All About Angles

General Outcome
Develop spatial sense.

Specific Outcomes
G1 Analyze puzzles and games that involve spatial reasoning, using problem-solving strategies.
G5 Solve problems that involve parallel, perpendicular and transversal lines, and pairs of angles formed between them.
G6 Demonstrate an understanding of angles, including acute, right, obtuse, straight and reflex, by:
  - drawing
  - replicating and constructing
  - bisecting
  - solving problems.

By the end of this chapter, students will be able to

<table>
<thead>
<tr>
<th>Section</th>
<th>Understanding Concepts, Skills, and Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>✓ estimate the measure of angles</td>
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<tr>
<td></td>
<td>✓ measure angles using a protractor</td>
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<td></td>
<td>✓ classify types of angles</td>
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<tr>
<td>5.2</td>
<td>✓ sketch angles using a reference</td>
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<td></td>
<td>✓ construct angles using a protractor</td>
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<td></td>
<td>✓ construct angles using a set square</td>
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<td>✓ bisect angles</td>
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<tr>
<td>5.3</td>
<td>✓ identify perpendicular, parallel, and transversal lines</td>
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<td></td>
<td>✓ identify patterns of angles formed by parallel lines</td>
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<td>✓ identify patterns of angles when two lines cross</td>
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<td>5.4</td>
<td>✓ solve problems involving angles formed by parallel lines and a transversal</td>
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<tr>
<td>Section/ Suggested Timing</td>
<td>Prerequisite Skills</td>
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<td><strong>Chapter Opener</strong></td>
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<td>20–30 min (TR page 233)</td>
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<tr>
<td><strong>Get Ready</strong></td>
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<td>40–50 min (TR page 241)</td>
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<td>Students should be familiar with</td>
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<tr>
<td></td>
<td>• adding and subtracting 2- and 3-digit numbers</td>
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<td></td>
<td>• solving simple linear equations</td>
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<td></td>
<td>• naming angles using correct mathematical conventions</td>
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<td>• using a protractor to measure angles</td>
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<td>• identifying right angles</td>
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<td><strong>5.1 Estimating and Measuring Angles</strong></td>
<td>Students should be familiar with</td>
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<tr>
<td>120–150 min (TR page 243)</td>
<td>• measuring angles less than 180° using a protractor</td>
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<td></td>
<td>• estimating and measuring angles of all sizes with a protractor</td>
</tr>
<tr>
<td></td>
<td>• accurately drawing straight lines of different lengths with a pencil and ruler</td>
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<tr>
<td></td>
<td>• ruler, protractor, 90-45-45 set square, 30-60-90 set square, compass, masking tape, markers, Mira™ (optional)</td>
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<tr>
<td></td>
<td>• ruler, protractor</td>
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<tr>
<td><strong>5.2 Angle Constructions</strong></td>
<td>Students should be familiar with</td>
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<tr>
<td>150–180 min (TR page 252)</td>
<td>• estimating and measuring angles of all sizes with a protractor</td>
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<tr>
<td></td>
<td>• accurately drawing straight lines of different lengths with a pencil and ruler</td>
</tr>
<tr>
<td></td>
<td>• ruler, protractor, 90-45-45 set square, 30-60-90 set square, compass, masking tape, markers, Mira™ (optional)</td>
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<td><strong>5.3 Lines and Angles</strong></td>
<td>Students should be familiar with</td>
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<tr>
<td>180–200 min (TR page 261)</td>
<td>• estimating, measuring, classifying, and constructing angles of all sizes</td>
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<td></td>
<td>• ruler, protractor, 90-45-45 set square, 30-60-90 set square, compass, masking tape, markers, Mira™ (optional)</td>
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<tr>
<td></td>
<td>• ruler, protractor, 90-45-45 set square, 30-60-90 set square, compass, masking tape, markers, Mira™ (optional)</td>
</tr>
<tr>
<td><strong>5.4 Angles in Our World</strong></td>
<td>Students should be familiar with</td>
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<tr>
<td>180–200 min (TR page 275)</td>
<td>• angles in parallel lines, supplementary and complementary angles, estimating, measuring, constructing, and classifying angles of all sizes</td>
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<td></td>
<td>• ruler, protractor, compass, calculator</td>
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<td></td>
<td>• ruler, protractor, compass, calculator</td>
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<tr>
<td><strong>Chapter 5 Skill Check</strong></td>
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<td>75–80 min (TR page 285)</td>
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<tr>
<td>Exercise Guide</td>
<td>Extra Support</td>
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</table>
| **Adapted:** #3–#7  
**Typical:** #1–#7 | Math at Work 10 Workbook | TR page 238 | TR page 238 | |
| **Adapted:** Explore #1–#4; On the Job 1 #1–#11; On the Job 2 #1–#2; Work With It #1–#10  
**Typical:** Explore #1–#5; On the Job 1 #1–#11; On the Job 2 #1–#6; Work With It #1–#10 | Math at Work 10 Workbook | TR pages 246, 251 | TR pages 247, 249, 250, 251 | |
| **Adapted:** Explore #1–#5; On the Job 1 #1–#11; #2a–e), #3a–e), #4, #6, #7; On the Job 2 #1–#5; Work With It #1–#9  
**Typical:** Explore #1–#5; On the Job 1 #1–#11; On the Job 2 #1–#5; Work With It #1–#9 | Math at Work 10 Workbook | TR pages 254, 260 | TR pages 255, 256, 257, 258 | |
| **Adapted:** Explore #1–#5; On the Job 1 #1–#11; #2a–e), #3a–e), #4, #6, #8; On the Job 3 #1, #2, #6; Work With It #1–#8  
**Typical:** Explore #1–#5; On the Job 1 #1–#11; On the Job 2 #1–#8; On the Job 3 #1–#7; Work With It #1–#8 | Math at Work 10 Workbook | TR pages 263, 274 | TR pages 265, 266, 268, 270, 272, 273 | |
| **Adapted:** Explore #1–#4; On the Job 1 #1–#4, #6; On the Job 2 #1–#5; Work With It #1, #3–#7, #9  
**Typical:** Explore #1–#5; On the Job 1 #1–#7; On the Job 2 #1–#6; Work With It #1–#9 | Math at Work 10 Workbook | TR pages 277, 284 | TR pages 280, 281, 282 | |
| Have students do at least one question related to any concept, skill, or process that has been giving them trouble.  
**Minimum:** #1–#2, #4–#5, #7–#8 | Math at Work 10 Workbook | TR page 285 | | |
<table>
<thead>
<tr>
<th>Section/ Suggested Timing</th>
<th>Prerequisite Skills</th>
<th>Materials/Technology</th>
<th>Teacher’s Resource Blackline Masters</th>
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<tr>
<td><strong>Chapter 5 Test Yourself</strong>&lt;br&gt;• 60–75 min (TR page 286)</td>
<td>• ruler&lt;br&gt;• protractor&lt;br&gt;• compass&lt;br&gt;• scientific calculator</td>
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<td>BLM 5–1 Chapter 5 Self-Assessment&lt;br&gt;BLM 5–15 Chapter 5 Test</td>
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<td><strong>Chapter 5 Project</strong>&lt;br&gt;• 120–150 min (TR page 287)</td>
<td>• ruler&lt;br&gt;• protractor&lt;br&gt;• compass&lt;br&gt;• grid paper</td>
<td></td>
<td>Master 2 1.0 Centimetre Grid&lt;br&gt;BLM 5–16 Chapter 5 Project Checklist&lt;br&gt;BLM 5–17 Chapter 5 Project Flag of Newfoundland and Labrador</td>
</tr>
<tr>
<td><strong>Chapter 5 Games and Puzzles</strong>&lt;br&gt;• 35–55 min (TR page 290)</td>
<td>• ruler&lt;br&gt;• protractor&lt;br&gt;• coin</td>
<td></td>
<td>BLM 5–18 Chapter 5 Within 10 Game Cards&lt;br&gt;BLM 5–19 Chapter 5 By the Letter Game Cards&lt;br&gt;BLM 5–20 Chapter 5 BLM Answers&lt;br&gt;BLM 5–21 Chapter 5 SE Answers</td>
</tr>
<tr>
<td>Exercise Guide</td>
<td>Extra Support</td>
<td>Assessment as Learning</td>
<td>Assessment for Learning</td>
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<tr>
<td>Provide students with the number of questions they can comfortably do in one class. Choose at least one question for each concept, skill, or process.</td>
<td>Math at Work 10 Workbook</td>
<td>TR page 286</td>
<td>TR page 286 BLM 5–15 Chapter 5 Test</td>
</tr>
<tr>
<td>Minimum: #1–#4, #6, #8</td>
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<td></td>
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<td></td>
<td>TR page 290</td>
</tr>
<tr>
<td>Assessment as Learning</td>
<td>Supporting Learning</td>
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<tr>
<td><strong>Assessment as Learning</strong></td>
<td><strong>Supporting Learning</strong></td>
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<tr>
<td>Use the Before column of BLM 5–1 Chapter 5 Self-Assessment to provide students with the big picture for this chapter and help them identify what they already know, understand, and can do. You may wish to have students keep this master in their math portfolio and refer to it during their work on the chapter.</td>
<td>During work on the chapter, have students keep track of what they need to work on in the What I Need to Work On section of their Chapter 5 Foldable. They can check off each item as they develop the skill or process at an appropriate level.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Assessment for Learning</strong></td>
<td><strong>Supporting Learning</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
| **Method 1:** Use the Get Ready on pages 220–221 in Math at Work 10 to activate student prior knowledge about the skills and processes that will be covered in this chapter.  
**Method 2:** Use the introduction on page 218 in Math at Work 10 to activate student prior knowledge about the skills and processes that will be covered in this chapter.  
**Method 3:** Have students develop a journal entry to explain what they personally know about angles or about jobs, careers, sports and recreational activities, or hobbies that involve classifying angles and estimating and measuring their size. | Have students use the What I Need to Work On section of their Chapter 5 Foldable to keep track of the skills and processes that need attention. They can check off each item as they develop the skill or process at an appropriate level. |
| **Assessment as Learning** | **Supporting Learning** |
| **Chapter 5 Foldable**  
As students work on each section in Chapter 5, have them keep track of any problems they are having in the What I Need to Work On section of their Chapter 5 Foldable. | As students complete each section, have them review the list of items they need to work on and check off any that have been handled.  
Encourage students to write definitions for the Key Words in their own words, including reminder tips that may be helpful for review throughout the chapter. |
| **Assessment for Learning** | **Supporting Learning** |
| **BLM 5–3 Chapter 5 Warm-Up**  
This reproducible master includes a warm-up to be used at the beginning of each section. Each warm-up provides a review of prerequisite skills needed for the section. | As students complete questions, note which skills they are retaining and which skills may need additional reinforcement.  
Use the warm-up to provide additional opportunities for students to demonstrate their understanding of the chapter material.  
Have students share their strategies for completing math calculations. |
What’s Ahead

In this chapter, students learn how to estimate, measure, and classify different types of angles. They learn how to bisect an angle and examine angle patterns constructed using parallel lines and a transversal. Students will apply their understanding of angles to solve contextual problems relating to real life situations.

Planning Notes

The chapter opener shows the flag of Newfoundland and Labrador. The questions relate to the types of angles that can be seen in the flag’s design. Before students start to answer the questions, take 5 min as a class to discuss what an angle is. Develop a definition of the term together. Encourage the idea that an angle describes the shape of a corner or a measurement of a turn. Ask students if they know the unit commonly used to measure the size of an angle and the name of the instrument used to do the measuring. If not, introduce the terms degree and protractor.

Have students work in pairs. Give them 5 min to read and discuss #1 to #4. Then, discuss responses as a class. Encourage students to use words from the Key Words list to help classify the angles. The answers to #1 and #2 will give a good indication of what students already know about measuring and classifying angles.

Use #3 and #4 to steer the discussion toward the types of work that require the use of angles. Examine the Career Link together and discuss where knowledge of angles may be required in another Red Seal trade such as plumbing or drywalling. As well, ask students to give examples from everyday life where they might have to be familiar with and use angles on a regular basis. Here you are looking for answers relating to activities such as sports and navigation.

Foldables® Study Tool: Directions for a Foldable for this chapter are on BLM 5–2 Chapter 5 Foldable. Have students work in a group to follow the directions on the worksheet. You may wish to group students so that they can share equipment and discuss each step. As students work through the chapter, have them define the Key Words beneath the tabs on the left panel. As they work on each section, have them record the key points about each On the Job under the tabs on the centre panel. They can use the pocket to store information on skills and processes that they need throughout the chapter. For example, many students would benefit from making up a series of notes on the different types of proportions and how to solve each one.

The right flap is a good place for students to keep track of what they need to work on. This will assist them with identifying and solving any difficulties with concepts, skills, and processes. Have them check off each item as they deal with it.

Meeting Student Needs

- Have rulers, protractors, and compasses available in the classroom.
- Create anchor charts that can be posted on the wall with the “key concepts” for each lesson.
- Create a word wall in the classroom. Have students discuss each new term and, as a class, create a definition for each term using language they are comfortable with. Then, write out the word and its definition and post them on the wall. Add labelled visuals where applicable. Keep the words posted for the duration of the chapter. Encourage students to write the words in their Foldable and revisit the words and their definitions regularly as they work through the chapter.
• Throughout the chapter, encourage students to create and use personal references for common angles. Encourage students to construct simple tools to identify 45°, 90°, 30°, and 60° angles.

**ELL**
• Encourage students to develop their own dictionary using diagrams and written descriptions.

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**Web Link**
Most trades have a profile that lists the essential skills, including numeracy, that are required for that trade. For more information about different trades, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.

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**Career Link**
Carpenters work on all types of construction projects. They can specialize in areas such as framing, decking, forming, and cabinet making. To be certified, a carpenter must meet several requirements:
- complete an approved training program
- have a minimum of 7200 hours of work experience
- pass the national Red Seal examination

For more information about careers in carpentry, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.
Get Ready

<table>
<thead>
<tr>
<th>Category</th>
<th>Question Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapted (minimum questions to cover the outcomes)</td>
<td>#3–#7</td>
</tr>
<tr>
<td>Typical</td>
<td>#1–#7</td>
</tr>
</tbody>
</table>

Planning Notes

Students need to understand how to
- add and subtract 2- and 3-digit numbers
- solve simple linear equations
- identify and name right angles using correct mathematical conventions
- use a protractor to measure angles

Method 1

Have students complete all sections of the Get Ready questions before starting the chapter.

Method 2

Have students complete selected questions from the Get Ready before they start on various sections of the chapter. For example, have students answer #6 to #8 before section 5.1 and #1 to #3 before section 5.3.

Method 3

Discuss with students the list of prerequisite skills. Have students work in pairs and assign each pair a prerequisite skill. Then, using the Get Ready as a guide, have each pair prepare an exemplar of their assigned skill and present it to the class. Once all students have been introduced to each skill, assign a portion of the Get Ready questions. Use the assigned questions to determine if students are prepared to move to the next stage. If students cannot complete the questions correctly, further instruction is needed.

Meeting Student Needs

- Students will require strong skills in working with ratios and proportions in order to create scales. Expose students to multiple strategies for working with ratios. Cross multiplication is effective from an algorithmic perspective but students should first be introduced to unit rate and equivalent ratios strategies. It is important that students get the chance to explore both the multiplicative and additive properties of ratios. Helping students to create a large table of equivalent ratios can allow them to see some interesting relationships and patterns.
- Encourage students who are struggling with some of the basic operations questions such as #1 and #2 to estimate prior to their final calculation. (Recent surveys show that about 80% of the calculations most adults make in their work are estimates.) These students will often need to explore some strategies for constructing and de-constructing numbers. Example: Can the numbers be put together in ways to simplify the task?
• It may be helpful to show a few parts of #3 in the form of a pan balance as this visual model helps students to understand the meaning of the equals sign in an equation. The visual reinforces the fact that the “equals sign” means that both sides of the equation must be balanced.

**Common Errors**

• Students use the wrong operation to solve a linear equation.

*R* Ask students to verbalize their thinking. Example: “Something” plus 30 equals 90. What is the “something”? What operation do you have to do to determine the “something”? Encourage students to realize that the number they add to 30 to make 90 must be smaller than 90, so they must do the opposite of add, which is subtract.

• Students order letters incorrectly when labelling angles.

*R* Remind students and model that the corner of the object angle is the middle letter of the three.

• Students use a protractor incorrectly.

*R* Review how to use a protractor. Ensure that students position the centre of the protractor on the vertex of the angle and that the base line of the protractor is on one of the arms of the angle. To read the size of the angle, make sure that students use the scale that starts at 0°. Use the angle measuring exercises on BLM 5–3 Chapter 5 Get Ready Extra Practice to give students additional practice.

<table>
<thead>
<tr>
<th>Assessment for Learning</th>
<th>Supporting Learning</th>
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<tbody>
<tr>
<td><strong>Get Ready</strong></td>
<td></td>
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</table>
| Have students complete the Get Ready exercise on pages 220–221 in Math at Work 10. | • Have students use the What I Need to Work On section of their Foldable to keep track of the skills and processes that need attention.  
• If students have difficulty completing #7 and #8, have them complete the angle measuring exercises on BLM 5–3 Chapter 5 Get Ready Extra Practice. This will give them additional practice measuring angles less than 180° with a protractor. |
Planning Notes

Have students complete the section 5.1 warm-up questions on BLM 5–3 Chapter 5 Warm-Up to reinforce prerequisite skills needed for this section.

Introduce this section by inviting the class to discuss the activities of the skier and the BMX rider pictured on page 222. In addition, the class could view videos on the Internet that show similar activities in which the participants rotate. Ask students if they participate in activities such as biking, skating, or dancing where they perform jumps or turns. Discuss the turns they make and any special names for them.

Discuss how athletes control their turns and measure how far they have turned. Then, extend the discussion by asking students about turning in their everyday life. Where and when do students make turns regularly? How can angles be applied to turning?

Explore Angles

In this exploration, students are introduced to the concept that an angle measures an amount of turn. They will see that one full turn makes 360°. They will also learn that fractions of a turn can be expressed as increments of 360°. Students will gain an understanding of the shape of the angle associated with its size in degrees.

This Explore helps students establish personal references for commonly used angles. They will then use these references to estimate the size of angles.

In pairs or groups of three, have students use masking tape to create a cross on the floor similar to the visual on page 222. They should mark 90° increments on the points of the cross.

In #1b), students rotate in a full circle to complete a “360.” In #2, they turn fractions of a circle to turn through different angles. Encourage students to place a ruler on the floor pointing from the centre of the cross in the direction of the turn. When they step off the cross, students can then see the shape of the angle they have turned and can draw a quick sketch using BLM 5–5 Section 5.1 Cross for Explore Angles to draw the turns. This will help to reinforce the shape of the angle associated with the size of the angle in degrees.
As students progress through the different fractions, encourage them to add more lines to the cross so that it more closely resembles a protractor. This will give them more references for the more difficult fractions and help to reinforce their basic numeracy skills.

In #3, students think of and sketch a personal reference for 90°. They work from that reference to establish references for other commonly used angles. Encourage students to use body parts or items close at hand. Invite each student to share their references with the class.

For #4 and #5, have students try to place their personal references over the angles to be measured, so they can see how closely the angles compare.

**Meeting Student Needs**

- It is recommended that students work in pairs throughout the exploration activity.
- Some students may prefer to use a pencil-and-paper approach to complete the *Explore*. If they choose this approach, encourage them to use a pencil as a pointer. They can complete the turns and mark them on the diagram on BLM 5–5 Section 5.1 Cross for Explore Angles.
- Allow students to use a calculator to perform the divisions in the table for #2.
- Students may need help in developing personal references. Body parts and items that are close at hand make the best references. Here are some ideas:

<table>
<thead>
<tr>
<th>Angle</th>
<th>Personal Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>90°</td>
<td>The corner of a book, floor tile, or square forms a 90° angle. The angle between an extended thumb and forefinger is also a good reference for 90°.</td>
</tr>
<tr>
<td>45°</td>
<td>Fold a 90° corner in half or note the angle that a diagonal of a square makes with an adjacent side.</td>
</tr>
<tr>
<td>60°</td>
<td>Make a triangle with your two thumbs and forefingers, keeping your palms flat out in front. This triangle should be approximately equilateral so that angles will be about 60°.</td>
</tr>
<tr>
<td>60°</td>
<td>Make the V symbol with two fingers on one hand. If the forefinger from your other hand fits between the two fingertips of the V, you have made an equilateral triangle and each angle is approximately 60°.</td>
</tr>
<tr>
<td>30°</td>
<td>Place your thumb on the knuckle of your opposite forefinger. Then, touch the tips of your two forefingers. The angle where your finger tips meet should be approximately 30°.</td>
</tr>
</tbody>
</table>

- Make available BLM 5–6 Section 5.1 Finger Positions to Create Angle References to illustrate to students the finger positioning described in the table.
- Some students may benefit from having reference angles available in class. This will help them to develop their personal references. A good way to do this would be to take photos of a student whose hands are in the positions described above. Then label and print out the images and either post them on the word wall or give copies out to students.
- Students are exploring movements by turning around a circle in the traditional counterclockwise direction and from the traditional starting point of facing the positive x-axis. Allow students to question and discover whether the references they come up with are the same regardless of starting point and turning direction.
Gifted and Enrichment

- In #2, have students do turns with fractions where the numerator is not 1. For example, \( \frac{3}{8}, \frac{5}{6}, \frac{5}{12}, \) or \( \frac{11}{12} \). They can do twelfths by dividing each quarter into three sections.
- Challenge students to combine personal references to make other angles.

Common Errors

- Students incorrectly turn the fractions requested in #2.
  - Check that students have done their division correctly. Make sure that students stand in the centre of the cross, turn counterclockwise, and end between the correct lines on the cross. It may be necessary to add extra lines to the cross so that it more closely resembles a protractor.
- Students incorrectly use their personal references to measure angles.
  - Make sure that the vertex of their reference tool is placed on the vertex of the angle and that one arm of the reference tool is placed on the arm of the angle to be measured.

Answers

Explore Angles

2. | Fraction of a Turn | Measure of Angle | Justify |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>a) ( \frac{1}{2} )</td>
<td>0° to 180° = 180°</td>
<td>( \frac{1}{2} ) of 360° = 180°</td>
</tr>
<tr>
<td>b) ( \frac{1}{4} )</td>
<td>0° to 90° = 90°</td>
<td>( \frac{1}{4} ) of 360° = 90°</td>
</tr>
<tr>
<td>c) ( \frac{3}{4} )</td>
<td>0° to 270° = 270°</td>
<td>( \frac{3}{4} ) of 360° = 270°</td>
</tr>
<tr>
<td>d) ( \frac{1}{8} )</td>
<td>0° to 45° = 45°</td>
<td>( \frac{1}{8} ) of 360° = 45°</td>
</tr>
<tr>
<td>e) ( \frac{1}{6} )</td>
<td>0° to 60° = 60°</td>
<td>( \frac{1}{6} ) of 360° = 60°</td>
</tr>
<tr>
<td>f) ( \frac{1}{3} )</td>
<td>0° to 120° = 120°</td>
<td>( \frac{1}{3} ) of 360° = 120°</td>
</tr>
</tbody>
</table>

3. Examples:
   - a) The corner of a page of this book is a right angle.
   - b) For 45°, use half of the corner angle. For 60°, use two-thirds of the corner angle. For 180°, use double the corner angle.
   - c) For 45°, fold a square of paper along its diagonal. Each angle that is not a right angle is 45°. For 60°, refer to a clock face. The angle between the hands at 2 o’clock is 60°. For 180°, use any straight line.

4. Examples:
   - a) The angle looks to be slightly larger than half a corner angle; estimate: 50°.
   - b) The angle is a bit larger than a corner angle; estimate: 100°

5. Examples:
   - a) 15°
   - b) 150°
   - c) 50°
   - d) 80°

Web Link
For additional practice estimating the measure of angles in games and other learning activities, go to www.mhrmathatwork10.ca and follow the links.
Assessment as Learning | Supporting Learning
---|---
**Reflect**
Listen as students discuss their answers to the Reflect questions. Answers should describe the given angles in relation to the references in #3. (Example: The angle in #4a) (52°) is larger than the reference for 45° and is smaller than the reference for 60°. The size of the angle appears to be about halfway between these two measures.)

- Students will need to consider how close the angles are to their references for the common angles. Prompt them to choose the reference closest to the angle and then ask
  - Is this angle larger or smaller than your reference?
  - Is this angle a lot larger or smaller than your reference?
  - How many degrees larger or smaller do you think the angle might be?
  - Lead them toward the answer with careful questioning.

**Extend Your Understanding**
Listen as students discuss how to estimate the sizes of the angles. The sizes of three of the angles (15°, 75°, and 150°) should lead students to use at least two references to make a determination. Encourage students to combine their angle references to make new angles.

- Encourage students to experiment by putting two of their angle references together. Ask what they think the size of the combined angle is. Ask them to compare this compound angle to one of the questions.
- Encourage them to experiment further by adding or subtracting the angles in their other personal angle references.

---

**On the Job 1**

This **On the Job** introduces acute and obtuse angles. Students need to have a good understanding of the shape of a right angle before starting this exercise. They should be able to easily identify and use a personal reference for 90°.

Have students consider the scenario and review the diagrams that show Kyla's different foot placements. The first two examples showing a right angle and an obtuse angle are explained from static dancing positions and can easily be seen. The third example may need a little more explanation. The 45° angle is created when the dancer steps in the direction the foot is pointing. The angle is measured relative to the direction the dancer is facing.

Ask students to consider other situations where classifying angles as acute or obtuse is important. For instance, have them look at the angles at which wood trim is cut to fit around a door frame or into the corners of a room. You may also want to have them look at how picture frames are put together.

**Meeting Student Needs**

- Students will benefit from having angle diagrams given from multiple orientations. This gives students a chance to get comfortable with the big idea of transforming an object or, in this case, an angle. It is important to focus on what properties of angles remain unchanged under a given transformation.
- Encourage students to keep a journal of all the new vocabulary. Have them use their journal entries to explain in their own words what each new word means.
- Have one or more students make a poster showing acute, right, and obtuse angles. Post it in the classroom for handy reference.

**Gifted and Enrichment**

- Challenge students who enjoy dancing to classify the angles of the various positions and steps according to the type of angle produced. Have them estimate the size of the angle using a personal reference.
Check Your Understanding

Try It

For #1 to #6, remind students that one full turn is 360°. Start by asking how many degrees would be in half a turn. You may have students work in pairs for these questions, with each partner doing either odd- or even-numbered questions. When they have finished, have students check the accuracy of each other’s work.

For #7 and #8, refer students to their journal or the word wall in the classroom to remind them what an acute, obtuse, and right angle are.

Apply It

For #11a) and #11b), students will have to determine the location of the angles from reading the text. Prompt students that the angle in each case is between the two connecting lines described in the question.

Meeting Student Needs

- It may be useful to have students develop a mnemonic to help them remember the difference between an acute and an obtuse angle. For example, a is closer to the beginning of the alphabet, so acute angles are smaller; o is later in the alphabet, so obtuse angles are larger.

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<tr>
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<tbody>
<tr>
<td>On the Job 1</td>
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<tr>
<td>Have students do the Your Turn related to On the Job 1. Check that</td>
<td></td>
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<tr>
<td>• angle estimates are reasonable</td>
<td></td>
</tr>
<tr>
<td>• angle classifications fit the estimates</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Encourage students to work in pairs to check the accuracy of their work.</td>
</tr>
<tr>
<td></td>
<td>• Encourage students to use their personal references to estimate the size of the angles.</td>
</tr>
<tr>
<td></td>
<td>• Encourage students to verbalize their thinking.</td>
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<tr>
<td></td>
<td>• Challenge students to develop additional angles for others to estimate the size and classify.</td>
</tr>
</tbody>
</table>

Assessment for Learning

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<th>Supporting Learning</th>
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<tbody>
<tr>
<td>Try It</td>
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<tr>
<td>Have students do #1 to #7. Students who have no problem with these questions can go on to the remaining questions.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provide additional coaching with the Explore to students who need help with #1 to #6.</td>
</tr>
<tr>
<td></td>
<td>• Provide additional coaching with On the Job 1 for students who need help with #7.</td>
</tr>
<tr>
<td></td>
<td>• Encourage students to use a concrete personal reference for a 90° angle to help differentiate between an acute and an obtuse angle. Acute angles would be inside this reference. Obtuse angles would fall outside.</td>
</tr>
</tbody>
</table>
On the Job 2

This On the Job introduces straight and reflex angles. Students need to have a good understanding of the shape of angles smaller than 180° before starting this exercise. They should be able to estimate, classify, and accurately measure the size of angles smaller than 180°. Make sure that all students can use a protractor to measure angles less than 180° before starting this On the Job.

This On the Job uses BMX biking to show that turning 180° makes a straight angle and that turning 270° makes a reflex angle. Have students read the explanation on page 229 on how to use a half-circle protractor to measure angles larger than 180°. Then, have them display and explain the method in their own words. You may also wish to demonstrate how to use a full-circle protractor for measuring this type of angle.

Have students complete the questions in the Your Turn. You may wish to have them work in pairs, checking and discussing each other’s work. Note that the angle in part a) is a straight angle. Make sure that students measure with a protractor to confirm this. The other two angles are reflex angles. Have pairs of students explain to each other how to measure these angles.

Show students the strategy for measuring reflex angles outlined in the Common Errors below. Have students try this strategy with the angles in the Your Turn. Discuss the advantages and disadvantages of each strategy. Which do they find easier to use?

Meeting Student Needs

- Take the time to have students become comfortable using both half-circle and full-circle protractors. Have students discuss the strategy that is more effective for them. Many will find it easier to measure the acute angle first and calculate the reflex angle by subtracting the acute angle from 360°. Others may want to start with a straight angle and add on the extra part of the reflex angle by using the half-circle protractor.
- Have students add straight angle and reflex angle to their vocabulary list.
- Have students add reflex angle to their mnemonic.
  - acute: first in alphabet → small angle, less than 90°
  - obtuse: middle of alphabet → medium angle, more than 90° but less than 180°
  - reflex: toward end of alphabet → large angle, more than 180° but less than 360°

Gifted and Enrichment

- An excellent application to have students work with is that of staking out a rectangular area for a deck using only a measuring tape. Ask students to attempt this and see if they can develop a strategy for ensuring that they have proper right angles at the corners of their deck. Think diagonals!
- Another excellent example could involve building a frame for a hexagonal deck structure. How would the frame boards need to be cut in order to create a perfect regular hexagon?
**Common Errors**

- Students have difficulty lining up a half-circle protractor to measure an angle larger than 180°.

**Rx** It is often easier to measure the smaller angle with the protractor and then subtract that value from 360° to calculate the reflex angle. For example, in the following visual the smaller angle is 90°. The reflex angle is 270° (360° − 90°).

- Students may confuse straight angles and reflex angles.

**Rx** Point out that a *straight* angle makes a *straight* line.

**Answers**

**On the Job 2: Your Turn**

a) straight angle; 180°
b) reflex angle; 350°
c) reflex angle; 245°

**Assessment Supporting Learning**

<table>
<thead>
<tr>
<th>Assessment</th>
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</table>
| **On the Job 2** | • Encourage students to work in pairs to check the accuracy of their work.  
• Encourage students to use their personal references to estimate the size of the angles before measuring with a protractor. This is particularly useful when determining the size of a reflex angle by measuring the size of the smaller angle and then subtracting it from 360°. |
| Have students complete the Your Turn related to On the Job 2. Check that • angle measurements are accurate • angle classifications fit the measurements |

**Check Your Understanding**

**Try It**

For #1, encourage students to use their journal or the word wall in the classroom to remind them what a straight angle and a reflex angle are. Have students use both strategies for measuring a reflex angle. Alternatively, have students work in pairs with each student using one of the strategies. They can then compare their results.

For #2, students may need to combine personal references to get some of the angles.

**Apply It**

For #5, students may have difficulty describing in writing the location of the angles. Give them the option of verbalizing their answers or drawing a sketch of the window and highlighting the straight and reflex angles.

For #6, encourage students to create their own step-by-step checklist or guide to measure a reflex angle using a half-circle protractor. You may wish to have them use both methods and then decide which they prefer.
Questions #7 and #8 give students the opportunity to estimate and measure both reflex angles and obtuse angles.

**Common Errors**

- When reading from a protractor, students give the obtuse or acute angle as the reflex angle.
- Remind students that a reflex angle is more than one-half of a turn and is larger than a half-circle protractor can measure.

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<tr>
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<tbody>
<tr>
<td><strong>Assessment for Learning</strong></td>
<td>• Provide additional coaching with On the Job 2 for students who need help with #1 to #3.</td>
</tr>
<tr>
<td><strong>Try It</strong></td>
<td>• If you have not already done so, show the method for measuring reflex angles illustrated in the Common Errors on page 249.</td>
</tr>
</tbody>
</table>

**Work With It**

Students have now completed On the Job 1 and On the Job 2 and the related Check Your Understanding questions. In the Work With It section, students have an opportunity to use the skills from both On the Job 1 and On the Job 2 in practical situations.

For #1, #3, and #5, provide students with BLM 5–7 Section 5.1. Work With It Figures. Having the larger diagrams will help students measure the angles accurately.

Encourage students to have fun with #1. It is intended to have them see how angles can be used in a number of playful ways. Students may need to use their journals or the classroom word wall to recall the definitions of the different angles they need to find. Students could work in pairs and take turns to verbally define each type of angle.

Question #4 can provide a good discussion point as ladder safety is an important life skill. Ask students to discuss what is likely to happen if the angle at the base of the ladder is too great or too small.

For #5, make sure students centre the protractor correctly and use the right scale for each angle in this question.

**Discuss It**

These questions are designed for students to discuss their understanding of the concepts covered in this section. They provide opportunities for students to explore applications of the concepts outside of the areas presented in this text. They also present problems which should challenge students’ understanding of the material and make them express clearly what they know about the topic.

Question #6 encourages students to look for angles in the classroom. They will find that the most common angle is 90°. Ask them to explain why this is the case. Prompt them to think about the shapes with 90° angles and what is special about the way they fit together.

**Web Link**

To explore other careers such as carpentry that require knowledge of angles and the ability to work with them, go to www.mhrmathatwork10.ca and follow the links.
For #7, have students classify the angles made by the two intersecting lines. What happens to these angles when the paper is folded vertically? What happens to the angles when the paper is folded horizontally? Discuss these observations with students, as this question leads toward On the Job 2 in the next section, where students learn to construct an angle bisector.

In #8, students will need to know that two straight lines joining at a vertex will always create two angles, but they have to identify which is the object angle by looking to see which side is marked.

In #9, extend the question by asking for the total of the angles that Peter and Andrée measured. Why do you think the answer is 180°? This will encourage students to think about patterns in angles and will help prepare them for material covered later in this chapter.

Question #10 provides a good research opportunity. Students can explore careers where they would have to use angles regularly.

Meeting Student Needs

- Provide BLM 5–8 Section 5.1 Extra Practice to students who would benefit from more practice.

Common Errors

- Students have difficulty reading the protractor correctly.

R.

Review the following steps:

- Place the protractor with the centre line on the vertex of the angle being measured.
- Run the bottom of the protractor along one arm of the angle being measured.
- Start at 0 on the protractor scale.
- Run your finger up that scale until you come to the second arm of the angle being measured.
- Read the number.

Post the steps on the classroom wall or encourage students to write the steps on an index card to keep in their Chapter 5 Foldable for reference.

Assessment as Learning

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<tr>
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</thead>
<tbody>
<tr>
<td>Discuss It</td>
<td>Encourage students to share their thoughts and ideas orally before writing anything down.</td>
</tr>
<tr>
<td></td>
<td>If computers are available, allow students to do research on the Internet for #10. Alternatively, invite a picture framer, artist, or tiler to speak to the class about their job.</td>
</tr>
</tbody>
</table>
### 5.2 Angle Constructions

<table>
<thead>
<tr>
<th>Category</th>
<th>Question Numbers</th>
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</table>
| Adapted (minimum questions to cover the outcomes) | Explore #1–#5  
On the Job 1 #1, #2a–e), #3a–e), #4, #6, #7  
On the Job 2 #1–#5  
Work With It #1–#9 |
| Typical                         | Explore #1–#5  
On the Job 1 #1–#8  
On the Job 2 #1–#5  
Work With It #1–#9 |

### Planning Notes

Have students complete the section 5.2 warm-up questions on **BLM 5–3 Chapter 5 Warm-Up** to reinforce prerequisite skills needed for this section.

As a class, discuss what drafters do. Show a few images of design plans to illustrate their work. Have students work in pairs to brainstorm about jobs that would require you to read and use plans that drafters create.

This is a good place for a cross-curricular link. Here you can ask about other curriculum subjects that work with plans. Where else in school do you have to create designs? Depending on the courses offered in your school, students may respond that they have seen plans and designs in art, technology, geography, and fashion. You can also ask about the tools used to create and read the designs in these classes.

### Explore Set Squares

In this exploration, students discover how set squares can be used to construct angles quickly. They are introduced to the 90–45–45 and 30–60–90 set squares and use these tools to construct 30°, 45°, 60°, and 90° angles. The set squares should be explained as an accurate extension of their own personal references for these angles.

For this exercise, provide students with both types of set square. In #1, students have to draw around the corners of the set square. Encourage them to be careful and to take their time when tracing the pencil around the acute angles.

In #2, students should use a protractor to measure the angles. Have students compare their answers before moving on to #3.

Question #3 repeats #1 and #2 with the other set square.

Question #4 invites students to reflect on the angles of the set squares in order to associate each set square with its correct name (with ABC being the 45-45-90 set square and DEF being the 30-60-90 set square). You could also ask students to measure the sides of the triangles and look for any patterns in the lengths of the sides of each set square.

### Web Link
To see samples of design plans that drafters prepare, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.
Question #5 extends students’ understanding by asking students to put two set squares together to create more angles. Encourage students to label the size of each angle as they draw it. Also make sure students realize that the vertex of both angles has to be the same point and that one arm of the first angle is the baseline of the next. This way they can see the size of the two angles next to each other and can then total them. They should be able to construct angles measuring 60°, 75°, 90°, 105°, 120°, 135°, 150°, and 180°.

In the Puzzler, ask students if it is possible to position two set squares to make other reference angles that measure less than 30°. If not, and given what students discovered in #5, what does this suggest about the angles that can be formed?

**Meeting Student Needs**
- Once students have been able to successfully draw basic angles like 45° and 60°, try to extend their thinking into how set squares could be used to create angles like 15° and 135°.
- Observe the different ways that students may work with the tools in order to create angles. There is an opportunity here to see which students will be more successful in kinesthetic or visual approaches. Make sure you have protractors available so students can test their strategic approaches to creating these more difficult angles.
- Some students may benefit from working in pairs throughout the Explore.
- Help students recall their personal references for 30°, 60°, and 45°. Refer them to their journals where they should have pictures of these angles.
- Some students may need prompting to recognize the operation required when combining the angles in #5.

**Gifted and Enrichment**
- Challenge students to create angles of 105° and 165° using the set squares.
- Challenge students to create multiple ways of drawing each angle using the set squares.

**Common Errors**
- Students do not trace the set square accurately.
  - **R** Encourage students to take their time and use a sharp pencil.
- Because of rounded corners on some set squares, students will have problems making the vertices of the different set squares meet at the same point.
  - **R** Encourage students to adjust their measuring. Have them draw a base line first. Then, put both set squares down together with the edge of one on the straight line to draw the new angle.
Explore Set Squares

1. 

2. \( \angle A = 45°, \angle B = 90°, \) and \( \angle C = 45° \)

3. 

\( \angle D = 60°, \angle E = 30°, \) and \( \angle F = 90° \)

4. 
   a) \( \text{ABC is a 90-45-45 set square.} \)
   b) \( \text{DEF is a 30-60-90 set square.} \)

5. Examples: \( 30° + 45° = 75°, \)
   \( 60° + 45° = 105°, 30° + 90° = 120°, \)
   \( 60° + 90° = 150° \)

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Assessment Supporting Learning

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<tbody>
<tr>
<td><strong>Reflect</strong></td>
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<tr>
<td>Listen as students discuss their answers to the Reflect question. Ask students what they think the names of the set squares represent. Students should respond that the name of each set square gives the size of the set square’s angles. Students should then be able to identify that ABC is the 30-60-90 set square and DEF is the 90-45-45 set square.</td>
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</table>

| **Extend Your Understanding** |
| Have students experiment by placing the set squares side by side and meeting at a common corner, and then adding the angles. Or Ask students to experiment with the size of the angles in the set squares by adding two angles together at a time and then trying to draw the angles using the set squares. |

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<th>Supporting Learning</th>
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<tr>
<td>• Ask students to directly compare the names of the set squares with the angles inside them. Then, ask students to describe any similarities.</td>
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</table>

| • Try asking students the following questions: |
| – What is 45° + 30°? |
| – How does this apply to the set squares? |
| – What would you have done to the set square to make this angle? |
| – What other operations can you think of using the angles in the set squares? |

---

On the Job 1

This **On the Job** asks students to sketch an angle using a set square as a reference. Then, students are to use a protractor to construct the angle and measure it. Students will need to have access to both a set square and a protractor.

Have students consider the illustration and relate it to their own experience. You might ask:

- Why is it important for the solar panel to be installed at the correct angle?
- What other objects might need to be installed at specific angles?
- What could Morgan use to measure the angle at which he needs to set the panel?
- How could Morgan check that he installed the solar panel at the correct angle?

Tradespeople, especially framers and formers, often work with large-scale set squares. Ask students what they think framers and formers do. Then, ask why it would be useful for these tradespeople to have large-scale set squares.

Example a) sketches the 60° angle using a set square. Example b) shows the steps to construct the angle with a half-circle protractor. You will need to adjust the instructions if you are using a full-circle protractor. Emphasize the importance of lining up the protractor on the straight line as if you were going to measure an angle.
Meeting Student Needs

- Students may be confused in part a) of the Your Turn about the use of a reference to draw an angle of 42°. Ask them which set square could be useful to them in creating such an angle. Have students play with the set square and have a discussion of how to manipulate the set square to get a reasonable estimate of the angle.
- Have students write their own explanation of how to construct an angle using a protractor. Then, as a class, compile their instructions to develop a common approach. This can then be recorded in their journals and placed on the word wall for quick reference.
- Encourage students to check their constructions against their personal references to ensure the accuracy of their drawings.
- Also encourage students to check their constructions with their partners to ensure the accuracy of their drawings.
- Students can use dynamic geometry software to make their constructions.

Gifted and Enrichment

- Challenge students to construct reflex angles using a protractor.

Answers

On the Job 1: Your Turn
Sketches may vary.

a)  

b)  

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<thead>
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</table>
| On the Job 1            | Have students complete the Your Turn for On the Job 1. Check that:  
  • students use a suitable personal reference  
  • sketches are reasonable  
  • constructions are accurate |  
  • You may want students to work in pairs. They can compare the references they use, as well as their sketches and the accuracy of their constructions.  
  • Encourage students to verbalize their thinking.  
  • You might have students use dynamic geometry software to construct the angles.  
  • Encourage students to use appropriate personal references when estimating. Prompt them to question whether the desired angle is more or less than their personal reference. |

Check Your Understanding

Try It

For #1, students are required to construct angles using set squares. Part c) is the only angle that requires the use of both set squares.

For #2 and #3, encourage students to work in pairs. Suggest that each partner do every other part. On completion, students can check each other’s work. Remind students to use a personal reference to estimate the size of the angles first, and then draw a rough sketch before doing an accurate construction.

In #4, students are expected to be competent at using the protractor in order to recognize the error. You could also ask what other common error might occur when using a protractor.
Question #5 provides a good discussion point because Shaun could be correct if he marks the other side of the angle. Ask students: What is $360^\circ - 140^\circ$? Then, ask whether Shaun should mark the larger angle or the smaller one. Also ask about the scale on the full-circle protractor: What does the inside scale and outside scale total?

**Apply It**

For #6, remind students where necessary to do a rough sketch first.

For each of #7 and #8, encourage students to do a rough sketch first. They can record all of their measurements on this sketch and then draw the figures accurately (triangle logo in #7 and star system diagram in #8).

**Meeting Student Needs**

- Students may benefit from using dynamic geometry software such as *The Geometer’s Sketchpad®* to construct angles accurately.

**Common Errors**

- Students read the wrong scale on their protractor.
  - $R_x$ Remind students to start counting from 0 on the pencil line they draw.
- Students do not properly centre their protractor.
  - $R_x$ Remind students to check that the protractor is centred on one end of the pencil line they drew.
- Students do not hold their protractor in place while drawing a dot to mark the size of an angle.
  - $R_x$ Remind students to use one hand to hold the protractor in place while measuring the angle. If the protractor moves, the angle will not be accurate.

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<tbody>
<tr>
<td><strong>Try It</strong></td>
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<tr>
<td>Have students do #1 to #3. Students who have no difficulty with these questions can go on to the remaining questions.</td>
<td>Provide additional coaching using the Explore for students who need help with #1. Provide additional coaching using On the Job 1 part b) for students who need help with #2 and #3. Encourage students to always use a personal reference and a sketch before constructing accurately. Encourage students to use their personal references to check the reasonableness of their answers. Students can also ask their partner to check the accuracy of their constructions.</td>
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</table>

**On the Job 2**

This On the Job asks students to construct angle bisectors using paper folding, a protractor, and a compass. Each method is explained in turn. In addition to having protractors and compasses available to students, you may also want to consider using Mira™ or dynamic geometry software as alternative methods to bisect the angles.

This On the Job provides an ideal opportunity for collaborative activity. You could organize students into three (or four if you include the Mira™ approach) groups with equal numbers of students. Assign each group one of the three methods and challenge them to work to become experts in that method. They

Welding is a technical process used to permanently join pieces of metal. Because the bonds formed are very strong, welding is used to build automobile and airplane framing, and to join metal beams that form the frames of bridges and buildings. Students may confuse welding with other processes that melt metal to join two materials, such as soldering or brazing. These processes melt an added piece of metal, and form bonds that are not as strong as welded bonds. Discuss when soldering or brazing may be preferable to use over welding. Why is it important for the steelworker in #4 to use welding? To learn more, go to www.mhmathatwork10.ca and follow the links.
should also prepare an example they can use to teach the other students. When you are confident each group understands their method, reorganize the class into groups of three students, with one from each of the expert groups. Now, each expert has to teach their method to the other two members of the group. This process should take 30–40 min.

**Meeting Student Needs**

- Ensure that students are convinced that the paper folding technique of determining the angle bisector will work in all cases. Have students attempt questions where the sides of the angles are different lengths. It can also be helpful to see that transformations of the angle will not affect the result.
- After students have drawn the first arc on the angle using a compass, have them change the setting before drawing the next two arcs. Have them measure with a protractor to see if this affects the result. Try a new question where they change the compass setting after each of the three arc sweeps to see if the angle bisector measurement is affected.
- Have students write their own explanation of how to construct an angle bisector using each of the three methods. Then, as a class, discuss and compile their instructions to develop a common approach. This can then be recorded in their journals and placed on the word wall for quick reference.

**Gifted and Enrichment**

- There are many interesting angle constructions that can be done using a straight edge and compass only. Have students research one of the more well-known constructions as a research project. (Example: A 30° angle can be constructed by starting with a fixed line segment and creating an equilateral triangle using the compass. You can then do the angle bisector of one of the 60° angles.)
- Have students explore and critique the angle bisector strategies for a reflex angle to see if there are any limitations to their use. Challenge students to construct the bisector of large reflex angles using the different methods. Ask them to compare their constructions with the bisectors of the matching acute or obtuse angles. For example, construct the angle bisectors of 320° and 40°; what do you notice?

**Answers**

**On the Job 2: Your Turn**

![Diagram of angles](image)

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<tr>
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<tr>
<td>Have students complete the Your Turn for On the Job 2. Check that • students draw angles accurately  • students use their protractor and compass correctly  • constructions of angle bisectors are accurate</td>
<td>• You may want students to work in pairs. They can compare their sketches and the accuracy of their constructions.  • Encourage students to verbalize their thinking.  • You might have students use dynamic geometry software or Mira™ to construct the angle bisectors.  • Prompt students to question whether the angle bisector cuts the given angle exactly in the middle.</td>
</tr>
</tbody>
</table>

**Web Link**

To challenge students to do some constructions with a pencil, ruler, and compass, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.
Check Your Understanding

Try It
For #1, students are required to construct the angle bisector using paper folding.
For #2, students are required to construct the angle bisector using a protractor.
For #3, students are required to construct the angle bisector using a compass and ruler.

Apply It
Question #4 requires students to create a diagram modelling a real-life situation. This question could be used to reinforce the career link at the beginning of the section. When students are drawing their diagram, you could ask them to explain what they are doing and describe some occupations that would use these types of plans regularly.
For #5, encourage students to pick either the method they prefer or the method they think is the most appropriate to check the positioning of the middle rod. After students complete the question, ask them to explain their choice of method. This will help prepare students for the Discuss It portion of the Work With It exercise that follows.

Meeting Student Needs
• Students may benefit from using dynamic geometry software or Mira™ to construct the angle bisectors accurately.

Common Errors
• Students use their protractor incorrectly.
  Remind students about the common errors in using protractors and the steps to prevent them as described previously on page 256.
• Pencil in compass is not secured or aligned.
  Remind students that the pencil point and the tip of the compass point should be touching and that the pencil needs to be securely fastened.
• The two arcs that students draw do not meet at a point.
  Remind students that the distance between the compass point and the pencil needs to be shorter than the arms of the angle and stay the same length when drawing the arcs on the arms of the angle. Reset the compass and keep it the same length to draw the two new arcs.

Assessment Supporting Learning

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<tr>
<td>Try It</td>
<td></td>
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<tr>
<td>Have students complete #1 to #3. Students who have no difficulty with these questions can go on to the remaining questions.</td>
<td>• You may want students to work in pairs. They can compare their sketches and the accuracy of their constructions. • Encourage students to verbalize their thinking. • You might have students use dynamic geometry software or Mira™ to construct angle bisectors. • Encourage students to use appropriate personal references when estimating. Prompt them to question whether the angle bisector cuts the given angle exactly in the middle.</td>
</tr>
</tbody>
</table>
**Work With It**

For #1, students are constructing angles using set squares.

For #2, students are constructing angles using a protractor. Part d) is a large reflex angle and provides an opportunity to review strategies to construct reflex angles.

For #3, students are given a choice of method to construct an angle bisector. Encourage students to give a reason for their choice.

**MINI LAB** In #4, students create a compass rose by turning through the angles, bisecting them, and marking the directions using masking tape. This activity is especially good for kinesthetic learners. An alternative approach using paper constructions can be completed using the following procedure:
- Draw and cut out a 10 cm by 10 cm square.
- Fold the square in half horizontally.
- Fold the paper in half vertically.
- Fold the paper diagonally, making sure to start from the folded corner.
- Fold the paper diagonally again from the same corner.
- Label the directions.

You may choose to add to this Mini Lab by asking students to orient the compass rose to actual directions. To do this, you will need to know which direction is north from your classroom. Ask students to orient their compass rose so their north line points north. Prepare some fun questions relating to the eight-point compass rose. For instance, students can simply point to answer questions such as: Ottawa is due west. In which direction do I need to go to get to Ottawa? London, England, is due east. In which direction do I need to go to get to London?

Alternatively, you could ask direction questions using a large map of Canada. Students will need to know that north is always pointing up. They can place the centre of their compass rose on their current location to read off the required direction.

For #5, students have to copy the design shown. Encourage them to draw a very rough sketch first. They can label their sketch with the angles and lengths as they measure them. They can then use their sketch as a guide to creating an accurate copy of the design.

For #6, students are required to draw a diagram showing a car door in its fully open and half-open positions. Encourage students to put some detail in the diagram, labelling the door jamb, the half-open, and the fully open doors.

**Discuss It**

For #7, the length of the compass setting has to be changed so that it is greater than half the distance between the first arcs. This will ensure that the arcs meet at an appropriate point.

For #8, students have to describe a pro and a con of the methods used to construct an angle bisector. You may want to remind students that in the context of this question, a pro is an advantage and a con is a disadvantage.
Meeting Student Needs

- Students may benefit from using dynamic geometry software to construct the angles and angle bisectors accurately.
- Students may benefit from using Mira™ to construct the angle bisectors accurately.
- For #4, provide BLM 5–9 Section 5.2 Compass Rose to students who may benefit from having a larger visual of a compass rose to refer to for labelling purposes.
- Provide BLM 5–10 Section 5.2 Extra Practice to students who would benefit from more practice.

Common Errors

- Students use either their protractor or compass incorrectly.
  
  \textbf{Rx} Refer students to their notes on how to construct an angle. Remind them of the key steps in the process.

  \textbf{Rx} Refer students to the three methods that can be used to construct an angle bisector. Encourage them to go over the key steps in each method.

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| **Discuss It**  
These questions give students an opportunity to explain their understanding of how to construct an angle and an angle bisector. Have all students complete #7 to #9. | • Encourage students to share their thoughts and ideas orally before writing anything down.  
• For #8, ask students to compare each other’s pros and cons and try to get a class opinion on which of the three methods that students can use is the best approach, and why. |
Lines and Angles

<table>
<thead>
<tr>
<th>Category</th>
<th>Question Numbers</th>
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<tr>
<td>Adapted (minimum questions to cover the outcomes)</td>
<td>Explore #1–#5</td>
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<tr>
<td></td>
<td>On the Job 1 #1–#4, #6</td>
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<tr>
<td></td>
<td>On the Job 2 #1–#3, #6, #8</td>
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<tr>
<td></td>
<td>On the Job 3 #1, #2, #6</td>
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<td></td>
<td>Work With It #1–#8</td>
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<tr>
<td>Typical</td>
<td>Explore #1–#5</td>
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<td>On the Job 1 #1–#7</td>
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<td></td>
<td>On the Job 2 #1–#8</td>
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<tr>
<td></td>
<td>On the Job 3 #1–#7</td>
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<tr>
<td></td>
<td>Work With It #1–#8</td>
</tr>
</tbody>
</table>

Planning Notes

Have students complete the section 5.3 warm-up questions on BLM 5–3 Chapter 5 Warm-Up to reinforce prerequisite skills needed for this section.

As a class, discuss the map of St. John’s. Ask students to explain what is meant by a block system. Have students think about other towns and cities in Newfoundland and Labrador or elsewhere to see if they know of any locations with a similar style of street layout. If not, ask them why they think this is the case. Then, ask if anyone has visited another city designed on a block system.

Explore Angles in Parallel Lines and Perpendicular Lines

In this exploration, students will identify parallel lines, perpendicular lines, and transversal lines. They will also measure angles in systems of parallel lines and a transversal, looking for patterns.

Make BLM 5–11 Section 5.3 Street Map of St. John’s available for students to use in this exploration. The larger scale will make it easier for students to find the required streets. Students can also draw on their copy of the map and keep it for future reference.

For #2, if you are using BLM 5–11 Section 5.3 Street Map of St. John’s, the parallel lines, transversal, and angles are already drawn on the map. Students can start by measuring the angles for part b). Encourage students to draw the new transversals for parts c) and d) on their map. Again, this will mean that they do not have to draw the parallel lines.

The choice of parallel and perpendicular streets is quite limited as the map area is small. Have students work in pairs and encourage them to look for sets of streets different from their partner’s.

Math at Work 10, pages 246–261

Suggested Timing
180–200 min

Materials
- ruler
- protractor
- calculator

Blackline Masters
BLM 5–3 Chapter 5 Warm-Up
BLM 5–11 Section 5.3 Street Map of St. John’s
BLM 5–12 Section 5.3 Extra Practice

Mathematical Processes
✓ Communication (C)
✓ Connections (CN)
   Mental Math and Estimation (ME)
✓ Problem Solving (PS)
   Reasoning (R)
   Technology (T)
✓ Visualization (V)

Specific Outcome
G5 Solve problems that involve parallel, perpendicular and transversal lines, and pairs of angles formed between them.

Web Link
Many cities in Canada and the United States use a block system with streets laid out on a grid pattern. For more information, go to www.mhrmathatwork10.ca and follow the links.
For #4, students are looking for angles that are the same size, which they should notice both visually and through their measurements. Remind students about straight angles. You might ask:
- Where are the pairs of angles that are the same sizes?
- What pattern or letter does a junction between two lines make?
- What is a straight angle?
- What is the total of the two different angles?
- Why do you think the total is 180°?
- What is the total of the four angles at a junction?
- Why do you think the total is 360°?

For #5, encourage students to use BLM 5–11 Section 5.3 Street Map of St. John's with the streets highlighted. Students may not understand the restriction that the bus cannot make turns at angles less than 90°. Explain that this refers to any acute angle that would be on Jessie's right measured from Gower Street to a transversal street. Have students measure the angles made by all the transversal streets. Then, students should trace routes from Gower Street running in both directions. Ask them whether the starting direction makes any difference in their answer.

**Meeting Student Needs**

- Students can use a transparent ruler test to look for streets that follow parallel lines. The test involves the distance between the two streets staying constant. Run the ruler perpendicular to the two streets in question with the zero mark of the ruler on the bottom street. Have students determine whether or not the top street is continuing to be at the same mark as you run the ruler along the two streets.
- There are excellent opportunities to use references in this section as the concept of the transversal is brought in. Start by asking students to identify angles created by the transversal as obtuse, acute, or right. This will help them to see which angles could be congruent.

**Gifted and Enrichment**

- Challenge students to extend what they have discovered in the Explore by increasing the number of parallel lines. Will adding more parallel lines make a difference to the angles at the junction of parallel lines and a transversal? Ask students to explain their answer to the class.

**ELL**

- There are many new Key Words in this chapter. Encourage students to make their own dictionary of angle terms and refer to it on a regular basis. To assist in this, have students post definitions of Key Words around the room.

**Common Errors**

- Students have difficulty reading the protractor correctly.

**Rx** Remind students to go over the steps for using a protractor correctly, which are posted on the classroom wall or which students have written on an index card in their Chapter 5 Foldable.
Answers

Explore Angles in Parallel Lines and Perpendicular Lines

1. Example:
   a) Duckworth Street and Water Street
   b) The streets will not cross each other so long as they are parallel because parallel lines do not intersect.

2. a) Gower Street
   Cochrane Street
   Duckworth Street
   b) \( a = 70^\circ, b = 110^\circ, c = 70^\circ, d = 110^\circ, e = 70^\circ, f = 110^\circ, g = 70^\circ, \) and \( h = 110^\circ \)
   c) Example: Kings Road is a transversal for Bond Street and Gower Street.
   d) Pairs of angles in similar positions are equal.

3. a) Example: Prescott Street crosses Gower Street and Duckworth Street at right angles.
   b) Prescott Street
   Gower Street
   Duckworth Street
   c) \( p = 90^\circ, q = 90^\circ, r = 90^\circ, s = 90^\circ, t = 90^\circ, u = 90^\circ, v = 90^\circ, \) and \( w = 90^\circ; \)
   all of the angles measure 90°.

4. a) Angles on the same side of the transversal in the same position, either above or below, the parallel lines are equal.
   b) The angles formed by a perpendicular line and parallel lines are all 90°.

5. Example: Turn right onto Prescott Street. Then, turn left onto Duckworth Street.

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<tr>
<td>Reflect</td>
<td>• Most students should observe that angles in the same position relative to the parallel line and transversal are of equal size. Students may need help developing the term opposite.</td>
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<tr>
<td></td>
<td>• Encourage them to experiment with adding the pairs of different angles together.</td>
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<td></td>
<td>• Remind students of some of the special angle names and encourage them to check what they mean if they cannot remember (specifically, acute, obtuse, and straight angles).</td>
</tr>
<tr>
<td>Extend Your Understanding</td>
<td>• Students should plan the route out on the map. The angles are measured relative to the current direction of travel.</td>
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<td>• Encourage students to think about direction. Ask: Will your answer change if you are travelling in the opposite direction?</td>
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<tr>
<td></td>
<td>• Encourage students to develop multiple answers, and ask why it might be necessary to have alternative routes planned when travelling through a city.</td>
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On the Job 1

This On the Job activity introduces opposite, complementary, and supplementary angles. Students will need to recognize and know the measure of right angles and straight angles.

Start by asking students if they recognize any of the marine signal flags. Ask if they know any more. Discuss the geometric designs on the flags, encouraging students to use terms such as diagonals, perpendicular lines, parallel lines, transversals, and symmetry.

After students have read the question and before reading the solution, discuss as a class how the flags are similar to the streets in the Explore.
For part a), you might ask:
- Which intersection does this flag look like?
- What letter shape does the flag make?
- What does this mean about the angles on each side?
- What does it mean about two angles next to each other?

For part b), ask students in pairs to discuss the angles in the flag. Then, ask how the angles compare to the streets in the Explore.

For part c), students may not recognize that the diagonal is a transversal line. Ask:
- If the diagonal were extended, what would the diagram look like? (Ask a student to draw the diagram on the board.)
- What other special name can we give the diagonal line?
- How many pairs of parallel lines do you see?
- What does this mean about the angles?

Use this discussion to help students follow the worked examples in the text.

Have students read the solution to part a). Then, you might ask:
- What are angles in an X pattern called?
- What does it mean when angles are in an X pattern?
- What do angles on a straight line add up to?
- What are angles that add up to 180° called?

After reading part b), you might ask:
- How is this flag different from the flag in part a)?
- Are the angles in this flag easier or harder to classify? Explain why.

For part c), you might ask:
- How do we know that angle c is a right angle?
- What do angles in a right angle total?
- What are angles that total 90° called?

Have students write their own definitions of the terms in their journal, and place posters showing the relationship on the word wall.

Have students study the diagrams in the Your Turn questions and then compare each diagram to the flags. Prior to starting the questions, students should note which example to use for each question.

Meeting Student Needs

- Prior to their taking precise measurements of the various angles in flag signals, encourage students to use their 90° reference in order to look for patterns. In the first flag signal shown, students should be able to classify the angles as acute or obtuse and this may help them predict that vertically opposite angles are congruent.
- After students have explored the “man overboard” signal, it would be good to ask whether the angle will always be 45° when a diagonal line is drawn from one corner of a flag to the other. Have students explore a few rectangles to discover that this generalization does not hold.
- Some students may benefit from a flash card activity to review all the different angle terms. Have students work in pairs and use index cards to write the definition of a term with a sketch on one side and the term on the other. They can then play a game to either define or state the term as they hold up the cards to one another. Give students a few minutes to play at the beginning or end of each lesson. New cards can be written as the number of terms increases. This will benefit all students in the class, but will be particularly useful for ELL students.
- Allow students to use a calculator where necessary.
On the Job 1: Your Turn

a) The lines intersect; \(d = 37^\circ\), \(e = 143^\circ\), and \(f = 37^\circ\)
b) The lines intersect at right angles; \(j = k = l = 90^\circ\)
d) A right angle is divided into two parts, making the angles complementary; \(m = 58^\circ\)

Check Your Understanding

Try It

For #1 to #3, refer students to their definitions of the terms. Use the word wall, journals, or flash cards as reminders.

For #4, remind students of the letter pattern and ask them what it means about opposite angles and side-by-side angles.

For #5, remind students about angles in a straight angle.

Apply It

Consider having students work with a partner. Encourage students to discuss strategy prior to solving each problem. Then, they can review each other’s solution and check for accuracy.

For #6, ask what the corner angle is. Then, ask students to describe what is happening to the corner when the cut is being made. What is the special name given to cutting angles in half?

For #7, students need to recognize that the angle between a horizontal line and a vertical line is 90°. This question provides a good opportunity not only to introduce the angle between the lines but to reinforce the direction of each type of line. You can also relate the shape of each triangle to a set square.

Meeting Student Needs

- For all of these angle rules, have students focus on angle patterns and numerical relationships. For example, angles in an X pattern are the same, angles in a right angle total 90°, and angles in a straight angle or on a line total 180°.
- Continue to reinforce the Key Words vocabulary using the classroom word wall, flash cards, and student journals.

ELL

- Because the vocabulary here is new for all students, activities used to reinforce the vocabulary will assist in the development of ELL students’ understanding.
**Gifted and Enrichment**
- Challenge students to look for other letter patterns and relationships within the drawing of a transversal and a pair of parallel lines.

**Common Errors**
- Students at first try to simply measure the angles rather than use the angle relationships.

\( R_x \) Caution students that not all of the diagrams are drawn to scale and remind them that they will have to use the relationships.
- Some students make calculation errors when working with complementary and supplementary angles.

\( R_x \) Allow students to use a calculator to perform the required operations.

Encourage them to check their solutions using addition as shown in the examples. Have students work with a partner to check each other’s work for accuracy.

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<td><strong>Try It</strong></td>
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</tr>
<tr>
<td>Have students do #1 to #4. Students who have no difficulty with these questions can go on to the remaining questions.</td>
<td>- Provide additional coaching with the Explore for students who have problems with #1.</td>
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<tr>
<td></td>
<td>- Provide additional coaching with On the Job 1 for students who have problems with #2 to #4.</td>
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<tr>
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<td>- Encourage students to always sketch and label the diagram.</td>
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<td>- Encourage students to give reasons for their answers.</td>
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**On the Job 2**

This **On the Job** activity introduces interior, exterior, and corresponding angles. For this section of the chapter, students should not use a protractor. You may need to review solving simple equations from the **Get Ready** section of the chapter.

Students should focus on recognizing the letter patterns and the associated angle rules. For example, angles in an F pattern are corresponding angles and are equal. Angles in a C pattern are interior or exterior and total 180°. Angles that total 180° are supplementary.

Before starting the **On the Job 2** exercise, briefly recall the section 5.3 **Explore** by considering the following diagram.

```
   A B
  /\  \/
 /   \
D   C
```

```
   E F
  /\  \/
 /   \
H   G
```

Discuss angles in the same position relative to the transversal but on different parallel lines. To encourage students to think about different patterns in the angles, you might ask:
- Which angle on the top parallel line is the same as angle G?
- Which angle on the top parallel line is the same as angle F?
- What is the total of angles F and G?
- What is the total of angles B and C?

---

**Web Link**
For more information about angle relationships and patterns, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.
• What is the total of angles B and G?
• What is the total of angles C and F?
• Why do they total 180°?
• What is the total of angles B and G?
• Why do they total 180°?
• Do you see any more patterns like this?

As a class, read the question and look at the sketch of the situation. Then, ask students to work with a partner to compare the sketch to the diagram above. Have students use what they know about the angles on parallel lines to discuss which angles they think are the same size as the given angle and to determine the size of the missing angles.

When students finish their work, have them read the solutions in the text. Ask why they think there are three different methods.

Reinforce the definitions of corresponding, exterior, and interior angles by giving students more examples with angles in different orientations and asking them to describe the relationship between the marked angles. Here are sample illustrations:

**Corresponding angles in F pattern**

![Corresponding angles in F pattern]

**Interior angles in C pattern**

![Interior angles in C pattern]

**Exterior angles in C pattern**

![Exterior angles in C pattern]

Have students write their own definitions of the terms in their journal, and place posters showing the relationship on the word wall.

**Meeting Student Needs**

• In discussions of the new terminology in this section, it is important to scaffold the learning for students. (Example: When working with interior angles, have the students classify the two angles using a 90° angle as a reference. In all but one special case (perpendicular transversal), they will find one obtuse and one acute angle. Have students discover that for multiple cases this is true and that the sum of the two angles is 180°.) By working in this fashion, students will develop meaningful conjectures.

• Some students may benefit from a flash card activity to review all the different angle terms. Have students work in pairs and use index cards to write the...
definition of a term with a sketch on one side and the term on the other. They can then play a game to either define or state the term as they hold up the cards to one another. Give students a few minutes to play at the beginning or end of each lesson. New cards can be written as the number of terms increases. This will benefit all students in the class, but will be particularly useful for ELL students.

- Allow students to use a calculator where necessary.
- Point out to students that the scale on their protractor is a great calculator for supplementary angles. For example 45° and 135° are marked together and they total 180°. This means that they are supplementary angles.

### Answers

**On the Job 2: Your Turn**

a) \( a = 85° \) and \( b = 95° \)

b) \( c = 124° \) and \( d = 56° \)

c) \( e = 115° \) and \( f = 65° \)

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<td><strong>On the Job 2</strong></td>
<td>Encourage students to draw a sketch.</td>
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<td>Remind students that not all the diagrams are drawn to scale, so they should use a protractor to measure angles.</td>
</tr>
<tr>
<td></td>
<td>Encourage students to identify the angle relationships by looking for the letter patterns and to include them in their answer.</td>
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<td></td>
<td>Students could work with a partner and check each other’s solutions for accuracy.</td>
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<tr>
<td></td>
<td>Allow students to use a calculator where necessary.</td>
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<tr>
<td></td>
<td>Encourage students to verbalize their thinking.</td>
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### Check Your Understanding

**Try It**

For #1, refer students to their definitions of the terms. Use the classroom word wall, student journals, or flash cards as references.

Question #2 directs students which angles to use. Encourage students to keep their definitions on hand to refer to. This way they can easily check what the pattern means.

For #3, students are asked to determine the size of the angle. Encourage students to give reasons for their answers. They can do this orally or in written form. Accept either the letter pattern or the full name as a valid reason.

For #4, two steps are required. Students have to use either opposite angles or supplementary angles before they can use one of the relationships from this section. This would provide for a good class discussion about methods. Encourage students to work in pairs for this question. Have partners compare their answers to see if they used the same method.

**Apply It**

These questions require students to apply their understanding of the concepts in contextual situations. Encourage students to draw simple sketches using single straight lines so that they can see the angle relationships more easily.
For #6, decide whether students will need to draw several sketches and label each pair of angles separately, or whether they should draw one diagram and use different colours to mark in the different pairs of angles.

For #7, ask what angle is the corner. What is happening to the corner when the cut is being made? What is the special name given to cutting angles in half?

For #8, you may consider discussing in pairs or as a class what the measure of angles would be looking up from the bottom of the stairs compared to looking down from the top.

Meeting Student Needs
- Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
- Remind students that they should not be using a protractor to determine the size of any angles.

Common Errors
- Students do not use the correct relationships.
  - Students need to practise identifying which relationship to use and determining whether more than one step is required. Encourage students to sketch the diagram and draw in the letter shapes around the required angles one step at a time. The following illustrates a two-step approach to determining the measure of angle \( x \) shown in the diagram.

\[
\begin{align*}
\text{120°} & \\
\text{120°} & \\
\text{x} & \\
\end{align*}
\]

In the first step, the X pattern is used to show that the angle opposite the reference angle is the same size as the reference angle.

\[
\begin{align*}
\text{120°} & \\
\text{120°} & \\
\text{120°} & \\
\text{x} & \\
\end{align*}
\]

By identifying an F pattern in the second step, students can see that angle \( x \) and the opposite angle in step 1 are corresponding angles. Therefore, angle \( x \) is 120°.

\[
\begin{align*}
\text{120°} & \\
\text{120°} & \\
\text{120°} & \\
\text{x = 120°} & \\
\end{align*}
\]

Remind students that there is often more than one way to develop the answer to a question.
### Assessment for Learning

**Try It**

Have students do #1 to #5. Students who have no difficulty with these questions can go on to the remaining questions.

For students who have problems with #1 to #5:
- Provide additional coaching with On the Job 1.
- Encourage students to draw a sketch.
- Remind students that not all the diagrams are drawn to scale, so they should not use a protractor.
- Encourage students to identify the angle relationships by looking for the letter patterns and to include them in their answer.
- Students could work with a partner and check each other's solutions for accuracy.
- Allow students to use a calculator where necessary.
- Encourage students to verbalize their thinking.

### Supporting Learning

- Remind students that not all the diagrams are drawn to scale, so they should not use a protractor.
- Encourage students to identify the angle relationships by looking for the letter patterns and to include them in their answer.
- Students could work with a partner and check each other's solutions for accuracy.
- Allow students to use a calculator where necessary.
- Encourage students to verbalize their thinking.

---

### On the Job 3

This **On the Job** activity builds on the previous section by introducing interior alternate and exterior alternate angles. For this section of the chapter, students should not use a protractor.

Again, students should focus on recognizing the letter patterns and the associated angle rules. For example, angles in a Z pattern are alternate angles, angles in an F pattern are corresponding angles and are equal, and angles in a C pattern are interior or exterior and total 180° (supplementary).

Before introducing the **On the Job**, review the **Explore** section briefly by considering the following diagram.

\[
\begin{array}{c}
A \\
B \\
D \\
C \\
E \\
F \\
H \\
G \\
\end{array}
\]

You might ask:
- Which angle under the top parallel line is the same as angle E?
- Which angle under the top parallel line is the same as angle F?

Have students read the question and look at the sketch of the situation. Ask student pairs to compare it to the one above. Using what they know about the angles on the parallel lines, have them discuss which angles they think are the same size as the given angle. Partners can then work together to determine the size of the missing angles.

Have students compare what they have done to the answer in the text. They should see that a new letter pattern and angle relationship is described.

Reinforce the definitions of alternate exterior and alternate interior angles by giving students more examples of the definition in different orientations and asking them to describe the relationship between the marked angles. Here are sample illustrations:
Alternate exterior angles

Alternate interior angles

Have students write their own definitions of the terms in their journals. In addition, place posters showing the relationship on the word wall.

Meeting Student Needs

- Encourage students to make meaningful conjectures through the use of previously learned angle theorems, in particular the supplementary angle and opposite angle theorems. The goal is to have students string theorems together to handle the more complicated problem situations.
- It is important to continue a kinesthetic approach in this section and to have students follow up on their conjectures with the use of a protractor or other measurement tool to confirm. It is strongly recommended that students establish an ability to explore these types of problems with software programs such as The Geometer's Sketchpad® as well.
- Some students may benefit from a flash card activity to review all the different angle terms. Have students work in pairs and use index cards to write the definition of a term with a sketch on one side and the term on the other. They can then play a game to either define or state the term as they hold up the cards to one another. Give students a few minutes to play at the beginning or end of each lesson. New cards can be written as the number of terms increases. This will benefit all students in the class, but will be particularly useful for ELL students.
- Allow students to use a calculator where necessary.

Gifted and Enrichment

- The latter questions in the Work With It section give students an excellent opportunity to start stringing together a series of the angle relationships they have been working with. Create as many multiple-step problems as possible to allow for strong students to interact with these angle properties. Have students discuss the strategies they used to attack such problems.
- With very strong students, it may be possible to start working on some deductive reasoning problems to try and take some of their conjectures and establish a stronger argument for why various angle relationships hold true.

Answers

On the Job 3: Your Turn

\[ m = 95^\circ; \ l = 85^\circ \]
**Check Your Understanding**

**Try It**

For #1 and #2, refer students to their definitions of the terms. Use the word wall, journals, or flash cards as references.

For #3, two steps are required. Many different approaches are possible for this question. Have students work in pairs to develop different strategies to determine the sizes of the missing angles. Then, use their answers to discuss the different ways and relationships that can be used.

For #5, relate this question to the diagram at the beginning of the section.

**Apply It**

As students answer each question, encourage them to draw a simpler sketch using single straight lines so that they can see the angle relationships more easily. Students should also realize that there is more than one way to arrive at a correct solution to these problems.

For #6, students will have to use the alternate angles property in a straightforward application.

Question #7 can be extended to examine any object or piece of furniture with the same type of foldable legs. Students can brainstorm where they have seen pieces of furniture with collapsible legs. Given the question they have just completed, students should be able to make some general observations about the angles the legs make with the floor and the top surface.

**Meeting Student Needs**

- Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
- Remind students that they should not be using a protractor to determine the size of any angles.
- Encourage students to create a table on an index card to summarize what they know about patterns and angle relationships. Information similar to the following will help students decide what to do when they are looking at a diagram.

<table>
<thead>
<tr>
<th>Angle Pattern</th>
<th>Angle Relationship</th>
<th>What Angle Relationship Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>opposite</td>
<td>angles are equal</td>
</tr>
<tr>
<td>C</td>
<td>same side exterior or same side interior</td>
<td>angles add to 180°</td>
</tr>
<tr>
<td>F</td>
<td>corresponding</td>
<td>angles are equal</td>
</tr>
<tr>
<td>Z</td>
<td>alternate exterior or alternate interior</td>
<td>angles are equal</td>
</tr>
</tbody>
</table>
**Common Errors**

- Students do not use the correct relationships.

**Rx** Encourage students to practise identifying which relationship to use and whether more than one step is required to arrive at a solution. Encourage them to sketch a diagram and draw in the letter shapes around the required angles one step at a time. Remind students that there is often more than one way to develop the answer to a question.

<table>
<thead>
<tr>
<th>Assessment</th>
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</thead>
<tbody>
<tr>
<td><strong>Assessment for Learning</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Try It</strong></td>
<td>• Provide additional coaching with On the Job 3 for students who have problems with #1 and #2.</td>
</tr>
<tr>
<td>Have students do #1 and #2. Students who have no difficulty with these questions can go on to the remaining questions.</td>
<td>• Encourage students to draw a sketch.</td>
</tr>
<tr>
<td></td>
<td>• Remind students that not all the diagrams are drawn to scale and so they should use a protractor.</td>
</tr>
<tr>
<td></td>
<td>• Encourage students to identify the angle relationships by looking for the letter patterns and to include them in their answer.</td>
</tr>
<tr>
<td></td>
<td>• Students could work with a partner and check each other's solutions for accuracy.</td>
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<tr>
<td></td>
<td>• Allow students to use a calculator where necessary.</td>
</tr>
<tr>
<td></td>
<td>• Encourage students to verbalize their thinking.</td>
</tr>
</tbody>
</table>

**Work With It**

For #1, give students a target number of pairs as there are many possible combinations. Draw students’ attention to the fact the window panes are depicted to have beveled edges. These edges bisect the angles at the corners of each pane. This will help students identify other pairs of equal angles and classify the angles in each pair as complementary because each corner is a right angle.

For #2, students can use either supplementary angles repeatedly or supplementary angles with opposite angles. Suggest both methods. Then, have students work in pairs with each student using a different method to see which approach they prefer.

For #4b), instead of marking the supplementary angles on another diagram, students could use the same diagram they used in part a) but mark the angles in another colour. This will make sure they identify them all as every angle should be marked.

**Discuss It**

For #6, have students work in pairs or small groups to set up the equation and solve for x. Encourage students to verbalize what they know first. For instance, the three angles must total 90°, so $x + x + 35° = 90°$. From this point, students should be able to solve for x.

For #7, students should be asking what letter pattern Ellie or Paul used. Then, they need to check whether it was appropriate to use that pattern. Working in pairs, one student could check Ellie's work and the other student could check Paul's work. Then, have the students decide who was correct.

For #8, the purpose is to discuss different approaches to reaching the same goal. This discussion should follow on from questions in the previous two sections.
Meeting Student Needs

- Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
- Remind students that they should not be using a protractor to determine the size of any angles.
- Encourage students to refer to the table on their index card that summarizes angle patterns and relationships.
- Provide BLM 5–12 Section 5.3 Extra Practice to students who would benefit from more practice.

Common Errors

- Students do not use the correct relationships.
- Encourage students to practise identifying which relationship to use and whether more than one step is required to arrive at a solution. Encourage them to sketch a diagram and draw in the letter patterns around the required angles one step at a time. Remind students that there is often more than one way to develop the answer to a question.

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<tr>
<th>Assessment as Learning</th>
<th>Supporting Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discuss It</td>
<td></td>
</tr>
<tr>
<td>These questions give students an opportunity to explain their understanding of the different angle patterns in parallel lines and special angles. Have all students do #6 to #8.</td>
<td>• Students should work in pairs for #6. You may have to review solving two-step linear equations for this question.</td>
</tr>
</tbody>
</table>
Planning Notes

Have students complete the section 5.4 warm-up questions on BLM 5–4 Chapter 5 Warm-Up to reinforce prerequisite skills needed for this section.

In this section, students will use their knowledge of angles in problem solving situations. They will need to be able to apply all of the new skills and information from the previous sections in order to be successful here. Questions in this section build on students’ knowledge and experience of the concepts covered already. The questions tend to be longer and involve more steps.

As a class, discuss the construction of the water tower. Focus on the use of parallel, perpendicular, and transversal lines. Ask if students have seen this type of construction before. If so, invite them to give examples. Have students discuss the importance of angles for tradespeople such as ironworkers, steel workers, and steel riggers.

You may want to use flash cards to review all the angle definitions and relationships between a transversal and parallel lines prior to starting the Explore activity. Have students work in pairs to prepare the flash cards, putting the term on one side and the definition/relationship on the other. Taking turns, students hold a card up and either state the term or define the term to their partner.

Explore Relationships Between Angles

In this exploration, students will use their knowledge of angles in parallel lines to determine the size of some of the angles in a set of plans for a steel water tower. Students should be able to identify all of the angles in the bottom half of the plans, but do not have enough information to determine the size of the angles in the top half.

For #1 to #3, make BLM 5–13 Section 5.4 Diagram of Water Storage Tower available to students. Have them use angle patterns to determine as many of the angles in the plans as possible. Students will need to look repeatedly for letter patterns and use these relationships to determine the size of missing angles. Encourage students to explain their reasoning by stating which letter pattern they are using to work out each angle. Have students mark on the BLM the angles they have worked out.
For #4, students should first discuss with a partner which angles cannot be determined using the angle properties. Then, have the class as a whole discuss the situation. You might start by asking:

- Where are the missing angles all located?
- Does the top half of the tower have any lines in common with the bottom half?
- What types of lines are they?
- The top half and bottom half do not have what type of line in common?
- Would you be able to determine the missing angles if there were a transversal from the top of the tower to the bottom?
- What additional information would you need to work out the angles?

For #5a), have students work out the new angle sizes. After the first couple of solutions, students should notice a pattern in the answers. For part b), students will need to redraw the diagram to see what would happen to the angles. Before they draw the new plan, ask them what the tower could look like. Ask which would be more stable: a tank with a narrow bottom and wide top, or a tank with a wide bottom and narrow top.

**Meeting Student Needs**

- The notion that certain angles will not be identifiable will be difficult for most students to see without some strong leading questions. It may come down to having to ask directly whether or not they can identify certain angles like angle AFB or BCA. It would then be possible to ask whether they could determine these angles if they knew a side relationship like \( DE = CF \). In this case, the angles would still be unidentified. What if we knew that \( EF = AF \)?
- Some students may benefit from working in pairs throughout the Explore.
- Encourage students to keep their flashcards on hand so that they can check the angle relationships quickly.
- Remind students to look for letter patterns first to help them determine the size of the angles.
- Allow students to use a calculator should they require it.

**ELL**

- Students will need constant reinforcement of all the vocabulary associated with angles and their properties.

**Gifted and Enrichment**

- Challenge students to work out all the angles when the tower is designed as shown below. Ask them if they can work out all the missing angles. Does knowing the angles that the sides make with the horizontal make a difference? Can they classify the triangles the interior sections make? If so, what is special about them? (Horizontal lines are parallel.) Where have they seen steel structures using this design? Challenge them to research electricity pylon construction.
Common Errors

- Students assume that the top half of the tower has the same dimensions as the bottom half.

Remind students that all they know are the angles and directions of the lines. Because they do not know any lengths, students cannot assume that the top half and bottom half are the same.

Explore Relationships Between Angles

1. a) $96^\circ$
b) $\angle EHD$ is opposite $96^\circ$ and opposite angles are equal.

2. a) $48^\circ$
b) $\angle HCD + 42^\circ$ make a right angle, so $\angle HCD = 90^\circ - 42^\circ$.

3. Examples: a) and b)
$\angle ABC = \angle AFC = \angle FED = \angle EDC = \angle DCF = \angle BCF = 90^\circ$; they are all corners of the rectangles; $\angle HED = 42^\circ$, alternate interior angles; $\angle CEF = \angle DCCE = 48^\circ$, alternate interior angles; $\angle CFH = 180^\circ - (96^\circ + 42^\circ) = 42^\circ$, angle sum of a triangle; $\angle HDE = 42^\circ$, alternate interior angles

4. a) The acute angles in $ABCF$ cannot be determined.
b) It is not known whether $BF$ is parallel to $CE$ or whether $AC$ is parallel to $DF$.

5. a) If $\angle FHC$ was $100^\circ$, then each of $\angle FCH$ and $\angle CFH$ would be $40^\circ$, as would their equal alternate angles, $\angle HED$ and $\angle HDE$.
b) If $AE$ and $BC$ were not parallel, but the three horizontal lines still are parallel, then the acute alternate angles would be equal but the shapes would no longer be rectangles.

Assessment Supporting Learning

<table>
<thead>
<tr>
<th>Assessment as Learning</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Reflect</td>
<td>Check that students realize that the top and bottom are completely separate systems as they are not connected with a common transversal.</td>
</tr>
<tr>
<td></td>
<td>Check that students understand that they need to have a transversal that passes through all the parallel lines with a known angle in order to calculate all the missing angles.</td>
</tr>
<tr>
<td>Extend Your Understanding</td>
<td>Have students work in pairs for this question.</td>
</tr>
<tr>
<td></td>
<td>Encourage them to make oral predictions about how the situation will change.</td>
</tr>
<tr>
<td></td>
<td>Suggest that they make a rough sketch of the new situations.</td>
</tr>
<tr>
<td></td>
<td>Encourage them to label the lengths with the words <em>parallel</em> or <em>transversal</em>.</td>
</tr>
</tbody>
</table>

On the Job 1

As an introduction to this activity, you could show a video that demonstrates what a wet saw is and how it is used to cut tile.

Have students read the question and the solution. Then, as a class, discuss the process behind the solution. You might ask:
- What was the first step in the solution?
- The diagram was labelled with letters and numbers. What do the letters and numbers represent?

Web Link

For video demonstrations on using wet saws to cut ceramic tile, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.
Why do you think this is important?
Starting with the number 1 piece, how would you determine its missing angles?
Can you determine all the angles of the number 1 piece without looking at any other tile? If not, what tile would you also include? Why?
When you have finished the first tile, what would you do next?

Reinforce these steps by asking students to write them down in their journal. Then, encourage students to follow the same steps when doing the Your Turn question. Remind students with a prompt before they start: What are you going to do first? What will you do next?

Meeting Student Needs

Try to get students to discover in answering these types of multistep problems whether or not there were angles that could not be obtained independently. Excellent personal strategies will be developed out of discussion as to what angle relationships were used and in what order they came up.
It will be helpful for students to communicate their thinking in a well-organized manner. Students should get into the habit of properly labelling unknown angles and then creating a T-chart to order their reasoning with two columns. (Statement and Reason)
Students may benefit from working in pairs for the Your Turn questions.
The concepts in this question have been dealt with before. It is the size of the problem that is new. Students need to be organized in their approach to the problem. Encourage students to use a step-by-step guide showing how to break the problem down into smaller chunks.
Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
Allow students to use a calculator should they require it.
Encourage students to refer to the table on their index card that summarizes angle patterns and relationships.

ELL

Ensure that students are familiar with all the terms referring to construction activities in this On the Job.

Gifted and Enrichment

Challenge students to construct their own design for a floor using mosaic tiles. Have them incorporate parallel lines and transversals in the design and record the size of the angles.

Answer

On the Job 1: Your Turn
In the top piece, each of the top two angles is 64° and each of the lower two angles is 116°. For the other piece, each of the two angles on the left is 90°, the acute angle is 64°, and the obtuse angle is 116°.
Check Your Understanding

Try It

For #1, remind students that a quick way to draw parallel lines is to draw a line on each side of a ruler. Encourage them to draw one Z pattern with the Z in the normal orientation and another with the Z reversed.

For #2, encourage students to check for parallel lines. If there are no parallel lines, students should know that they will not find certain angles. Have them look for a straight angle.

For #3 and #4, refer students to the examples in the On the Job activity and remind them to break the questions down into smaller parts. As there are several diagrams to work on, you could have students work in pairs to do alternate questions and then check each other’s work.

Apply It

These questions require students to apply their knowledge of angles to solve problems. Consider having students complete the questions independently and then work with a partner to check each other’s solutions.

For #5, students need to be aware that every triangle is not the same because the angles are different.

For #6, ask students which way they usually look when they walk. Do they look up, look down, or look forward in the direction they are walking? This is to give students a reference line against which to measure angles of elevation or depression. You want students to recognize that these angles should always be measured relative to the horizontal.

For #7, allow students to use a protractor to check their answers.

Meeting Student Needs

- Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
- Remind students that they should not be using a protractor to determine the size of any angles.
- Allow students to use a calculator should they require it.
- Encourage students to refer to the table on their index card that summarizes angle patterns and relationships.
ELL

- Make sure students know what a telescope is for in #6.

Common Errors

- Students assume in diagrams with several triangles that all triangles are the same.

R\textsubscript{x} Remind students not to make assumptions about angle measures but to determine the size of angles based on the relationships. Encourage students to work out each angle using a letter pattern.

- Students use an incorrect reference line in determining angles of elevation or depression.

R\textsubscript{x} Remind students that angles of elevation or depression are measured relative to the horizontal, not the vertical.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Supporting Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>On the Job 1</td>
<td>If students have problems answering specific parts of #3 and #4, refer them to the relevant portions of section 5.3.</td>
</tr>
<tr>
<td>On the Job 1</td>
<td>Encourage students to draw a sketch.</td>
</tr>
<tr>
<td>On the Job 1</td>
<td>Remind students that because not all the diagrams are drawn to scale, they should not use a protractor.</td>
</tr>
<tr>
<td>On the Job 1</td>
<td>Encourage students to identify angle relationships by looking for the letter patterns and to include them in their answer.</td>
</tr>
<tr>
<td>On the Job 1</td>
<td>Students could work with a partner and check each other’s solutions for accuracy.</td>
</tr>
<tr>
<td>On the Job 1</td>
<td>Encourage students to verbalize their thinking.</td>
</tr>
<tr>
<td>On the Job 1</td>
<td>Allow students to use a calculator should they require it.</td>
</tr>
</tbody>
</table>

On the Job 2

This On the Job uses the relationships between a transversal and a pair of parallel lines to check whether the lines are actually parallel. If the lines are parallel, then the rules will work correctly. If the rules do not work correctly, the lines are not parallel.

Note that this problem presents many questions of a similar type that students will need to break down into smaller parts.

Have students read the question and the solution. Then, as a class, discuss the process behind the solution. You might ask:

- What was the first step in the solution?
- The diagram was labelled with letters and numbers. What do the letters and numbers represent?
- Why do you think this is important?
- Starting with stud number 1, what did Kent do?
- When Kent finished checking the first stud, what did he do next?
- What followed that step?

Reinforce these steps by asking students to write them down in their journal. Then, encourage students to follow similar steps when doing the Your Turn question. Remind students with a prompt before they start: What are you going to do first? What will you do next?
Meeting Student Needs

- The framing example used in this section lends itself well to a kinesthetic approach. An excellent project could be developed where students create a small scale model of a framed wall (even toothpicks could be used) and have to develop at least three ways in which the wall could be checked for parallel studs. Students may even be able to trace their model frame onto poster board to do further analysis.
- Again, it is possible here to address the issue of how a carpenter could know that the frame is squared off properly. Ask for student ideas and research on how this may be confirmed.
- Students may benefit from working in pairs for the Your Turn questions.
- The math concepts in this question have been dealt with before. It is the size of the problem that is new. Students need to be organized in their approach to the problem. Encourage students to use a step-by-step guide showing how to break the problem down into smaller chunks.
- Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
- Remind students that they should not be using a protractor to determine the size of any angles.
- Encourage students to refer to the table on their index card that summarizes angle patterns and relationships.

Gifted and Enrichment

- An excellent hands-on project for students in this section would be the construction of a periscope. By actually using mirror plates and playing with different angles, students will gain a great deal of insight into not only angles but also optics.
- If you work in problems with a square and its diagonals (a barn door problem, perhaps), then it is possible to tie in the idea of stretching the size of the door to be rectangular. How would angles change when this happened and by how much? You can give initial measurements and have students do scale diagramming work. They can then measure angles to see the effect of doubling or tripling the base length or height on the size of the angle. This problem could have ties to the big ideas of measurement, transformation, and trigonometry all in one scenario.

Answer

On the Job 2: Your Turn

The two end pieces are parallel because both top interior angles are marked as 90°. The middle piece is not parallel to the top because the angle that is supplementary to 163° is 17°. This angle should be an equal corresponding angle to the 18° angle at the top but it is too small by one degree.

<table>
<thead>
<tr>
<th>Assessment for Learning</th>
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</thead>
<tbody>
<tr>
<td><strong>On the Job 2</strong></td>
<td></td>
</tr>
<tr>
<td>Have students do the Your Turn questions related to On the Job 2. Check that • students sketch and label a diagram of the situation • students break the questions down into smaller manageable parts • reasons are correct • calculations are correct</td>
<td>• Remind students that the diagrams are not drawn to scale and so they should not use a protractor. • Encourage students to identify the angle relationships by looking for the letter patterns and to include them in their answer. • Students could work with a partner and check each other’s solutions for accuracy. • Encourage students to verbalize their thinking. • Allow students to use a calculator should they require it.</td>
</tr>
</tbody>
</table>

Web Link

For additional practice using a compass and a ruler to construct angles, go to www.mhrmathatwork10.ca and follow the links.
Check Your Understanding

Try It
For #1 to #3, students need to check whether the lines are parallel. If necessary, remind students of the process. Refer them to the letter pattern rules and encourage them to check with their partner which shape to use.

Apply It
These questions have students apply their knowledge to a real-life problem. Encourage students to verbalize their reasoning with a partner prior to writing anything down.

For #4, if necessary remind students to look for a letter pattern that would connect the 47° angle and the X angle.

For #5, have students work in pairs and sketch gurneys at different heights. From their sketches they should be able to see whether the top and bottom of the gurney are always parallel. To challenge students, you could ask if this is true even when the paramedics are raising the height of the stretcher.

Meeting Student Needs
• Make sure all definitions of Key Words are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
• Encourage students to refer to the table on their index card that summarizes angle patterns and relationships.

Common Errors
• Students do not use the correct relationships.

Rx Encourage students to practise identifying which relationship to use and whether more than one step is required to arrive at a solution. Also encourage them to sketch a diagram and draw the letter patterns around the required angles one step at a time. Remind students that there is often more than one way to develop the answer to a question.

Assessment Supporting Learning

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<tr>
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</thead>
<tbody>
<tr>
<td>On the Job 2</td>
<td>If students have problems with #1 and #2, provide additional coaching using the examples in On the Job 2.</td>
</tr>
<tr>
<td>Have students complete #1 and #2. If they do not have any difficulty, then they should be able to complete all of the questions. Check that • correct letter patterns are used • calculations are correct</td>
<td>Encourage students to draw a sketch.</td>
</tr>
<tr>
<td>• Remind students that not all diagrams are drawn to scale so they should not use a protractor.</td>
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<tr>
<td>• Allow students to use a calculator if they require it.</td>
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</tr>
</tbody>
</table>
**Work With It**

For #1, have students try to complete their solution without first referring to their journals, flash cards, or word wall. Then, they can check their work using these resources.

Question #2 can easily be extended to consider any number of parallel lines being cut by the same transversal.

For #3, you can discuss a scientific concept. Ask students if they have done any work on reflections in science. They should know that the angle of incidence is the same as the angle of reflection.

For #4, refer students to the example shown in the On the Job 2 activity to see how they can check whether the sides of the chair are parallel.

**Discuss It**

For #5, one of the games at the end of the chapter is ideal. It allows students to use manipulatives to create letters using parallel lines. See page 279.

For #6, students should experiment by trying to sketch the situation and then check whether any of the angle properties work for their diagram.

Question #7 follows directly from #6. You might ask students what angles in #6 would have made the diagram possible. Which angle would satisfy this question?

For #8, encourage students to name the lines in the diagram before they discuss the situation. Then, they should look for a letter pattern to determine whether or not Kristin is correct.

For #9, relate this question to the telescope situation in #6 in the Apply It section of On the Job 1 on page 267.

**Meeting Student Needs**

- Make sure all definitions of **Key Words** are easily accessible and reinforce them regularly through the use of a word wall or flash cards.
- Remind students that they should not be using a protractor to determine the size of any angles.
- Allow students to use a calculator should they require it.
- Students may benefit from working in pairs to complete these questions.
- Encourage students to refer to the table on their index card that summarizes angle patterns and relationships.
- Continue to encourage students to follow a logical sequence for solving word problems. After they read and understand a problem, they should sketch a diagram, estimate the answer, calculate the answer, and then check the reasonableness of the answer. Reinforce the importance of using estimation to help determine if a solution makes sense.
- Provide **BLM 5–14 Section 5.4 Extra Practice** to students who would benefit from more practice.

**Web Link**

For more information on light and optics, including reflections, go to [www.mhrmathatwork10.ca](http://www.mhrmathatwork10.ca) and follow the links.
Common Errors

- Students do not use the correct relationships.

Rx Encourage students to practise identifying which relationship to use and whether more than one step is required to arrive at a solution. Also encourage them to sketch a diagram and draw the letter patterns around the required angles one step at a time. Remind students that there is often more than one way to develop the answer to a question.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Supporting Learning</th>
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</thead>
<tbody>
<tr>
<td>Assessment as Learning</td>
<td></td>
</tr>
</tbody>
</table>
| Discuss It | • Encourage students to use any class discussion to assist in the formulation of their own answers.  
• Encourage students to discuss their ideas orally before writing them down.  
• Have students work in pairs or small groups and recommend that they agree on an answer before writing anything down. |
| These questions provide students with an opportunity to explain their thinking either orally or in written form. Have all students complete #5 to #7. |
Skill Check

Planning Notes

Have students who are not confident discuss strategies with you or a classmate. Encourage them to refer to their notes, On the Jobs, and previously completed questions in the related sections of the student resource.

Have students make a list of questions that they need no help with, a little help with, and a lot of help with. They can use this list to help them prepare for the Test Yourself.

Next, organize your classroom into four review stations. At each station, students work on a different section of the chapter. You might also consider a fifth station for definitions and Key Words. If students struggle to remember the names of different angles and angle relationships, then this station could focus on learning the Key Words.

Ask students to prioritize the two sections they most need to work on and give them about 20 min to work at each station. At each station students can work through relevant questions in the Skill Check. As they work, students should have access to additional notes and examples should they require them. At the Key Words station, encourage students to use their flash cards or journal to help memorize the definitions.

These are the minimum Skill Check questions that will meet the related curriculum outcomes: #1–2, #4–#5, and #7–#8.

Meeting Student Needs

- Students who require more practice on a particular topic may refer to BLM 5–8 Section 5.1 Extra Practice, BLM 5–10 Section 5.2 Extra Practice, BLM 5–12 Section 5.3 Extra Practice, and BLM 5–14 Section 5.4 Extra Practice.

<table>
<thead>
<tr>
<th>Assessment for Learning</th>
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</thead>
<tbody>
<tr>
<td>Chapter 5 Skill Check</td>
<td>Have students revisit any section that they are having difficulty with prior to working on the Test Yourself.</td>
</tr>
<tr>
<td></td>
<td>Encourage students to refer to their notes and previously completed work as a resource.</td>
</tr>
<tr>
<td></td>
<td>Have students use the Web Links listed earlier in the chapter to review and practise the concepts.</td>
</tr>
</tbody>
</table>
Test Yourself

Planning Notes

This Test Yourself is a practice test that can be assigned as an in-class or take-home assignment. Provide students with the number of questions they can comfortably do in one class. These are the minimum questions that will meet the related curriculum outcomes: #1–#4, #6, and #8.

Study Guide

<table>
<thead>
<tr>
<th>Question(s)</th>
<th>Section(s)</th>
<th>Refer to</th>
<th>The student can …</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1, #5, #9</td>
<td>5.1</td>
<td>On the Job 1</td>
<td>✓ classify types of angles</td>
</tr>
<tr>
<td>#2, #5</td>
<td>5.3</td>
<td>On the Job 2, On the Job 3</td>
<td>✓ identify patterns of angles formed by parallel lines</td>
</tr>
<tr>
<td>#3, #4</td>
<td>5.3</td>
<td>On the Job 1</td>
<td>✓ identify patterns of angles when two lines cross</td>
</tr>
<tr>
<td>#4, #10, #11</td>
<td>5.4</td>
<td>On the Job 1, On the Job 2</td>
<td>✓ solve problems involving angles formed by parallel lines and a transversal</td>
</tr>
<tr>
<td>#6</td>
<td>5.1</td>
<td>On the Job 2</td>
<td>✓ measure angles using a protractor</td>
</tr>
<tr>
<td>#7</td>
<td>5.2</td>
<td>On the Job 1</td>
<td>✓ sketch angles using a reference</td>
</tr>
<tr>
<td>#7, #8</td>
<td>5.2</td>
<td>On the Job 1</td>
<td>✓ construct angles using a protractor</td>
</tr>
<tr>
<td>#8</td>
<td>5.2</td>
<td>On the Job 2</td>
<td>✓ bisect angles</td>
</tr>
</tbody>
</table>

Assessment Supporting Learning

<table>
<thead>
<tr>
<th>Assessment of Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 5 Self-Assessment</td>
</tr>
<tr>
<td>Have students review their math journal notes, Chapter 5 Foldable, and earlier responses on BLM 5–1 Chapter 5 Self-Assessment.</td>
</tr>
<tr>
<td>• Have students use their responses on the practice test and work they completed earlier in the chapter to identify areas in which they may need to reinforce their understanding of skills or concepts. Before the chapter test, coach them in the areas in which they are having difficulties.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supporting Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chapter 5 Test</td>
</tr>
<tr>
<td>After students complete the Test Yourself, you may wish to use BLM 5–15 Chapter 5 Test as a summative assessment.</td>
</tr>
<tr>
<td>• Consider allowing students to use their Chapter 5 foldable.</td>
</tr>
</tbody>
</table>
Chapter Project

Planning Notes

This chapter project has students apply their knowledge of angles in a practical context. Introduce the project by having students think back to the discussion at the beginning of Chapter 5 about angles represented in the flag of Newfoundland and Labrador.

Discuss with students what is being asked of them. Have them brainstorm as a class what math skills they will need to complete the project, as well as any additional information they feel they will need that is not provided in the project outline. Students can use BLM 5–16 Chapter 5 Project Checklist as a guide.

Students should each measure the angles and side lengths in the provincial flag, as well as complete their own flag design. However, encourage students to discuss difficulties and steps with others in the class as they work through the project.

To make it easier for students to measure angles in the provincial flag, you may wish to provide them with the enlarged version in BLM 5–17 Chapter 5 Project Flag of Newfoundland and Labrador. For the design phase of the project, provide Master 2 1.0 Centimetre Grid for students to use to create their sketches.

Meeting Student Needs

• Have rulers, protractors, and compasses available to students.
• Allowing students to discuss and formulate their plan with someone else will help them to have a clearer picture of what they are doing.
• Students could use dynamic software to complete their design if they are more comfortable with this format.

Common Errors

• Students do not use their protractor or compass correctly.
  \textbf{R}_x \text{ Refer students to their notes on using a protractor as well as notes on how to construct an angle. Remind them of the key steps in the process.}

  \textbf{R}_x \text{ Refer students to the three methods that can be used to construct an angle bisector. Encourage them to go over the key steps in each method.}

  • Students do not use the correct angle relationships.

  \textbf{R}_x \text{ Students need to practise identifying which relationship to use and determining whether more than one step is required to determine the measure of an unknown angle.}
**Assessment for Learning**

<table>
<thead>
<tr>
<th><strong>Chapter 5 Project</strong></th>
<th><strong>Supporting Learning</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>This chapter project gives students an opportunity to apply and display their knowledge of angles. It should be evident that students can</strong></td>
<td><strong>BLM 5–16 Chapter 7 Project Checklist</strong> can be used as a self-assessment prior to handing in the project. If students have not used this master to help them organize their project, have them use it possibly to improve what they have done.</td>
</tr>
<tr>
<td>• identify, classify, and measure angles</td>
<td>You may wish to use <strong>Master 1 Project Rubric</strong>, or photocopy and distribute the following TR page, leaving the Specific Question Notes blank. Work with students to develop what should go into those notes.</td>
</tr>
<tr>
<td>• replicate and construct angles</td>
<td></td>
</tr>
<tr>
<td>• bisect angles</td>
<td></td>
</tr>
<tr>
<td>• correctly use a protractor and a compass</td>
<td></td>
</tr>
</tbody>
</table>

**The Master 1 Project Rubric** provides a holistic descriptor to help in assessing student work on this project. See the notes on page 289 of this TR about how to use this rubric.
The chart below shows Master 1 Project Rubric for the Chapter 5 project and provides notes that suggest possible ways to score answers for this project.

<table>
<thead>
<tr>
<th>Score/Level</th>
<th>Holistic Descriptor</th>
<th>Specific Question Notes</th>
</tr>
</thead>
</table>
| 5 (Standard of Excellence) | ☐ Applies/develops thorough strategies and mathematical processes making significant comparisons/connections that demonstrate a comprehensive understanding of how to develop a complete solution | □ uses a flag of their own design to demonstrate a comprehensive understanding of how to estimate, construct, and measure angles  
□ includes at least two of the following features: parallel lines, transversal, perpendicular lines, angle bisector, and angles in the F, Z, X, and C pattern  
□ explains, at an excellent understanding level, how their flag design shows what they know about angles  
□ transfers knowledge to given situations and builds on understanding to enhance project design  
□ supports detailed drawings mathematically  
□ communicates clearly and logically |
| 4 (Above Acceptable) | ☐ Applies/develops thorough strategies and mathematical processes for making reasonable comparisons/connections that demonstrate a clear understanding  
☐ Procedures are reasonable and may contain a minor mathematical error that may hinder the understanding in one part of a complete solution  
☐ Uses appropriate mathematical language to explain their understanding and provides clear support for their conclusion | □ uses a flag of their own design to demonstrate a very good understanding of how to estimate, construct, and measure angles  
□ uses at least two of the following features: parallel lines, transversal, perpendicular lines, and angle bisector and/or angles in the F, Z, X, and C pattern  
□ explains, at a very good understanding level, how their flag design shows what they know about angles; some features may be left incompletely described  
□ communicates well  
□ attempts to meet all criteria for the project  
□ may have some minor errors or omissions and lack of clarity  
□ may seek help occasionally |
| 3 (Meets Acceptable) | ☐ Applies/develops relevant strategies and mathematical processes making some comparisons/connections that demonstrate a basic understanding  
☐ Procedures are basic and may contain a major error or omission  
☐ Uses common language to explain their understanding and provides minimal support for their conclusion | □ uses a flag of their own design to demonstrate a good understanding of how to estimate, construct, and measure angles  
□ uses at least two of the following features: parallel lines, transversal, perpendicular lines, and angle bisector and/or angles in the F, Z, X, and C pattern  
□ explains, at a good understanding level, how the flag design shows what they know about angles; some features may be left out, incorrect, or incompletely described  
□ includes some errors or omissions but demonstrates a good conceptual understanding  
□ tries to communicate, with some weaknesses and inconsistent organization  
□ requires some initial prompting |
| 2 (Below Acceptable) | ☐ Applies/develops some relevant mathematical processes making minimal comparisons/connections that lead to a partial solution  
☐ Procedures are basic and may contain several major mathematical errors  
☐ Communication is weak | □ with direct assistance is able to create a flag that demonstrates a basic understanding of how to estimate, construct, and measure angles  
□ uses at least one of the following features: parallel lines, transversal, perpendicular lines, and angle bisector and/or angles in the F, Z, X, and C pattern  
□ explains, with prompts, how the flag design shows what they know about angles; some features may be left out, incorrect, or inadequately described  
□ requires a moderate amount of support; lacks confidence to proceed without guidance  
□ attempts to meet project requirements but has many omissions and errors  
□ may include some communication, but it is weak |
| 1 (Beginning) | ☐ Applies/develops an initial start that may be partially correct or could have led to a correct solution  
☐ Communication is weak or absent | □ needs assistance to create a flag that meets some of the criteria  
□ requires extensive help showing the criteria features, but is beginning to be able to show some of them  
□ is unable to explain the connection between their flag design and the criteria  
□ makes repeated initial starts to the project  
□ relies on modelled examples; is unable to transfer learning from examples to new situations  
□ may be able to apply some formulas but not consistently and often incorrectly |
Games and Puzzles

Planning Notes

Within 10 is a good game to reinforce students’ skills of estimating and measuring angles. Consider playing the game at the end of section 5.1 or as a review tool at the end of the chapter. Provide BLM 5–18 Chapter 5 Within 10 Game Cards for students to use. Make sure when students play the game that they use a personal reference to estimate the size of each angle prior to sketching it. Have students go over their personal references for different angles before playing the game. If time to play is limited, you might consider limiting the game play to only five cards each, and then use the game again later in the chapter.

By the Letter reinforces the letter shape and parallel line relationships. Students have to put the angle shapes together to make different letters. It would be a good idea to photocopy BLM 5–19 Chapter 5 By the Letter Game Cards onto an overhead projector slide or similar transparency. This will allow students to rotate and flip the angle cards when making letters. When students have finished playing, discuss as a class what is special about the letters they could form.

Meeting Student Needs

- Use BLM 5–18 Chapter 5 Within 10 Game Cards and BLM 5–19 Chapter 5 By the Letter Game Cards so that students do not need to make the cards.
- Have their journals or posters available in the class showing the personal reference for different size angles.

Gifted and Enrichment

- Challenge students to create game cards for reflex angles.
- Encourage students to reflect on the letters they could make using reflex angle cards and discuss any similarities.

### Assessment

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<tbody>
<tr>
<td><strong>Chapter 5 Games</strong></td>
<td>Review personal references for angles and encourage students to use them when playing the game.</td>
</tr>
<tr>
<td><strong>Within 10</strong> is designed to reinforce students’ ability to estimate and measure angles.</td>
<td>Have their journals or posters available in the class showing the personal reference for different size angles.</td>
</tr>
<tr>
<td><strong>By the Letter</strong> is designed to help reinforce the letter pattern connections to the angle properties exhibited by a pair of parallel lines and a transversal.</td>
<td>Encourage students to flip as well as rotate the cards.</td>
</tr>
<tr>
<td></td>
<td>Encourage students to think about different ways the angle cards can meet, cross, or overlap.</td>
</tr>
</tbody>
</table>