigate the relationship.

Focus the students' attention on looking for the relationship between side length and opposite angle sizes: What relationship can you find between the length of the sides in a triangle and the size of the opposite angle?

Students sketch a triangle, measuring and recording the size of each angle and the length of each side. They create enough triangles to notice a relationship and record their observations, e.g., the largest angle lies across from the longest side; the smallest angle lies across from the smallest side; if two angles are equal, then the two opposite sides are equal. Circulate, taking note of which students to ask to share in the whole-class discussion.

**Reasoning and Proving/Oral Questions/Checklist:** Assess students' ability to determine triangle properties through investigation.

Focus the students' attention on what proving, reasoning, reflecting, and communicating "looks like" and "sounds like."

Record types of triangles on Word Wall.

**Consolidate Debrief Whole Class → Discussion**

Students choose a triangle to share with the class and cut it out for posting. One student shares a sample triangle, then another student shares a different type of triangle. Continue until there are enough samples to discuss the relationship.

Post their samples in categories (scalene; equilateral; isosceles; obtuse; right; 1, 2, 3 lines of symmetry). Discuss and record the relationships students discovered. Connect to lines of symmetry as well.

**Home Activity or Further Classroom Consolidation**


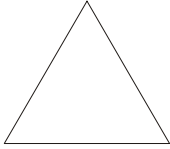
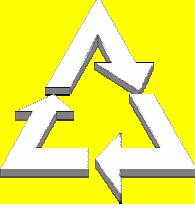


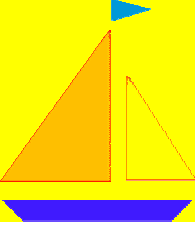
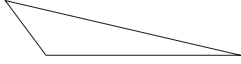
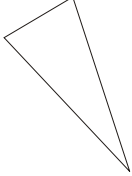
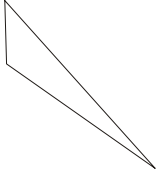
*Reflection*

- Write a journal report about discoveries you made about the relationship between the length of the sides in a triangle and the size of the opposite angle. Illustrate your report with diagrams.
- Find pictures of quadrilaterals used in daily life and bring them to class.

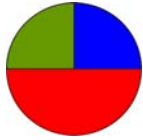
Collect and assess students' journal entries.

## 6.2.1: Classifying Triangles Word Sort

Cut apart and place the set of cards in an envelope. Make sufficient copies for students to work in pairs.

	<b>1 line of symmetry</b>	<b>Equilateral triangle</b>	
	<b>All three angles are equal</b>		<b>Obtuse-angled triangle</b>
<b>All three angles are acute</b>	<b>Right-angled triangle</b>	<b>3 lines of symmetry</b>	
	<b>Two sides are equal</b>	<b>Isosceles triangle</b>	<b>Three sides are equal</b>
<b>Acute-angled triangle</b>	<b>Two angles are acute</b>		<b>0 lines of symmetry</b>
<b>Scalene triangle</b>			<b>1 angle is obtuse</b>





**Math Learning Goals**

- Classify and name quadrilaterals and illustrate their characteristics.
- Classify quadrilaterals based on geometric properties, e.g., symmetry, number of equal sides, number of equal angles....

**Materials**

- pattern blocks
- BLM 6.3.1

**Assessment Opportunities**

**Minds On... Whole Class → Demonstration and Sharing**

Connect the concepts studied about triangles (Day 2) to quadrilaterals, using regular-shaped pattern blocks. Place two triangles together to form a quadrilateral. Students join various pattern block shapes to create their own quadrilaterals.

Share images students brought in, depicting various places that quadrilaterals occur, e.g., road signs, paper, cereal boxes, labels.

**Individual → Anticipation Guide**

Students complete the Before column on the Anticipation Guide (BLM 6.3.1).

**Curriculum Expectations/Observation/Mental Note:** Assess students' prior knowledge of characteristics of quadrilaterals.

**Action! Groups of 4 → Guided Investigation**

Students create as many different types of quadrilaterals as they can with pattern blocks. They draw sketches and note:

- the number of lines of symmetry;
- sum of interior angles;
- side lengths.

To reinforce students' understanding of the characteristics of quadrilaterals, ask them to share their sketches and post these examples under lines of symmetry, sum of interior angles, and length of sides.

Name the quadrilaterals, e.g., square, rectangle, trapezoid, rhombus.

If pattern blocks are unavailable, students can use geometric shapes on coloured construction paper.

Word Wall  
 • quadrilaterals  
 • lines of symmetry  
 • interior angles

**Consolidate Debrief Individual → Anticipation Guide**

Students complete the After column and compare it to the Before column on their anticipation guide. Discuss the answers.

**Home Activity or Further Classroom Consolidation**

Choose one of the quadrilaterals used in class. Apply what you know about “similarity” to this situation by drawing a small, medium, and large example. Explain how the characteristics apply regardless of the size of the quadrilateral.

*Application  
 Concept Practice  
 Reflection*

## 6.3.1: Anticipation Guide

Name:

Date:

	Before	Statement	After
1.	Agree/Disagree	The sum of all interior angles in a quadrilateral is equal to 360 degrees.	Agree/Disagree
2.	Agree/Disagree	In a quadrilateral there is a relationship between the number of lines of symmetry and the number of pairs of equal sides.	Agree/Disagree
3.	Agree/Disagree	In a quadrilateral the number of equal sides is always related to the number of equal angles.	Agree/Disagree



Name:

Date:

	Before	Statement	After
1.	Agree/Disagree	The sum of all interior angles in a quadrilateral is equal to 360 degrees.	Agree/Disagree
2.	Agree/Disagree	In a quadrilateral there is a relationship between the number of lines of symmetry and the number of pairs of equal sides.	Agree/Disagree
3.	Agree/Disagree	In a quadrilateral the number of equal sides is always related to the number of equal angles.	Agree/Disagree

**Math Learning Goals**

- Investigate the relationship between the number of sides in a regular polygon and the number of lines of symmetry it possesses.
- Investigate the relationship in a quadrilateral between the number of lines of symmetry and if it has  $180^\circ$  or  $90^\circ$  rotational symmetry.

**Materials**

- BLM 6.4.1, 6.4.2
- overhead pattern blocks
- construction paper
- scissors
- fastener pins

**Assessment Opportunities****Minds On... Whole Class → Discussion**

Using an overhead and overhead pattern blocks demonstrate rotational symmetry.

Ask:

- How many degrees are in a full rotation? ( $360^\circ$ )
- How many degrees are in a quarter rotation? ( $360 \div 4 = 90^\circ$ )
- How many degrees are in an eighth of a rotation?

**Pairs → Investigation**

Begin with two congruent squares. Ask: If I rotate one square on top of the other square, how many times would the squares match in one full rotation? (4)

Students repeat this process with a regular triangle and a regular hexagon using pattern blocks.

Relate rotational symmetry to degrees, fractions, and time, e.g., a quarter of an hour is 15 minutes, which is a  $90^\circ$  rotation of the minute hand. It is also called a quarter turn.

Students work with a partner to find the number of lines of symmetry in a square, a regular triangle, and a regular hexagon (BLM 6.4.1). They consider how the lines of symmetry relate to rotational symmetry.

**Action!****Groups of 3 → Representing/Modelling**

Students create a design for three different timing devices involving rotational symmetry and quadrilaterals – a 15-minute timer ( $90^\circ$  rotational symmetry), a 30-minute timer ( $180^\circ$  rotational symmetry), and a 60-minute timer ( $360^\circ$  rotational symmetry). When the quadrilaterals rotate and match, the timer goes off (BLM 6.4.2).

**Reflecting/Demonstration/Checklist:** Assess students' ability to make conclusions from the results of a task.

**Consolidate Debrief Whole Class → Discussion**

Pose questions to guide the discussion:

- What shapes did you use for a 15-minute timer, for a 30-minute timer, for a 60-minute timer?
- How did you use lines of symmetry to help you choose the quadrilaterals?

Discuss the responses to BLM 6.4.2 to reinforce students' understanding of the relationship between lines of symmetry and rotational symmetry.

**Home Activity or Further Classroom Consolidation**

Choose a regular polygon other than a quadrilateral and answer the following question:

If you were to create a timer using another regular polygon, how long would students be able to stay on the computer? Include the timer's rotational symmetry and the lines of symmetry.

Their timer should indicate when a full rotation has occurred (one hour).

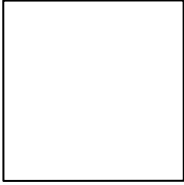
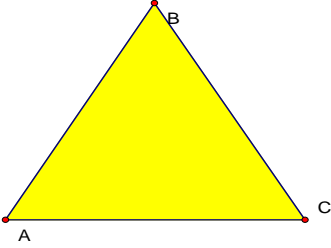
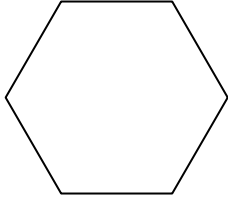
Provide students with a variety of materials to create their timer: construction paper, scissors, fastener pins, etc.

Remind students to use pictures, words, numbers, and terminology when responding.

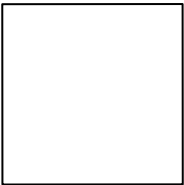
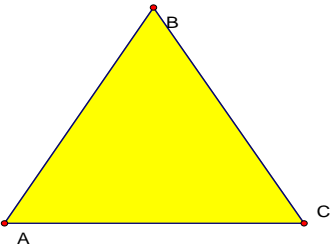
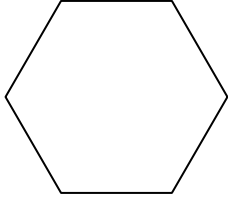
*Application  
Exploration  
Practice*

Students refer to their work on BLM 6.4.2.

## 6.4.1: Lines of Symmetry and Rotational Symmetry

		
Number of Lines of Symmetry: _____	Number of Lines of Symmetry: _____	Number of Lines of Symmetry: _____
How many times do the shapes match in one full rotation?	How many times do the shapes match in one full rotation?	How many times do the shapes match in one full rotation?
<b>Rotational Symmetry:</b> _____°	<b>Rotational Symmetry:</b> _____°	<b>Rotational Symmetry:</b> _____°



		
Number of Lines of Symmetry: _____	Number of Lines of Symmetry: _____	Number of Lines of Symmetry: _____
How many times do the shapes match in one full rotation?	How many times do the shapes match in one full rotation?	How many times do the shapes match in one full rotation?
<b>Rotational Symmetry:</b> _____°	<b>Rotational Symmetry:</b> _____°	<b>Rotational Symmetry:</b> _____°

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## 6.4.2: Who's On the Computer?

Your task is to develop a system to make sure each student has equal opportunity and time to use the computers.

Use three different quadrilaterals to develop a system based on rotational symmetry for 15-minute (square:  $90^\circ$  rotation), 30-minute (rectangle:  $180^\circ$ ), and 60-minute ( $360^\circ$ ) activities.

Type of Quadrilateral	Lines of Symmetry	Rotational Symmetry (Degrees)

### Questions for Reflection:

1. Is there a relationship between the number of lines of symmetry and degrees of rotational symmetry? Explain your reasoning.
  
2. Describe other quadrilaterals that you did not experiment with that might be used for the 15-minute, 30-minute, or 60-minute activities? Explain how they can be used.



**Math Learning Goals**

- Construct perpendiculars and the perpendicular bisector of a line using a variety of tools and strategies.
- Use appropriate symbols to mark 90° angles and equal line segments.
- Investigate perpendicular bisectors and angle bisectors of triangles.

**Materials**

- board compass
- protractor
- board protractor
- Mira
- BLM 6.6.1

**Assessment Opportunities**

**Minds On... Whole Class → Guided Investigation**

Guide students through a series of investigations to help them understand that there are similarities and differences between a perpendicular line and perpendicular bisectors (BLM 6.6.1).

**Curriculum Expectation/Mental Note:** Observe students' understanding of perpendicular lines and bisectors.

A perpendicular line is not necessarily a perpendicular bisector.

**Action! Groups of 3 → Investigation**

Use a cut-out sample of a triangle to demonstrate how to find the perpendicular bisector of one of the sides of a triangle.

**Problem to Investigate**

What are the special properties of the perpendicular bisectors of the 3 sides of a triangle?

Students investigate what happens when they draw the perpendicular bisector for all three sides of an isosceles triangle and individually record what they notice, including a description, a diagram, and characteristics. They repeat this investigation with scalene and equilateral triangles to determine if other triangles have the same properties.

**Individual → Investigation**

**Problem to Investigate**

What are the special properties of the 3 angle bisectors of a triangle?

Students investigate what happens when the angles of an isosceles, an equilateral, and a scalene triangle are bisected, and record their findings.

**Problem Solving/Observation/Anecdotal Note:** Assess how students apply the problem-solving process during the investigation.

Word Wall  
 • perpendicular lines  
 • bisector  
 • perpendicular bisector

**Consolidate Debrief Whole Class → Discussion**

Record students' findings on an overhead under Description, Diagram, Characteristics. Students add to and edit what they have included.

**Home Activity or Further Classroom Consolidation**

Write a journal entry to describe what you learned about perpendicular bisectors and line bisectors.

*Exploration Practice*

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## 6.6.1: Investigating Perpendicular Bisector and Angle Bisectors (Teacher)

### Part A: Perpendicular to a Line

1. Review the meaning of perpendicular lines.
2. Ask what tools they could use to create a perpendicular to a line segment. (Mira, paper folding, protractor, etc.)
3. Students draw a line segment using a pencil and ruler and create a perpendicular line segment by folding paper.
4. Demonstrate how to check if the line segment is perpendicular? (Use the corner of a ruler, the corner of a book, a protractor.)
5. Ask: Is there another line perpendicular to this line segment? Demonstrate another perpendicular.
6. Students find other perpendiculars to their line segment by paper folding, using a Mira, or using a protractor.
7. Ask:
  - What is the relationship between these perpendicular lines? (They are parallel.)
  - What kind of angles are created when a perpendicular line segment is created?
8. Mark it on the sample on the board.
9. Students mark these on their own diagram.
10. Ask: Does the perpendicular always cut the line in half? (No, it just creates a  $90^\circ$  angle.)
11. Demonstrate using folding and using a board protractor.

### Part B: Perpendicular Bisector

1. Ask:
  - What does it mean when we bisect a line segment or an angle?
  - How can we create a perpendicular bisector of a line segment? (folding, using a ruler, using a protractor, etc.)
2. Students, draw another line segment and create a perpendicular bisector, using paper folding.
3. Ask:
  - How many perpendicular bisectors can you create for any given line segment?
  - How do you know?
  - How is this different from creating perpendicular lines?
4. Demonstrate how to mark  $90^\circ$  and equal line segments.
5. Students mark the  $90^\circ$  and equal line segments on their line.

### Part C: Finding the Perpendicular Bisector Using a Compass

Demonstrate how to find the perpendicular bisector with a compass as an alternative way to find a perpendicular bisector.

**Math Learning Goals**

- Construct parallel lines using a variety of tools.
- Determine angle properties created by parallel lines.
- Use angle properties to construct parallel lines.
- Investigate angles in a parallelogram.

**Materials**

- sticky notes (two colours)
- geoboards
- compasses
- protractors
- blank paper

**Assessment Opportunities****Minds On... Whole Class → Review**

Provide students with two different-coloured sticky notes. Post the following statements in columns:

- Perpendicular bisectors meet inside triangles: (1<sup>st</sup> colour)
  - all the time
  - sometimes
  - never
- Angle bisectors meet inside the triangle: (2<sup>nd</sup> colour)
  - all the time
  - sometimes
  - never

Students place the sticky note on the columns they deem as correct. Facilitate a whole-class discussion around student responses.

**Whole Class → Demonstration**

Using a board compass, demonstrate how to construct parallel lines using a compass and ruler. Discuss the properties of parallel lines used to do this construction. Construct a parallelogram.

Students practise constructing parallel lines.

**Action!****Pairs → Investigation**

Students fold a blank paper to create two parallel lines, and then trace the lines with a ruler and pencil (make parallel lines approximately 10 cm apart). They then draw a diagonal line, called a transversal, that crosses the parallel lines at an angle (not 90°). Students measure and compare all angles and compile a list of all angle patterns they discover. They verify their results by making two parallel lines on a geoboard with a transversal and repeating their angle measurements.

**Selecting Tools/Demonstration/Anecdotal Note:** Assess students' selection and use of tools to measure angles.

**Consolidate Debrief Whole Class → Discussion**

Use a diagram of two parallel lines intersected by a transversal at 45° to initiate discussion. Discuss and record student findings.

Ask:

- What do you notice?
- How can this angle property (F pattern or Z pattern) be used to construct a third parallel line? (I know that the transversal cuts both parallel lines at 45°, so I could draw a third parallel line that intersects with the diagonal at 45°. This new line is now parallel to the original two parallel lines.)

**Home Activity or Further Classroom Consolidation**

*Concept Practice*

Construct parallelograms using pairs of parallel lines created by paper folding or by using a compass. Measure the interior angles of the parallelogram to determine any angle relationships that exist.

Verify findings by constructing another parallelogram with a different orientation and measuring its angles. Describe your findings in a journal entry. Include well-labelled diagrams.

Answer:  
Perpendicular bisectors: sometimes (obtuse triangles do not meet inside triangles).

Angle bisector: all the time

These answers can be demonstrated using GSP<sup>®</sup>4 and a data projector.

Ask students how to ensure that the paper folding has created parallel lines. (Measure the distance between the lines at each end, perpendicularly, with a ruler.)

Students should discover angle relationships in F, Z and C patterns. The terminology *corresponding*, *alternate* and *interior angles* are Grade 8 expectations.

Assess individual student reasoning and proving and communication from the written journal entries.





### Math Learning Goals

- Plot points on the coordinate plane in the first quadrant.
- Draw a triangle using ordered pairs in the first quadrant.
- Distinguish between similar shapes and congruent shapes.

### Materials

- BLM 6.10.1
- overhead geoboard
- grid paper

### Assessment Opportunities

#### **Minds On...** Whole Class/Pairs → Demonstration

Demonstrate on an overhead geoboard, as students work with a partner using a student geoboard, how to create a right-angled triangle using the ordered pairs (0,0), (0,4), and (4,0).

- Where would the midpoints be located on the sides of the triangles?
- Name the ordered pairs: (2,0), (2,2), (0,2).
- Using geoboards, join the midpoints.

Discuss the shape created by joining the midpoints.

What else do you notice? Some sample responses: (4 triangles created are congruent; creates 3 pairs of parallel sides; numerous equal angles; interior triangle sides are half the exterior side length; several similar triangles).

Reinforce concepts related to similarity, congruency, and proportional reasoning.

Note: Work in the first quadrant only.

Teacher labels scale on the sides of the geoboard to indicate the  $x$ -axis and the  $y$ -axis with (0,0) at the lower left corner.

Some students may benefit from a review of graphing with ordered pairs.

#### **Action!** Pairs → Investigation

Students work with a partner to encourage mathematical talk. They draw the  $y$ -axis and the  $x$ -axis (first quadrant only) on their grid paper, and label the scale. They draw a triangle and determine the ordered pairs of the triangle's vertices.

Students complete BLM 6.10.1.

**Communicating/Observation/Mental Note:** Assess students' ability to correctly identify coordinate points in the first quadrant.

Students familiarize themselves with the Cartesian grid.

#### **Consolidate Debrief** Think/Pair/Share → Discussion

Students take turns sharing their findings. Partner 1 states one finding and how he/she knows the finding is true. Partner 2 states a different finding and states how he/she knows the finding is true.

Continue the process back and forth so students can share some of their findings.

As a class record the overall findings on a two-column chart labelled Property and Proof, e.g., the line joining the midpoint of 2 sides of a triangle is parallel to the third side and I know this because I used a ruler to measure the perpendicular distance between the lines at either end.

#### Home Activity or Further Classroom Consolidation

Repeat your investigation of the midpoints using a quadrilateral. Select four points on the coordinate system, determine the midpoints, and join the midpoints to create the interior quadrilateral. Describe the patterns that you find.

*Exploration Practice*

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## 6.10.1: Triangle Investigation Using Grid Paper and Midpoints

1. Draw in the  $y$ -axis and the  $x$ -axis on your grid paper, and label the scale.
2. Draw a triangle.
3. Label the ordered pairs of the triangle's vertices.
4. Find the midpoints of the sides of the triangle using a ruler or by paper folding. Join the midpoints to create an interior triangle.
5. Label the midpoint ordered pairs to the nearest tenth.
6. Investigate the new characteristics:
  - a) Mark parallel sides.
  - b) Mark equal angles.
  - c) Mark the lengths of the sides.
  - d) What relationship exists between the newly created triangles? How do you know?
7. Record all your findings.