Two rays with a common endpoint form an angle. The common endpoint is called the vertex. You can use a protractor to draw and measure angles in degrees.

1. Angles can be classified by their measures. Name the three classifications and then draw an example of each.
   - Acute angle:
   - Right Angle:
   - Obtuse Angle:

2. Measure each angle and classify it according to its measure.
   a. 47°, acute
   b. 68°, acute
   c. 147°, obtuse
   d. 90°, right
   e. 110°, obtuse

   To read this angle, say "angle ABC," "angle CBA," or "angle B."
**ACTIVITY 3.1 Continued**

3. **Group Presentation** Have students share their answers to this question on white boards.

4. **Guess and Check** Students are matching angles to form a complementary pair or a supplementary pair.

**TEACHER TO TEACHER** Watch for students who conclude that each right angle in Parts b and f is complementary to itself. Complementary angles must be a pair of angles.

**Math Tip**
Complementary angles are two angles whose sum is 90°. Supplementary angles are two angles whose sum is 180°.

**SUGGESTED LEARNING STRATEGIES:** Group Presentation, Guess and Check

Angles can be paired in many ways.

3. **Compare and contrast complementary and supplementary angles.**

*Answers may vary. Sample answer:* Complementary angles have a sum of 90°, but supplementary angles have a sum of 180°. Two angles are needed to form both kinds of angle pairs. Complementary angles will form a right angle if they are placed next to each, but supplementary angles form a straight angle when they are placed next to each other.

4. **Name pairs of angles that form complementary or supplementary angles. Justify your choices.**

![Diagram with angles](image)

The angles in Parts a and g are complementary because $37° + 53° = 90°$; the angles in Parts b and f are supplementary because $90° + 90° = 180°$; the angles in Parts d and e are complementary because $31° + 59° = 90°$; the angles in Parts a and h are supplementary because $37° + 143° = 180°$. 
Angle Pairs
What's Your Angle?

SUGGESTED LEARNING STRATEGIES: Think/Pair/Share, Group Presentation, Quickwrite, Work Backward, Create Representations

5. Why are angles 1 and 2 in this diagram complementary?

![Diagram](image1)

Answers may vary. Sample answer: ∠ABC is a right angle that measures 90°. Since ∠ABC is formed by ∠1 and ∠2, then ∠1 and ∠2 must be complementary.

6. Why are angles 1 and 2 in this diagram supplementary?

![Diagram](image2)

Answers may vary. Sample answer: A straight angle (180°) is formed by ∠1 and ∠2, so ∠1 and ∠2 must be supplementary.

7. Can two obtuse angles be supplementary? Explain your reasoning.

Answers may vary. Sample answer: Obtuse angles have a measure that is greater than 90°, so the sum of two obtuse angles would be greater than 180°, so they could not be supplementary.

8. Give the complement and supplement, if possible, of an angle that measures 32°.

Complement: 90° – 32° = 58°; Supplement: 180° – 32° = 148°

9. Give the complement and supplement, if possible, of an angle that measures 98°.

Complement: 90° – 98° = (−8°), so complement does not exist. Supplement: 180° – 98° = 82°.

10. Two angles are complementary. One measures (2x)° and the other measures 48°.

a. Write an equation to find the measure of the missing angle.
   \[2x + 48 = 90\]

b. Solve the equation for x.
   \[x = 21\]

c. What is the value of the other angle? Show your work.
   \[42° \times 2(21) = 42\]

MATH TERMS
In Items 5 and 6, angles 1 and 2 are examples of adjacent angles. Adjacent angles have a common side but no common interior.

ACTIVITY 3.1 Continued

5. Think/Pair/Share Make sure students understand that these two angles share a ray in such a way that they form a 90° angle, thus forming a complementary pair.

6. Group Presentation Students should see that angles 1 and 2 form a straight line measuring 180°, thus forming a supplementary pair.

7. Quickwrite Have students draw two obtuse angles if they need help understanding that two obtuse angles cannot be supplementary. There should be several different counterexamples within the class so that students should clearly visualize this concept.

8. Work Backward

9. Think/Pair/Share Students will not be able to give a complement because the 98° angle is obtuse.

Suggested Assignment
CHECK YOUR UNDERSTANDING
p. 158, #1–2
UNIT 3 PRACTICE
p. 229, #1–3

10. Create Representations This question takes students to a more abstract level. Be on the lookout for students who think that the measure of the second angle is 21°. The value of x is 21. Students must substitute the value of x into the expression 2x to find the unknown angle.
ACTIVITY 3.1 Continued

11 Create Representations This question is similar to Item 10. Make sure that students substitute the value of $x$ into the expression $3x$ to find the measure of the unknown angle.

Differentiating Instruction Challenge students who may be ready for a more complex problem after completing Item 11 with this problem:

$\angle ABC$ and $\angle JKL$ are complementary.

$m\angle ABC = \left(\frac{3}{4}x - 13\right)^\circ$ and $m\angle JKL = (3x - 17)^\circ$. Find the measure of each angle. Show your work.

Answer: $x = 32$; $m\angle ABC = 11^\circ$, $m\angle JKL = 79^\circ$.

12 Use Manipulatives

Some students may have an easier time recognizing vertical angles if they see them as two “v’s” that have a common vertex.

13 Think/Pair/Share Ask students to share their conclusions on white boards for the entire class to see.

14 Quickwrite If necessary, remind students that the symbol for congruent is $\equiv$ and that they should say that numbers are equal and figures are congruent.

Have students study the figure below Item 14. You may want them to identify vertical angles and angles that form supplementary pairs before going on to the next question.

11. Two angles are supplementary. One angle measures $(3x)^\circ$ and the other measures $123^\circ$.

a. Write an equation to find the measure of the missing angle.

$b. \quad 3x + 123 = 180$

b. Solve the equation for $x$.

$x = 19$

c. What is the measure of the other angle? Show your work.

$57^\circ$; $3(19) = 57$

Vertical angles are formed when two lines intersect.

12. $\angle 1$ and $\angle 3$ are vertical angles. Find the measure of each angle using your protractor.

$m\angle 1 = 130^\circ$; $m\angle 3 = 130^\circ$

13. Name another pair of vertical angles and find the measure of each angle.

$2$ and $4$; $m\angle 2 = 50^\circ$, $m\angle 4 = 50^\circ$

14. What conjectures can you make about the measures of a pair of vertical angles?

Vertical angles are congruent.

When two parallel lines are cut by a transversal, eight angles are formed.
**ACTIVITY 3.1 Continued**

15. \( \angle 4 \) and \( \angle 8 \) are **corresponding angles**.
   
   a. Why do you think that they are called corresponding angles?
   
   Answers may vary. Sample answer: Corresponding angles are on the same side of the parallel lines and the transversal.
   
   b. Measure angles 4 and 8.  
   \( m\angle 4 = 68° \)  \( m\angle 8 = 68° \)
   
   c. Name three more pairs of corresponding angles and give their measures.
   \( m\angle 1 = m\angle 5 = 68° \),  \( m\angle 3 = m\angle 7 = 112° \),  \( m\angle 2 = m\angle 6 \approx 112° \)
   
   d. What conjectures can you make about pairs of corresponding angles formed when parallel lines are cut by a transversal?
   
   They are congruent.

16. \( \angle 3 \) and \( \angle 6 \) are **alternate interior angles**.
   
   a. Why are they called alternate interior angles?
   
   Answers may vary. Sample answer: Alternate interior angles are inside the parallel lines but on opposite sides of the transversal.
   
   b. Measure angles 3 and 6.  
   \( m\angle 3 = 112° \)  \( m\angle 6 = 112° \)
   
   c. Name another pair of alternate interior angles and give their measures.
   \( m\angle 4 = m\angle 5 = 68° \)
   
   d. What conjectures can you make about pairs of alternate interior angles formed when parallel lines are cut by a transversal?
   
   They are congruent.

17. \( \angle 2 \) and \( \angle 7 \) are **alternate exterior angles**.
   
   a. Why are they called alternate exterior angles?
   
   Answers may vary. Sample answer: Alternate exterior angles are outside the parallel lines but on opposite sides of the transversal.
   
   b. Measure angles 2 and 7.  
   \( m\angle 2 = 112° \)  \( m\angle 7 = 112° \)
   
   c. Name another pair of alternate exterior angles and give their measures.
   \( m\angle 1 = m\angle 8 = 68° \)
   
   d. What can you conclude about pairs of alternate exterior angles formed when parallel lines are cut by a transversal?
   
   They are congruent.

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**Suggested Assignment**

CHECK YOUR UNDERSTANDING

p. 158, #3–5

UNIT 3 PRACTICE

p. 229, #4–6

**Group Presentation**  Help students to see that the interior angles are “inside” the parallel lines.

**Diffentiating Instruction**

For the students who need a concrete visual representation of alternate interior angles, you may want to use the letter \( Z \). Angles “tucked” inside the letter \( Z \) are alternate interior angles. You can show how to change the orientation of the letter \( Z \) so that it looks like the letter \( N \), or a backward \( Z \), or a backward \( N \).

**Think/Pair/Share**  Help students see that the exterior angles are outside the parallel lines.

Visual learners may have better success at naming angle pairs if they can represent the parallel lines and transversal using pipe cleaners and counters. Ask the student to place 2 pipe cleaners so that they are parallel to each other, and then place another pipe cleaner so that it intersects both parallel lines. As you call out an angle pair, such as “alternate interior angles,” students will identify 2 alternate interior angles using their markers.
ACTIVITY 3.1 Continued

18. Look for a Pattern  This question serves as a review of alternate interior angles.

19. Think/Pair/Share  This question serves as a review of alternate exterior angles.

20. Look for a Pattern  This question gives students another opportunity to work with corresponding angles.

18. In Figure A, two parallel lines are cut by a transversal. The measure of $\angle 1 = 42^\circ$. Find $m\angle 2$ and describe the relationship that helped you determine the measure.

![Figure A](image)

Explanations may vary. Sample answer: $m\angle 2 = 42^\circ$; alternate interior angles are congruent when two parallel lines are cut by a transversal.

19. In Figure B, two parallel lines are cut by a transversal. The measure of $\angle 1 = 138^\circ$. Find $m\angle 2$ and describe the relationship that helped you determine the measure.

![Figure B](image)

Explanations may vary. Sample answer: $m\angle 2 = 138^\circ$; alternate exterior angles are congruent when two parallel lines are cut by a transversal.

20. In Figure C, two parallel lines are cut by a transversal. The measure of $\angle 1 = 57^\circ$. Find $m\angle 2$ and describe the relationship that helped you determine the measure.

![Figure C](image)

Explanations may vary. Sample answer: $m\angle 2 = 57^\circ$; corresponding angles are congruent when two parallel lines are cut by a transversal.
ACTIVITY 3.1 Continued

**What’s Your Angle?**

**SUGGESTED LEARNING STRATEGIES: Group Presentation**

Use the work you did and the conjectures you made in Questions 14–17 to help answer Questions 21 and 22.

### 21. In Figure D, lines \( j \) and \( k \) are parallel and are cut by a transversal. The measure of \( \angle 4 = 72^\circ \). Give the measures of the remaining seven angles. Justify your answers.

<table>
<thead>
<tr>
<th>Angle</th>
<th>Measure</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>108°</td>
<td>( \angle 1 ) and ( \angle 4 ) are supplementary angles.</td>
</tr>
<tr>
<td>2</td>
<td>72°</td>
<td>( \angle 2 ) and ( \angle 4 ) are congruent because they are vertical angles.</td>
</tr>
<tr>
<td>3</td>
<td>108°</td>
<td>( \angle 1 ) and ( \angle 3 ) are vertical angles.</td>
</tr>
<tr>
<td>4</td>
<td>72°</td>
<td>Given.</td>
</tr>
<tr>
<td>5</td>
<td>108°</td>
<td>( \angle 3 ) and ( \angle 5 ) are alternate interior angles. Alternate interior angles are congruent when lines are parallel.</td>
</tr>
<tr>
<td>6</td>
<td>72°</td>
<td>( \angle 4 ) and ( \angle 6 ) are alternate interior angles. Alternate interior angles are congruent when lines are parallel.</td>
</tr>
<tr>
<td>7</td>
<td>72°</td>
<td>( \angle 1 ) and ( \angle 7 ) are corresponding angles. Corresponding angles are congruent when lines are parallel.</td>
</tr>
<tr>
<td>8</td>
<td>108°</td>
<td>( \angle 1 ) and ( \angle 8 ) are alternate exterior angles. Alternate exterior angles are congruent when lines are parallel.</td>
</tr>
</tbody>
</table>

### 22. Find an angle pair that supports your conjecture about each type of angle pair.

- **a. Vertical angles**
  Answers may vary. Possible answers: angles 1 and 3, 2 and 4, 5 and 6, or 6 and 7

- **b. Corresponding angles**
  Answers may vary. Possible answers: angles 1 and 5, 4 and 7, 2 and 6, or 3 and 8

- **c. Alternate interior angles**
  Answers may vary. Possible answers: angles 3 and 5 or 4 and 6

- **d. Alternate exterior angles**
  Answers may vary. Possible answers: angles 1 and 8 or 2 and 7
ACTIVITY 3.1 Continued

22. Visualize, Look for a Pattern This question helps students see that their study of geometry does connect to their everyday lives.

Suggested Assignment
CHECK YOUR UNDERSTANDING p. 158, #6
UNIT 3 PRACTICE p. 229, #7

CHECK YOUR UNDERSTANDING

1. Find the complement and/or supplement of each angle.
   a. $32°$
   b. $113°$

2. Find the measure of angle 1. Explain how you found your answer.
   a. Sample answer: $32°$; the right angle symbol means that the two angles must be complementary, so the measure of angle 1 is $32°$.
   b. Sample answer: $43°$; a straight line measures $180°$, so the two angles must be supplementary making the measure of angle 1 equal to $43°$.

3. $5x + 75 = 180$
   $5x = 105$
   $x = 21$
   $m\angle MNO = 105°$

4. $m\angle 1 = 73°$ because vertical angles are congruent; $m\angle 2 = 107°$ because angle 1 and angle 2 are supplementary; $m\angle 3 = 107°$ because angles 2 and 3 are vertical angles and vertical angles are congruent.

5a. $m\angle 3 = 98°$
5b. $m\angle 7 = 98°$
5c. $m\angle 5 = 98°$
   Explanations may vary.
   Sample explanation for Part a: $m\angle 2 = 82°$ because $\angle 8$ and $\angle 2$ are vertical angles. $m\angle 3 = 98°$ because $\angle 3$ and $\angle 2$ are same-side interior angles and are supplementary.

6. Answers may vary. Sample answer: students might draw non-parallel lines cut by a transversal and measure the angles.