

# Chapter 3

## Chapter 3 Opener

### Try It Yourself (p. 101)

1. The angles are vertical.

$$x + 8 = 120$$

$$x = 112$$

So, the value of  $x$  is 112.

2. The angles are adjacent.

$$(x + 3) + 43 = 90$$

$$x + 46 = 90$$

$$x = 44$$

So, the value of  $x$  is 44.

3. The angles are complementary.

$$(x - 8) + 20 = 90$$

$$x + 12 = 90$$

$$x = 78$$

So, the value of  $x$  is 78.

4. The angles are supplementary.

$$(2x + 4) + 76 = 180$$

$$2x + 80 = 180$$

$$2x = 100$$

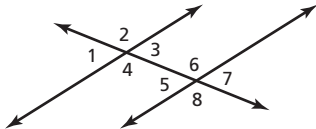
$$x = 50$$

So, the value of  $x$  is 50.

## Section 3.1

### 3.1 Activity (pp. 102–103)

1. a. Eight angles are formed. *Sample answer:*



- b.  $\angle 2$ ,  $\angle 4$ ,  $\angle 6$ , and  $\angle 8$  have equal measures.

$\angle 1$ ,  $\angle 3$ ,  $\angle 5$ , and  $\angle 7$  have equal measures.

*Sample answer:*

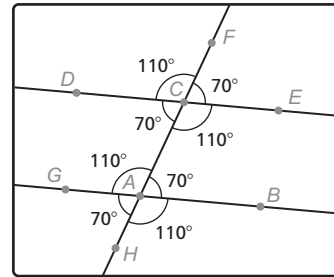
$\angle 2$  and  $\angle 4$ ,  $\angle 6$  and  $\angle 8$ ,  $\angle 1$  and  $\angle 3$ ,  $\angle 5$  and  $\angle 7$  are vertical angles. Vertical angles have the same measure. Using a protractor, you can determine that the following angles have equal measures:

$\angle 1$  and  $\angle 5$ ,  $\angle 2$  and  $\angle 6$ ,  $\angle 3$  and  $\angle 7$ ,  $\angle 4$  and  $\angle 8$ .

You can also determine this by visually placing an angle over the angle that corresponds to it to see that they have equal measures.

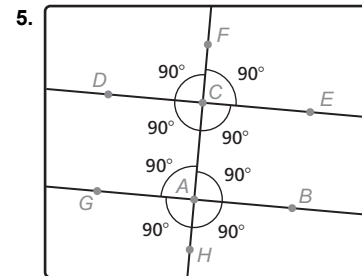
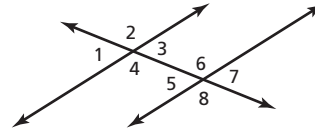
2. a. *Sample answer:* Measure the vertical angles and the angles that correspond to them and make sure they are congruent.
- b. The studs are parallel lines and the diagonal support beam is a transversal.

3. a. *Sample answer:*



- b. *Answer should include, but is not limited to:* Students should adjust the parallel lines or transversal. The angle measures should increase and decrease as they adjust the lines.

4. *Sample answer:* When two parallel lines are intersected by a transversal, eight angles are formed as shown. In the figure,  $\angle 1$ ,  $\angle 3$ ,  $\angle 5$ , and  $\angle 7$  are congruent, and  $\angle 2$ ,  $\angle 4$ ,  $\angle 6$ , and  $\angle 8$  are congruent.



The measures of all eight angles are  $90^\circ$ .

### 3.1 On Your Own (pp. 104–106)

1.  $\angle 1$  and the  $63^\circ$  angle are corresponding angles. They are congruent. So, the measure of  $\angle 1$  is  $63^\circ$ .
2.  $\angle 1$  and  $\angle 2$  are supplementary.
- $$\angle 1 + \angle 2 = 180^\circ$$
- $$63^\circ + \angle 2 = 180^\circ$$
- $$\angle 2 = 117^\circ$$
- So, the measure of  $\angle 2$  is  $117^\circ$ .

# Chapter 3

3. The  $59^\circ$  angle is supplementary to both  $\angle 1$  and  $\angle 3$ .

$$\angle 1 + 59^\circ = 180^\circ$$

$$\angle 1 = 121^\circ$$

So, the measures of  $\angle 1$  and  $\angle 3$  are  $121^\circ$ .

$\angle 2$  and the  $59^\circ$  angle are vertical angles. They are congruent. So, the measure of  $\angle 2$  is  $59^\circ$ .

Using corresponding angles, the measures of  $\angle 4$  and  $\angle 6$  are  $121^\circ$ , and the measures of  $\angle 5$  and  $\angle 7$  are  $59^\circ$ .

4. Because all of the letters are slanted at a  $65^\circ$  angle, the dashed lines are parallel. The piece of tape is the transversal. Using corresponding angles, the  $65^\circ$  angle is congruent to the angle that is supplementary to  $\angle 1$ . So, the measure of  $\angle 1$  is  $180^\circ - 65^\circ = 115^\circ$ .

5.  $\angle 3$  and  $\angle 4$  are supplementary angles.

$$\angle 3 + \angle 4 = 180^\circ$$

$$\angle 3 + 84^\circ = 180^\circ$$

$$\angle 3 = 96^\circ$$

So, the measure of  $\angle 3$  is  $96^\circ$ .

6.  $\angle 4$  and  $\angle 5$  are alternate interior angles. Because the angles are congruent, the measure of  $\angle 5$  is  $84^\circ$ .

7.  $\angle 4$  and  $\angle 5$  are alternate interior angles. Because the angles are congruent, the measure of  $\angle 5$  is  $84^\circ$ .  $\angle 5$  and  $\angle 6$  are supplementary angles.

$$\angle 5 + \angle 6 = 180^\circ$$

$$84^\circ + \angle 6 = 180^\circ$$

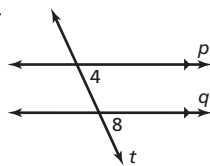
$$\angle 6 = 96^\circ$$

So, the measure of  $\angle 6$  is  $96^\circ$ .

## 3.1 Exercises (pp. 107–109)

### Vocabulary and Concept Check

1. *Sample answer:*



$\angle 4$  and  $\angle 8$  are corresponding angles.

2. Because  $\angle 2$  and  $\angle 6$  are corresponding angles, and  $\angle 6$  and  $\angle 8$  are vertical angles,  $\angle 2$ ,  $\angle 6$ , and  $\angle 8$  are congruent. Because  $\angle 5$  and  $\angle 6$  are supplementary angles, the statement “The measure of  $\angle 5$ ” does not belong with the other three.

### Practice and Problem Solving

3. Lines  $m$  and  $n$  are parallel.

4. Line  $t$  is the transversal.

5. Eight angles are formed by the transversal.

6. Using vertical angles and corresponding angles,  $\angle 1$ ,  $\angle 3$ ,  $\angle 5$ , and  $\angle 7$  are congruent, and  $\angle 2$ ,  $\angle 4$ ,  $\angle 6$ , and  $\angle 8$  are congruent.

7.  $\angle 1$  and the  $107^\circ$  angle are corresponding angles. They are congruent. So, the measure of  $\angle 1$  is  $107^\circ$ .

$\angle 1$  and  $\angle 2$  are supplementary angles.

$$\angle 1 + \angle 2 = 180^\circ$$

$$107^\circ + \angle 2 = 180^\circ$$

$$\angle 2 = 73^\circ$$

So, the measure of  $\angle 2$  is  $73^\circ$ .

8.  $\angle 3$  and the  $95^\circ$  angle are corresponding angles. They are congruent. So, the measure of  $\angle 3$  is  $95^\circ$ .

$\angle 3$  and  $\angle 4$  are supplementary angles.

$$\angle 3 + \angle 4 = 180^\circ$$

$$95^\circ + \angle 4 = 180^\circ$$

$$\angle 4 = 85^\circ$$

So, the measure of  $\angle 4$  is  $85^\circ$ .

9.  $\angle 5$  and the  $49^\circ$  angle are corresponding angles. They are congruent. So, the measure of  $\angle 5$  is  $49^\circ$ .

$\angle 5$  and  $\angle 6$  are supplementary angles.

$$\angle 5 + \angle 6 = 180^\circ$$

$$49^\circ + \angle 6 = 180^\circ$$

$$\angle 6 = 131^\circ$$

So, the measure of  $\angle 6$  is  $131^\circ$ .

10. The lines are not parallel, so the corresponding angles  $\angle 5$  and  $\angle 6$  are not congruent.

11. Because  $\angle 1$  and  $\angle 2$  are corresponding angles, the measure of  $\angle 2$  is  $60^\circ$ .

12. *Sample answer:* The yard lines on a football field are parallel. The lampposts on a road are parallel.

13. *Sample answer:* Rotate the figure  $180^\circ$  and translate down.

14. The least number of angle measures you need to know is one angle measure. Three other angles will be congruent to the known angle. The rest of the angle measures are supplementary to the known angle.

## Chapter 3

15.  $\angle 1$  and the  $61^\circ$  angle are corresponding angles. They are congruent. So, the measure of  $\angle 1$  is  $61^\circ$ .
- $\angle 1$  is supplementary to both  $\angle 2$  and  $\angle 4$ .
- $$\angle 1 + \angle 2 = 180^\circ$$
- $$61^\circ + \angle 2 = 180^\circ$$
- $$\angle 2 = 119^\circ$$
- So, the measures of  $\angle 2$  and  $\angle 4$  are  $119^\circ$ .
- $\angle 1$  and  $\angle 3$  are vertical angles. They are congruent. So, the measure of  $\angle 3$  is  $61^\circ$ .
- Using corresponding angles, the measures of  $\angle 5$  and  $\angle 7$  are  $119^\circ$ , and the measure of  $\angle 6$  is  $61^\circ$ .
16. The  $99^\circ$  angle is supplementary to both  $\angle 1$  and  $\angle 3$ .
- $$\angle 1 + 99^\circ = 180^\circ$$
- $$\angle 1 = 81^\circ$$
- So, the measures of  $\angle 1$  and  $\angle 3$  are  $81^\circ$ .
- $\angle 2$  and the  $99^\circ$  angle are vertical angles. They are congruent. So, the measure of  $\angle 2$  is  $99^\circ$ .
- Using corresponding angles, the measures of  $\angle 4$  and  $\angle 6$  are  $99^\circ$ , and the measures of  $\angle 5$  and  $\angle 7$  are  $81^\circ$ .
17. The right angle is supplementary to both  $\angle 1$  and  $\angle 3$ .
- $$90^\circ + \angle 1 = 180^\circ$$
- $$\angle 1 = 90^\circ$$
- So, the measures of  $\angle 1$  and  $\angle 3$  are  $90^\circ$ .
- $\angle 2$  and the right angle are vertical angles. They are congruent. So, the measure of  $\angle 2$  is  $90^\circ$ .
- Using corresponding angles, the measures of  $\angle 4$ ,  $\angle 5$ ,  $\angle 6$ , and  $\angle 7$  are  $90^\circ$ .
18. Using corresponding angles,  $\angle 1$  is congruent to  $\angle 8$ , which is supplementary to  $\angle 4$ .
- $$\angle 1 + \angle 4 = 180^\circ$$
- $$124^\circ + \angle 4 = 180^\circ$$
- $$\angle 4 = 56^\circ$$
- So, if the measure of  $\angle 1 = 124^\circ$ , then the measure of  $\angle 4 = 56^\circ$ .
19. Using corresponding angles,  $\angle 2$  is congruent to  $\angle 7$ , which is supplementary to  $\angle 3$ .
- $$\angle 2 + \angle 3 = 180^\circ$$
- $$48^\circ + \angle 3 = 180^\circ$$
- $$\angle 3 = 132^\circ$$
- So, if the measure of  $\angle 2 = 48^\circ$ , then the measure of  $\angle 3 = 132^\circ$ .
20. Because  $\angle 4$  and  $\angle 2$  are alternate interior angles,  $\angle 4$  is congruent to  $\angle 2$ . So, if the measure of  $\angle 4 = 55^\circ$ , then the measure of  $\angle 2 = 55^\circ$ .
21. Because  $\angle 6$  and  $\angle 8$  are alternate exterior angles,  $\angle 6$  is congruent to  $\angle 8$ . So, if the measure of  $\angle 6 = 120^\circ$ , then the measure of  $\angle 8 = 120^\circ$ .
22. Using alternate exterior angles,  $\angle 7$  is congruent to  $\angle 5$ , which is supplementary to  $\angle 6$ .
- $$\angle 7 + \angle 6 = 180^\circ$$
- $$50.5^\circ + \angle 6 = 180^\circ$$
- $$\angle 6 = 129.5^\circ$$
- So, if the measure of  $\angle 7 = 50.5^\circ$ , then the measure of  $\angle 6 = 129.5^\circ$ .
23. Using alternate interior angles,  $\angle 3$  is congruent to  $\angle 1$ , which is supplementary to  $\angle 2$ .
- $$\angle 3 + \angle 2 = 180^\circ$$
- $$118.7^\circ + \angle 2 = 180^\circ$$
- $$\angle 2 = 61.3^\circ$$
- So, if the measure of  $\angle 3 = 118.7^\circ$ , then the measure of  $\angle 2 = 61.3^\circ$ .
24. Because the two rays of sunlight are parallel,  $\angle 1$  and  $\angle 2$  are alternate interior angles. Because the angles are congruent, the measure of  $\angle 1$  is  $40^\circ$ .
25. Because the transversal is perpendicular to two parallel lines, they intersect at right angles. So, all the angles formed are  $90^\circ$ .
26. *Sample answer:* Using vertical angles,  $\angle 1$  is congruent to  $\angle 3$ .  $\angle 3$  and  $\angle 7$  are congruent because they are corresponding exterior angles. So,  $\angle 1$  is congruent to  $\angle 7$ . Using corresponding angles,  $\angle 1$  is congruent to  $\angle 5$ , and  $\angle 5$  and  $\angle 7$  are congruent because they are vertical angles. So,  $\angle 1$  is congruent to  $\angle 7$ .
27. The  $50^\circ$  angle is congruent to the alternate interior angle formed by the intersection of line  $a$  and line  $c$ . This angle is congruent to the corresponding angle formed by the intersection of line  $a$  and line  $d$ . This angle is supplementary to the  $x^\circ$  angle. So, the  $50^\circ$  angle is supplementary to the  $x^\circ$  angle.
- $$50 + x = 180$$
- $$x = 130$$
- So, the value of  $x$  is 130.

# Chapter 3

28. The  $115^\circ$  angle is congruent to the corresponding angle formed by the intersection of line  $b$  and line  $d$ . This angle is congruent to the  $x^\circ$  angle because they are alternate exterior angles. Because the  $115^\circ$  angle is congruent to the  $x^\circ$  angle, the value of  $x$  is 115.

29. a. no; The lines look like they will intersect somewhere to the left of the figure.

b. *Answer should include, but is not limited to:* The student will draw an optical illusion using parallel lines.

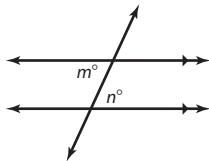
30. a.  $m + 64 + m = 180$

$$2m + 64 = 180$$

$$2m = 116$$

$$m = 58$$

So, the value of  $m$  is 58.



Because the sides of the table are parallel and  $\angle m$  and  $\angle n$  are alternate interior angles,  $\angle m$  is congruent to  $\angle n$ . The measure of  $\angle n$  is  $58^\circ$ .

$$58 + x + n = 180$$

$$58 + x + 58 = 180$$

$$x + 116 = 180$$

$$x = 64$$

So, the value of  $x$  is 64.

b. The goal is wider than the hockey puck. So, there is some leeway allowed for the value of  $x$ .

By studying the diagram, you can see that  $x$  cannot be much greater. However,  $x$  can be a little less and still have the hockey puck go into the goal.

## Fair Game Review

31.  $4 + 3^2 = 4 + 9 = 13$

32.  $5(2)^2 - 6 = 5 \cdot 4 - 6 = 20 - 6 = 14$

33.  $11 + (-7)^2 - 9 = 11 + 49 - 9 = 60 - 9 = 51$

34.  $8 \div 2^2 + 1 = 8 \div 4 + 1 = 2 + 1 = 3$

35. B;  $\frac{18}{27} = \frac{x}{18}$

$$27x = 324$$

$$x = 12$$

So,  $x$  is 12 feet.

## Section 3.2

### 3.2 Activity (pp. 110–111)

1. a–c. *Answer should include, but is not limited to:*

Students should draw a triangle and label the interior angles. They then cut out the triangle and tear off the three corners. Finally, they arrange angles  $A$  and  $B$  so that they share a vertex and are adjacent.

d. Place angle  $C$  so that it has the same vertex as angles  $A$  and  $B$ , and is also adjacent to angle  $A$  or angle  $B$ . The sum is  $180^\circ$ .

e. *Sample answer:* Students compare results with those of classmates.

f. They justify each other. The sum of the angle measures of a triangle is  $180^\circ$ .

2. a. The figure shows line  $m$  intersecting vertex  $B$  of a triangle parallel to the triangle's base, line  $n$ . Each side of the triangle is extended as shown by the dashed lines. Line  $s$  and line  $t$  are transversals.

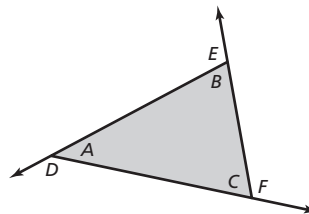
b. *Sample answer:* The sum of the measures of  $\angle D$ ,  $\angle B$ , and  $\angle E$  is  $180^\circ$  because the sum of adjacent angles forming a straight line is  $180^\circ$ .  $\angle A$  is congruent to  $\angle D$ , and  $\angle C$  is congruent to  $\angle E$  because they are alternate interior angles. Then by substitution, the sum of the measures of  $\angle A$ ,  $\angle B$ , and  $\angle C$  is  $180^\circ$ .

3. a–c. *Answer should include, but is not limited to:*

Students should draw a triangle and label the interior angles. They cut out the triangle and place it on a piece of paper extending one side to form an exterior angle.

d. The measure of exterior angle  $D$  is equal to the sum of the measures of the nonadjacent interior angles  $A$  and  $B$ .

4. a. *Sample answer:*



<b>Exterior Angle</b>	$D = 140^\circ$	$E = 108^\circ$	$F = 112^\circ$
<b>Interior Angle</b>	$B = 72^\circ$	$A = 40^\circ$	$A = 40^\circ$
<b>Interior Angle</b>	$C = 68^\circ$	$C = 68^\circ$	$B = 72^\circ$

The measure of an exterior angle of a triangle is equal to the sum of the measures of the two nonadjacent interior angles.

# Chapter 3

5. *Answer should include, but is not limited to:* Students should draw three triangles and repeat parts (b)–(d) from Activity 1 for each triangle. Yes, students should get the same results.
6. The sum of the measures of the interior angles of a triangle is  $180^\circ$ . The measure of an exterior angle of a triangle is equal to the sum of the measures of the two nonadjacent interior angles.

## 3.2 On Your Own (pp. 112–113)

1.  $x + 81 + 25 = 180$   
 $x + 106 = 180$   
 $x = 74$

2.  $x + (x - 35) + 43 = 180$   
 $2x + 8 = 180$   
 $2x = 172$   
 $x = 86$

3.  $40 + 30 = y$   
 $70 = y$

So, the measure of the exterior angle is  $70^\circ$ .

4.  $4n - 20 = (2n + 20) + n$   
 $4n - 20 = 3n + 20$   
 $4n = 3n + 40$   
 $n = 40$

So, the measure of the exterior angle is  $[4(40) - 20]^\circ = 140^\circ$ .

5.  $x + (x + 7.5) + 63.9 = 180$   
 $2x + 71.4 = 180$   
 $2x = 108.6$   
 $x = 54.3$

The value of  $x$  is 54.3.

## 3.2 Exercises (pp. 114–115)

### Vocabulary and Concept Check

1. Subtract the sum of the given angle measures from  $180^\circ$ .
2. 2; When the sides forming a vertex are extended, 2 angles are formed that are adjacent to the interior angle.
3.  $60^\circ + 55^\circ = 115^\circ$ ;  $65^\circ + 55^\circ = 120^\circ$ ;  
 $60^\circ + 65^\circ = 125^\circ$

### Practice and Problem Solving

4.  $30 + 90 + x = 180$   
 $120 + x = 180$   
 $x = 60$

So, the measures of the interior angles are  $30^\circ$ ,  $60^\circ$ , and  $90^\circ$ .

5.  $65 + 40 + x = 180$   
 $105 + x = 180$   
 $x = 75$

So, the measures of the interior angles are  $40^\circ$ ,  $65^\circ$ , and  $75^\circ$ .

6.  $35 + 45 + x = 180$   
 $80 + x = 180$   
 $x = 100$

So, the measures of the interior angles are  $35^\circ$ ,  $45^\circ$ , and  $100^\circ$ .

7.  $(x + 65) + 25 + x = 180$   
 $90 + 2x = 180$   
 $2x = 90$   
 $x = 45$

So, the measures of the interior angles are  $25^\circ$ ,  $45^\circ$ , and  $(45 + 65)^\circ = 110^\circ$ .

8.  $48 + (x - 44) + x = 180$   
 $4 + 2x = 180$   
 $2x = 176$   
 $x = 88$

So, the measures of the interior angles are  $(88 - 44)^\circ = 44^\circ$ ,  $48^\circ$ , and  $88^\circ$ .

9.  $73 + (x - 11) + x = 180$   
 $62 + 2x = 180$   
 $2x = 118$   
 $x = 59$

So, the measures of the interior angles are  $(59 - 11)^\circ = 48^\circ$ ,  $59^\circ$ , and  $73^\circ$ .

10.  $60 + x + x = 180$   
 $60 + 2x = 180$   
 $2x = 120$   
 $x = 60$

The value of  $x$  in the billiard rack is 60.

11.  $2x + 45 + x = 180$   
 $45 + 3x = 180$   
 $3x = 135$   
 $x = 45$

The value of  $x$  is 45.

12.  $38 + 90 = x$   
 $128 = x$

So, the measure of the exterior angle is  $128^\circ$ .

## Chapter 3

13.  $64 + 76 = k$

$$140 = k$$

So, the measure of the exterior angle is  $140^\circ$ .

14.  $(a + 10) + 44 = 2a$

$$a + 54 = 2a$$

$$54 = a$$

So, the measure of the exterior angle is  $2(54)^\circ = 108^\circ$ .

15. The measure of the exterior angle is equal to the sum of the measures of the two nonadjacent interior angles.

$$2x - 12 = x + 30$$

$$2x = x + 42$$

$$x = 42$$

The exterior angle is  $(2(42) - 12)^\circ = 72^\circ$ .

16.  $2x + 3x + 5x = 180$

$$10x = 180$$

$$x = 18$$

The interior angle measures are  $2(18)^\circ = 36^\circ$ ,

$$3(18)^\circ = 54^\circ, \quad 5(18)^\circ = 90^\circ.$$

17.  $90 + 3x = 180 - (5x - 6)$

$$90 + 3x = -5x + 186$$

$$3x = -5x + 96$$

$$8x = 96$$

$$x = 12$$

$$180 - (5(12) - 6) = 126$$

The measure of the exterior angle is  $126^\circ$ .

18. no; The two nonadjacent interior angles could be any two angle measures that sum to  $120^\circ$ .

19. sometimes; The sum of the angle measures must equal  $180^\circ$ .

20. always; Because the sum of the interior angle measures must equal  $180^\circ$  and one of the interior angles is  $90^\circ$ , the other two interior angles must sum to  $90^\circ$ .

21. never; If a triangle had more than one vertex with an acute exterior angle, then it would have to have more than one obtuse interior angle which is impossible.

22. You know that  $x + y + w = 180$  and  $w + z = 180$ . Substitute  $w + z$  for 180 in the first equation to get  $x + y + w = w + z$ . Subtract  $w$  from each side of the equation to get  $x + y = z$ .

### Fair Game Review

23.  $-4x + 3 = 19$       **Check:**  $-4x + 3 = 19$

$$\frac{-3}{-4} = \frac{-3}{-4}$$

$$-4x = 16$$

$$\frac{-4x}{-4} = \frac{16}{-4}$$

$$x = -4$$

$$-4(-4) + 3 = 19$$

$$16 + 3 = 19$$

$$19 = 19 \checkmark$$

24.  $2(y - 1) + 6y = -10$

$$2(y) - 2(1) + 6y = -10$$

$$2y - 2 + 6y = -10$$

$$8y - 2 = -10$$

$$\frac{+2}{8} = \frac{+2}{8}$$

$$8y = -8$$

$$\frac{8y}{8} = \frac{-8}{8}$$

$$y = -1$$

**Check:**  $2(y - 1) + 6y = -10$

$$2(-1 - 1) + 6(-1) = -10$$

$$2(-2) + (-6) = -10$$

$$-4 + (-6) = -10$$

$$-10 = -10 \checkmark$$

25.  $5 + 0.5(6n + 14) = 3$

$$5 + 0.5(6n) + 0.5(14) = 3$$

$$5 + 3n + 7 = 3 = 3$$

$$3n + 12 = 3$$

$$\frac{-12}{3} = \frac{-12}{3}$$

$$3n = -9$$

$$\frac{3n}{3} = \frac{-9}{3}$$

$$n = -3$$

**Check:**  $5 + 0.5(6n + 14) = 3$

$$5 + 0.5[6(-3) + 14] = 3$$

$$5 + 0.5(-18 + 14) = 3$$

$$5 + 0.5(-4) = 3$$

$$5 - 2 = 3$$

$$3 = 3 \checkmark$$

26. A

# Chapter 3

## Study Help

Available at *BigIdeasMath.com*.

### Quiz 3.1–3.2

1. Because the  $82^\circ$  angle and  $\angle 2$  are alternate exterior angles, the angles are congruent. So, the measure of  $\angle 2$  is  $82^\circ$ .
2. Because the  $82^\circ$  angle and  $\angle 6$  are vertical angles, the angles are congruent. So, the measure of  $\angle 6$  is  $82^\circ$ .
3. Because the  $82^\circ$  angle and  $\angle 4$  are corresponding angles, the angles are congruent. So, the measure of  $\angle 4$  is  $82^\circ$ .
4. Using corresponding angles, the  $82^\circ$  angle is congruent to  $\angle 4$ , which is supplementary to  $\angle 1$ . So, the measure of  $\angle 1$  is  $180^\circ - 82^\circ = 98^\circ$ .
5. Using alternate exterior angles,  $\angle 1$  is congruent to  $\angle 7$ . So, if the measure of  $\angle 1 = 123^\circ$ , then the measure of  $\angle 7 = 123^\circ$ .
6. Using corresponding angles,  $\angle 2$  is congruent to  $\angle 6$ , which is supplementary to  $\angle 5$ .  
$$\angle 2 + \angle 5 = 180^\circ$$
$$58^\circ + \angle 5 = 180^\circ$$
$$\angle 5 = 122^\circ$$
So, if the measure of  $\angle 2 = 58^\circ$ , then the measure of  $\angle 5 = 122^\circ$ .
7. Because  $\angle 5$  and  $\angle 3$  are alternate interior angles,  $\angle 5$  is congruent to  $\angle 3$ . So, if the measure of  $\angle 5 = 119^\circ$ , then the measure of  $\angle 3 = 119^\circ$ .
8. Because  $\angle 4$  and  $\angle 6$  are alternate exterior angles,  $\angle 4$  is congruent to  $\angle 6$ . So, if the measure of  $\angle 4 = 60^\circ$ , then the measure of  $\angle 6 = 60^\circ$ .

9.  $x + 60 + 60 = 180$   
 $x + 120 = 180$   
 $x = 60$

So, the measures of the interior angles are  $60^\circ$ ,  $60^\circ$ , and  $60^\circ$ .

10.  $x + 25 + 40 = 180$   
 $x + 65 = 180$   
 $x = 115$

So, the measures of the interior angles are  $25^\circ$ ,  $40^\circ$ , and  $115^\circ$ .

11.  $x + x + 90 = 180$   
 $2x + 90 = 180$   
 $2x = 90$   
 $x = 45$

So, the measures of the interior angles are  $45^\circ$ ,  $45^\circ$ , and  $90^\circ$ .

12.  $55 + 50 = b$   
 $105 = b$

So, the measure of the exterior angle is  $105^\circ$ .

13.  $(z + 10) + 4z = z + 50$   
 $5z + 10 = z + 50$   
 $4z + 10 = 50$   
 $4z = 40$   
 $z = 10$

So, the measure of the exterior angle is  $(10 + 50)^\circ = 60^\circ$ .

14. Using corresponding angles, the  $72^\circ$  angle is congruent to the angle that is supplementary to both  $\angle 1$  and  $\angle 2$ .  
$$\angle 1 + 72^\circ = 180^\circ$$
$$\angle 1 = 108^\circ$$

So, the measures of  $\angle 1$  and  $\angle 2$  are  $108^\circ$ .

15.  $x + 5x + 90 = 180$   
 $6x + 90 = 180$   
 $6x = 90$   
 $x = 15$

Exterior angle with wall:  $180^\circ - 15^\circ = 165^\circ$

Exterior angle with ground:  $180^\circ - 5(15)^\circ = 105^\circ$

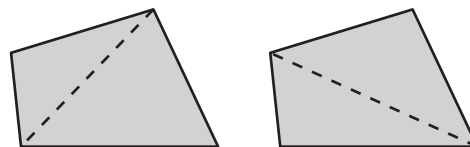
## Section 3.3

### 3.3 Activity (pp. 118–119)

1. a. Quadrilateral:  $n = 4$

Yes, there is more than one way to divide the figure into two triangles.

Sample answer:

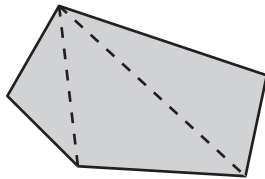


Draw one line that divides the quadrilateral into two triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the angle measures of the quadrilateral is  $2(180^\circ) = 360^\circ$ .

# Chapter 3

b. Pentagon:  $n = 5$

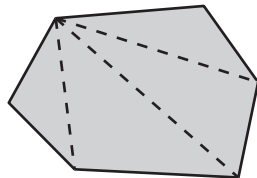
Sample answer:



Draw two lines that divide the pentagon into three triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the pentagon is  $3(180^\circ) = 540^\circ$ .

c. Hexagon:  $n = 6$

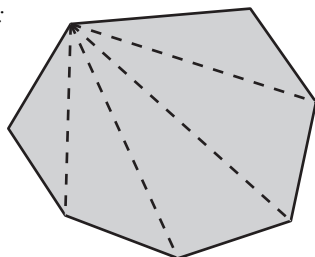
Sample answer:



Draw three lines that divide the hexagon into four triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the hexagon is  $4(180^\circ) = 720^\circ$ .

d. Heptagon:  $n = 7$

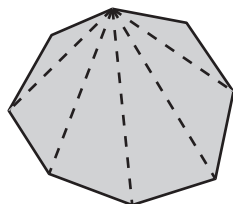
Sample answer:



Draw four lines that divide the heptagon into five triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the heptagon is  $5(180^\circ) = 900^\circ$ .

e. Octagon:  $n = 8$

Sample answer:



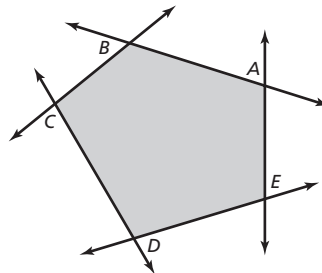
Draw five lines that divide the octagon into six triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the octagon is  $6(180^\circ) = 1080^\circ$ .

f.

Number of Sides, $n$	3	4	5	6	7	8
Number of Triangles	1	2	3	4	5	6
Angle Sum, $S$	$180^\circ$	$360^\circ$	$540^\circ$	$720^\circ$	$900^\circ$	$1080^\circ$

The sum of the interior angle measures of a polygon with 12 sides is  $10(180^\circ) = 1800^\circ$ .

2. a.



b. Students arrange the angles to be adjacent and joined at the vertices. The sum of the angles is  $360^\circ$ .

c. *Answer should include, but is not limited to:* Students repeat the procedure in parts (a) and (b) for the quadrilateral and the hexagon.

The sum of the measures of the exterior angles of a convex polygon is  $360^\circ$ . The sum does not depend on the number of sides of the polygon.

3.  $(n - 2) \cdot 180^\circ$

4. To find the sum of the interior angle measures of a polygon with  $n$  sides, use the expression  $(n - 2) \cdot 180^\circ$ .

The sum of the exterior angle measures of a convex polygon is  $360^\circ$ .

### 3.3 On Your Own (pp. 120–122)

1. The spider web is in the shape of a heptagon. It has 7 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (7 - 2) \cdot 180^\circ \\ &= 5 \cdot 180^\circ \\ &= 900^\circ \end{aligned}$$

The sum of the interior angle measures is  $900^\circ$ .

2. The honeycomb is in the shape of a hexagon. It has 6 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (6 - 2) \cdot 180^\circ \\ &= 4 \cdot 180^\circ \\ &= 720^\circ \end{aligned}$$

The sum of the interior angle measures is  $720^\circ$ .



# Chapter 3

3. The polygon has 6 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (6 - 2) \cdot 180^\circ \\ &= 4 \cdot 180^\circ \\ &= 720^\circ \end{aligned}$$

The sum of the interior angle measures is  $720^\circ$ .

$$\begin{aligned} 125 + 120 + 125 + 110 + 135 + x &= 720 \\ 615 + x &= 720 \\ x &= 105 \end{aligned}$$

The value of  $x$  is 105.

4. The polygon has 4 sides.

$$\begin{aligned} S &= (n \cdot 2) \cdot 180^\circ \\ &= (4 - 2) \cdot 180^\circ \\ &= 2 \cdot 180^\circ \\ &= 360^\circ \end{aligned}$$

The sum of the interior angle measures is  $360^\circ$ .

$$\begin{aligned} 115 + 80 + 90 + x &= 360 \\ 285 + x &= 360 \\ x &= 75 \end{aligned}$$

The value of  $x$  is 75.

5. The polygon has 5 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (5 - 2) \cdot 180^\circ \\ &= 3 \cdot 180^\circ \\ &= 540^\circ \end{aligned}$$

The sum of the interior angle measures is  $540^\circ$ .

$$\begin{aligned} 2x + 145 + 145 + 2x + 110 &= 540 \\ 4x + 400 &= 540 \\ 4x &= 140 \\ x &= 35 \end{aligned}$$

The value of  $x$  is 35.

6. An octagon has 8 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (8 - 2) \cdot 180^\circ \\ &= 6 \cdot 180^\circ \\ &= 1080^\circ \end{aligned}$$

The sum of the interior angle measures is  $1080^\circ$ .

$$1080^\circ \div 8 = 135^\circ$$

The measure of each interior angle is  $135^\circ$ .

7. A decagon has 10 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (10 - 2) \cdot 180^\circ \\ &= 8 \cdot 180^\circ \\ &= 1440^\circ \end{aligned}$$

The sum of the interior angle measures is  $1440^\circ$ .

$$1440^\circ \div 10 = 144^\circ$$

The measure of each interior angle is  $144^\circ$ .

8. An 18-gon has 18 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (18 - 2) \cdot 180^\circ \\ &= 16 \cdot 180^\circ \\ &= 2880^\circ \end{aligned}$$

The sum of the interior angle measures is  $2880^\circ$ .

$$2880^\circ \div 18 = 160^\circ$$

The measure of each interior angle is  $160^\circ$ .

9.  $90 + 90 + x + 90 + x = 360$

$$270 + 2x = 360$$

$$2x = 90$$

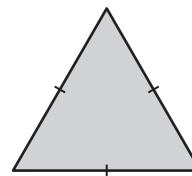
$$x = 45$$

So, the measures of the exterior angles are  $90^\circ$ ,  $90^\circ$ ,  $45^\circ$ ,  $90^\circ$ , and  $45^\circ$ .

## 3.3 Exercises (pp. 123–125)

### Vocabulary and Concept Check

1. A three-sided polygon is a triangle. Because it is a regular polygon, all sides are congruent. So, the polygon is an equilateral triangle.



2. Because the second figure is not made up entirely of line segments and the other three are, the second figure does not belong.

## Chapter 3

3. Because the question “What is the measure of an interior angle of a regular pentagon?” asks for one interior angle measure and the other three ask for the sum of the interior angle measures, it is different.

A regular pentagon has 5 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (5 - 2) \cdot 180^\circ \\ &= 3 \cdot 180^\circ \\ &= 540^\circ \end{aligned}$$

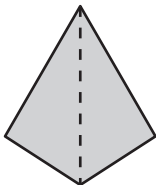
$$540^\circ \div 5 = 108^\circ$$

The measure of an interior angle of a regular pentagon is  $108^\circ$ .

The sum of the interior angle measures of a regular, convex, or concave pentagon is  $540^\circ$ .

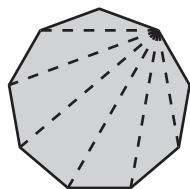
### Practice and Problem Solving

4.



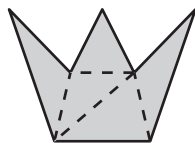
Draw one line that divides the quadrilateral into two triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the quadrilateral is  $2(180^\circ) = 360^\circ$ .

5.



Draw six lines that divide the 9-gon into seven triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the 9-gon is  $7(180^\circ) = 1260^\circ$ .

6.



Draw four lines that divide the heptagon into five triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the heptagon is  $5(180^\circ) = 900^\circ$ .

7. The polygon has 4 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (4 - 2) \cdot 180^\circ \\ &= 2 \cdot 180^\circ \\ &= 360^\circ \end{aligned}$$

The sum of the interior angle measures is  $360^\circ$ .

8. The polygon has 8 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (8 - 2) \cdot 180^\circ \\ &= 6 \cdot 180^\circ \\ &= 1080^\circ \end{aligned}$$

The sum of the interior angle measures is  $1080^\circ$ .

9. The polygon has 9 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (9 - 2) \cdot 180^\circ \\ &= 7 \cdot 180^\circ \\ &= 1260^\circ \end{aligned}$$

The sum of the interior angle measures is  $1260^\circ$ .

10. The formula is incorrect. The correct formula is the product of two less than the number of sides and  $180^\circ$ .

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (13 - 2) \cdot 180^\circ \\ &= 11 \cdot 180^\circ \\ &= 1980^\circ \end{aligned}$$

11. no;  $S = (n - 2) \cdot 180^\circ$

$$\begin{aligned} &= (5 - 2) \cdot 180^\circ \\ &= 3 \cdot 180^\circ \\ &= 540^\circ \end{aligned}$$

Because the sum of the given interior angle measures is  $120^\circ + 105^\circ + 65^\circ + 150^\circ + 95^\circ = 535^\circ$  and not  $540^\circ$ , a pentagon cannot have the given interior angle measures.

12. The polygon has 4 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (4 - 2) \cdot 180^\circ \\ &= 2 \cdot 180^\circ \\ &= 360^\circ \end{aligned}$$

$$155 + 25 + 137 + x = 360$$

$$317 + x = 360$$

$$x = 43$$

The measures of the interior angles are  $155^\circ$ ,  $25^\circ$ ,  $137^\circ$ , and  $43^\circ$ .

## Chapter 3

13. The polygon has 6 sides.

$$\begin{aligned}S &= (n - 2) \cdot 180^\circ \\ &= (6 - 2) \cdot 180^\circ \\ &= 4 \cdot 180^\circ \\ &= 720^\circ \\ 90 + 90 + x + x + x + x &= 720 \\ 180 + 4x &= 720 \\ 4x &= 540 \\ x &= 135\end{aligned}$$

The measures of the interior angles are  $90^\circ$ ,  $90^\circ$ ,  $135^\circ$ ,  $135^\circ$ ,  $135^\circ$ , and  $135^\circ$ .

14. The polygon has 6 sides.

$$\begin{aligned}S &= (n - 2) \cdot 180^\circ \\ &= (6 - 2) \cdot 180^\circ \\ &= 4 \cdot 180^\circ \\ &= 720^\circ \\ 3x + 45 + 135 + x + 135 + 45 &= 720 \\ 4x + 360 &= 720 \\ 4x &= 360 \\ x &= 90\end{aligned}$$

The measures of the interior angles are  $3(90^\circ) = 270^\circ$ ,  $45^\circ$ ,  $135^\circ$ ,  $90^\circ$ ,  $135^\circ$ , and  $45^\circ$ .

15. Find the number of sides.

$$\begin{aligned}S &= (n - 2) \cdot 180^\circ \\ 1260^\circ &= (n - 2) \cdot 180^\circ \\ 7 &= n - 2 \\ 9 &= n\end{aligned}$$

Because the regular polygon has 9 sides, the measure of each interior angle is  $1260^\circ \div 9 = 140^\circ$ .

16. The sum of the interior angle measures of a triangle is  $180^\circ$ .

$$\begin{aligned}180^\circ \div 3 &= 60^\circ \\ \text{The measure of each interior angle is } &60^\circ.\end{aligned}$$

17. The polygon has 9 sides.

$$\begin{aligned}S &= (n - 2) \cdot 180^\circ \\ &= (9 - 2) \cdot 180^\circ \\ &= 7 \cdot 180^\circ \\ &= 1260^\circ \\ 1260^\circ \div 9 &= 140^\circ\end{aligned}$$

The measure of each interior angle is  $140^\circ$ .

18. The polygon has 12 sides.

$$\begin{aligned}S &= (n - 2) \cdot 180^\circ \\ &= (12 - 2) \cdot 180^\circ \\ &= 10 \cdot 180^\circ \\ &= 1800^\circ \\ 1800^\circ \div 12 &= 150^\circ\end{aligned}$$

The measure of each interior angle is  $150^\circ$ .

19. The sum should have been divided by the number of interior angles, which is 20, not 18.

$$3240^\circ \div 20 = 162^\circ$$

The measure of each interior angle is  $162^\circ$ .

20. a. The bolt has 5 sides.

$$\begin{aligned}S &= (n - 2) \cdot 180^\circ \\ &= (5 - 2) \cdot 180^\circ \\ &= 3 \cdot 180^\circ \\ &= 540^\circ \\ 540^\circ \div 5 &= 108^\circ\end{aligned}$$

The measure of each interior angle is  $108^\circ$ .

b. *Sample answer:* Because the standard shape of a bolt is a hexagon, most people have tools to remove a hexagonal bolt and not a pentagonal bolt. So, a special tool is needed to remove the bolt from a fire hydrant.

21. The sum of the interior angles of the regular polygon is  $n \cdot 165$ , where  $n$  is the number of sides.

$$\begin{aligned}S &= (n - 2) \cdot 180 \\ n \cdot 165 &= (n - 2) \cdot 180 \\ 165n &= 180n - 360 \\ -15n &= -360 \\ n &= 24\end{aligned}$$

The polygon has 24 sides.

22.  $140 + 110 + x = 360$

$$\begin{aligned}250 + x &= 360 \\ x &= 110\end{aligned}$$

So, the measures of the exterior angles are  $140^\circ$ ,  $110^\circ$ , and  $110^\circ$ .

23.  $107 + 85 + 93 + w = 360$

$$\begin{aligned}285 + w &= 360 \\ w &= 75\end{aligned}$$

So, the measures of the exterior angles are  $107^\circ$ ,  $85^\circ$ ,  $93^\circ$ , and  $75^\circ$ .

# Chapter 3

24.  $(z + 45) + z + 74 + 78 + 55 = 360$   
 $252 + 2z = 360$   
 $2z = 108$   
 $z = 54$

So, the measures of the exterior angles are  $(54 + 45) = 99^\circ$ ,  $54^\circ$ ,  $74^\circ$ ,  $78^\circ$ , and  $55^\circ$ .

25.  $60^\circ$ ; The sum of the interior angle measures of a hexagon is  $(6 - 2) \cdot 180^\circ = 720^\circ$ . Because it is regular, each angle has the same measure. So, the measure of each interior angle is  $720^\circ \div 6 = 120^\circ$ , and the measure of each exterior angle is  $180^\circ - 120^\circ = 60^\circ$ .

26.  $n + n + 90 + n + n + 90 = 360$   
 $180 + 4n = 360$   
 $4n = 180$   
 $n = 45$

So, the measures of the exterior angles are  $45^\circ$ ,  $45^\circ$ ,  $90^\circ$ ,  $45^\circ$ ,  $45^\circ$ , and  $90^\circ$ .

27. Because the interior angles of the triangle have the same measure, the measure of each interior angle is  $180^\circ \div 3 = 60^\circ$ . Therefore, the measure of each exterior angle is  $180^\circ - 60^\circ = 120^\circ$ . So, the measures of the exterior angles are  $120^\circ$ ,  $120^\circ$ , and  $120^\circ$ .

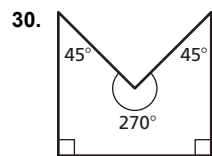
28. The exterior angle for  $55^\circ$  is  $180^\circ - 55^\circ = 125^\circ$ . The exterior angle for  $125^\circ$  is  $180^\circ - 125^\circ = 55^\circ$ . Two sides of the quadrilateral are parallel and the other sides act as transversals. Using alternate interior angles, the other exterior angles are  $55^\circ$  and  $125^\circ$ . So, the measures of the exterior angles are  $125^\circ$ ,  $55^\circ$ ,  $125^\circ$ , and  $55^\circ$ .

29.  $S = (n - 2) \cdot 180^\circ$   
 $= (8 - 2) \cdot 180^\circ$   
 $= 6 \cdot 180^\circ$   
 $= 1080^\circ$

The measure of each interior angle of the polygon is  $1080^\circ \div 8 = 135^\circ$ .

$8x = 360$   
 $x = 45$

The measure of each of exterior angle is  $45^\circ$ .



31. Find the sum of the interior angle measures of the heptagon.

$S = (n - 2) \cdot 180^\circ$   
 $= (7 - 2) \cdot 180^\circ$   
 $= 5 \cdot 180^\circ$   
 $= 900^\circ$

Let  $x$  represent the value of each of the three remaining interior angle measures, in degrees.

$4 \cdot 135 + 3 \cdot x = 900$   
 $540 + 3x = 900$   
 $3x = 360$   
 $x = 120$

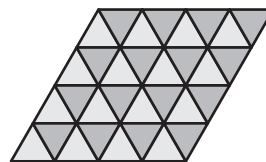
The measure of each remaining interior angle is  $120^\circ$ .

32. a. The polygon has 11 sides.

b.  $S = (n - 2) \cdot 180^\circ$   
 $= (11 - 2) \cdot 180^\circ$   
 $= 9 \cdot 180^\circ$   
 $= 1620^\circ$   
 $1620^\circ \div 11 \approx 147^\circ$

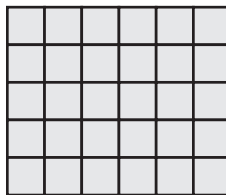
The measure of each interior angle is about  $147^\circ$ .

33. a. *Sample answer:*

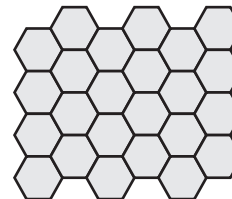


b. *Sample answer:*

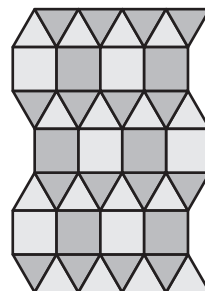
Squares:



Regular hexagons:



c. *Sample answer:* The tessellation is formed using equilateral triangles and squares.



# Chapter 3

- d. *Answer should include, but is not limited to:* a discussion of the interior and exterior angles of the polygons in the tessellation and how they add to  $360^\circ$  where the vertices meet.

## Fair Game Review

34.  $\frac{x}{12} = \frac{3}{4}$

$$x \cdot 4 = 12 \cdot 3$$

$$4x = 36$$

$$x = 9$$

The value of  $x$  is 9.

35.  $\frac{14}{21} = \frac{x}{3}$

$$14 \cdot 3 = 21 \cdot x$$

$$42 = 21x$$

$$2 = x$$

The value of  $x$  is 2.

36.  $\frac{9}{x} = \frac{6}{2}$

$$9 \cdot 2 = x \cdot 6$$

$$18 = 6x$$

$$3 = x$$

The value of  $x$  is 3.

37.  $\frac{10}{4} = \frac{15}{x}$

$$10 \cdot x = 4 \cdot 15$$

$$10x = 60$$

$$x = 6$$

The value of  $x$  is 6.

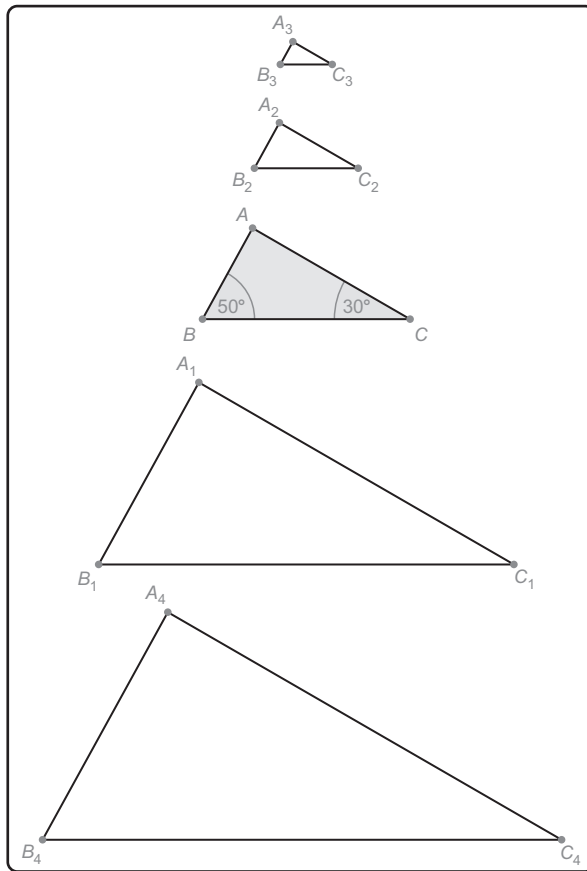
38. D; Because the ratio of tulips to daisies is  $3 : 5$ , the total number is a multiple of  $3 + 5 = 8$ . The multiples of 8 are 8, 16, 24, 32, ... . So, 16 is the only choice that could be the total number of tulips and daisies.

## Section 3.4

### 3.4 Activity (pp. 126–127)

1. a. *Sample answer:* Draw a line segment that is 8 centimeters long. Then use the line segment and a protractor to draw a triangle that has a  $60^\circ$  and a  $40^\circ$  angle. Label the triangle  $JKL$ .
- b. *Sample answer:* Draw a line segment that is 2 centimeters long. Then use the line segment and a protractor to draw a triangle that has a  $60^\circ$  and a  $40^\circ$  angle. Label the triangle  $PQR$ .
- c. yes; *Sample answer:* The corresponding angles of the triangles are congruent and the corresponding side lengths are proportional.

2. a.



- b. The third angle measure is  $100^\circ$  in each triangle.
  - c. Because two angles in the first triangle are congruent to two angles in the second triangle, the sum of the measures of the two angles in each triangle is the same. Therefore, when you subtract this sum from  $180^\circ$ , you get the measure of the third angle in each triangle. So, the triangles are similar.
3. a. Because the Sun's rays are parallel,  $\angle B$  and  $\angle E$  are corresponding angles and are therefore congruent:  $\angle B \cong \angle E$ . Because  $\angle A$  and  $\angle D$  are both right angles,  $\angle A \cong \angle D$ . Because two angles of  $\triangle ABC$  are congruent to two angles of  $\triangle DEF$ ,  $\angle C \cong \angle F$ . Therefore,  $\triangle ABC$  and  $\triangle DEF$  are similar triangles.
- b. Because  $\triangle ABC$  and  $\triangle DEF$  are similar triangles, the ratios of the corresponding side lengths are equal. So, write and solve a proportion to find the height of the flagpole.

$$\frac{\text{Height of flagpole}}{\text{Height of boy}} = \frac{\text{Length of flagpole's shadow}}{\text{Length of boy's shadow}}$$

$$\frac{x}{5} = \frac{36}{3}$$

$$3x = 180$$

$$x = 60$$

The height of the flagpole is 60 feet.

# Chapter 3

4. When two angles in one triangle are congruent to two angles in another triangle, you can conclude that the third angles are also congruent. So, the triangles are similar.
5. a. Because the flagpole is not being measured directly, the process is called “indirect” measurement.
- b–c. *Answer should include, but is not limited to:* The student will use indirect measurement to measure the height of something outside. The student will include a diagram of the process used with all measurements and calculated lengths labeled.
6. *Sample answer:* In the figure, you know that the streetlight forms a right angle with the ground and the person forms a right angle with the ground. Each triangle shares the same angle formed by the ground and the top of the streetlight. Because two angles in one triangle are congruent to two angles in another triangle, the third angles are also congruent. So, the triangles are similar.

## 3.4 On Your Own (p. 129)

1. no;  $x + 28 + 80 = 180$   
 $x + 108 = 180$   
 $x = 72$

The triangles do not have two pairs of congruent angles. So, the triangles are not similar.

2. yes;  $66 + 90 + x = 180$   
 $156 + x = 180$   
 $x = 24$

The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

3.  $\frac{x}{55} = \frac{40}{50}$   
 $55 \cdot \frac{x}{55} = 55 \cdot \frac{40}{50}$   
 $x = 44$

The distance across the river is 44 feet.

## 3.4 Exercises (pp. 130–131)

### Vocabulary and Concept Check

1. Because the ratios of the corresponding side lengths in similar triangles are equal, a proportion can be used to find a missing measurement.
2. The angle measures of  $\triangle ABC$ ,  $\triangle DEF$ , and  $\triangle GHI$  are  $35^\circ$ ,  $82^\circ$ , and  $63^\circ$ , so they are similar triangles. The angle measures of  $\triangle JKL$  are  $32^\circ$ ,  $85^\circ$ , and  $63^\circ$ . So,  $\triangle JKL$  does not belong with the other three.
3. *Sample answer:* The two angles in each triangle have the same sum. When you subtract this sum from  $180^\circ$ , you get the same third angle.

## Practice and Problem Solving

- 4–5. *Answer should include, but is not limited to:*

Students should draw a triangle with the same angle measures as the triangle in the textbook. The ratios of the corresponding side lengths should be equal. (Ratios may differ slightly due to rounding.)

6. yes; The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

7. no;  $x + 36 + 72 = 180$   
 $x + 108 = 180$   
 $x = 72$

The triangles do not have two pairs of congruent angles. So, the triangles are not similar.

8. no;  $x + 64 + 85 = 180$   
 $x + 149 = 180$   
 $x = 31$

The triangles do not have two pairs of congruent angles. So, the triangles are not similar.

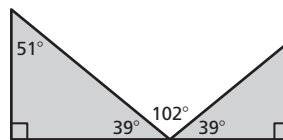
9. yes;  $x + 48 + 81 = 180$   
 $x + 129 = 180$   
 $x = 51$

The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

10.  $x + x + 90 = 180$   
 $2x + 90 = 180$   
 $2x = 90$   
 $x = 45$

The leftmost and rightmost rulers have two pairs of congruent angles. So, the third angles are congruent, and the rulers are similar in shape.

11. yes; The measure of the exterior angle is  $51^\circ + 90^\circ = 141^\circ$ .  
 $141^\circ - 102^\circ = 39^\circ$   
 $180^\circ - 102^\circ - 39^\circ = 39^\circ$



The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

# Chapter 3

12. Using vertical angles, the triangle on the left has an angle measure of  $29^\circ$ .

Using supplementary angles, the triangle on the right has an angle measure of  $180^\circ - 91^\circ = 89^\circ$ .

The triangles do not have two pairs of congruent angles. So, the triangles are not similar.

13. Using vertical angles, the triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

Find the missing dimension using indirect measurement.

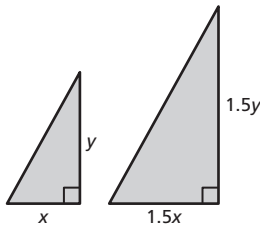
$$\frac{x}{300} = \frac{80}{240}$$

$$240x = 24,000$$

$$x = 100$$

You take 100 steps from the pyramids to the treasure.

14. no; Consider the two similar triangles below.



$$A = \frac{1}{2}bh \qquad A = \frac{1}{2}bh$$

$$= \frac{1}{2}xy \qquad = \frac{1}{2}(1.5x)(1.5y)$$

$$= (2.25)\frac{1}{2}xy$$

So, the area of the larger triangle is 2.25 times the area of the smaller triangle, which is a 125% increase.

15. Find the missing dimension using indirect measurement.

$$\frac{\text{Height of person}}{\text{Length of person's shadow}} = \frac{\text{Height of tree}}{\text{Length of tree's shadow}}$$

$$\frac{6}{3} = \frac{h}{15}$$

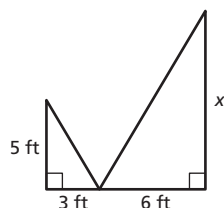
$$90 = 3h$$

$$30 = h$$

The height of the pine tree is 30 feet.

16. *Sample answer:* 10 ft

Assume that you are 5 feet tall.



17. maybe; They are similar when both have measures of  $30^\circ$ ,  $60^\circ$ ,  $90^\circ$  or both have measures of  $45^\circ$ ,  $45^\circ$ ,  $90^\circ$ . They are not similar when one has measures of  $30^\circ$ ,  $60^\circ$ ,  $90^\circ$  and the other has measures of  $45^\circ$ ,  $45^\circ$ ,  $90^\circ$ .

18.  $\triangle ABG \sim \triangle ACF$ ;  $\triangle ABG \sim \triangle ADE$ ;  $\triangle ACF \sim \triangle ADE$ ;  
Because  $AB$ ,  $BC$ , and  $CD$  are all equal, and the length of segment  $BD$  is 6.32 feet, the length of segment  $AB$  is  $6.32 \div 2 = 3.16$  feet and the length of segment  $AD$  is  $6.32 + 3.16 = 9.48$  feet.

Let  $x = BG$ .

$$\frac{AB}{AD} = \frac{BG}{DE}$$

$$\frac{3.16}{9.48} = \frac{x}{6}$$

$$18.96 = 9.48x$$

$$2 = x$$

So, the length of segment  $BG$  is 2 feet.

The length of segment  $AC$  is  $3.16 \cdot 2 = 6.32$  feet. Let  $y = CF$ .

$$\frac{CF}{AC} = \frac{DE}{AD}$$

$$\frac{y}{6.32} = \frac{6}{9.48}$$

$$9.48y = 37.92$$

$$y = 4$$

So, the length of segment  $CF$  is 4 feet.

## Fair Game Review

19.  $y - 5x = 3$

$$y - 5x + 5x = 3 + 5x$$

$$y = 3 + 5x$$

20.  $4x + 6y = 12$

$$4x - 4x + 6y = 12 - 4x$$

$$6y = 12 - 4x$$

$$\frac{6y}{6} = \frac{12 - 4x}{6}$$

$$y = 2 - \frac{2}{3}x$$

21.  $2x - \frac{1}{4}y = 1$

$$2x - 2x - \frac{1}{4}y = 1 - 2x$$

$$-\frac{1}{4}y = 1 - 2x$$

$$-4 \cdot \left(-\frac{1}{4}y\right) = -4(1 - 2x)$$

$$y = -4 + 8x$$

## Chapter 3

22. B;  $40 + (x + 16) + x = 180$

$$2x + 56 = 180$$

$$2x = 124$$

$$x = 62$$

### Quiz 3.3–3.4

1. The polygon has 10 sides.

$$S = (n - 2) \cdot 180^\circ$$

$$= (10 - 2) \cdot 180^\circ$$

$$= 8 \cdot 180^\circ$$

$$= 1440^\circ$$

The sum of the interior angle measures is  $1440^\circ$ .

2. The polygon has 13 sides.

$$S = (n - 2) \cdot 180^\circ$$

$$= (13 - 2) \cdot 180^\circ$$

$$= 11 \cdot 180^\circ$$

$$= 1980^\circ$$

The sum of the interior angle measures is  $1980^\circ$ .

3. The polygon has 4 sides.

$$S = (n - 2) \cdot 180^\circ$$

$$= (4 - 2) \cdot 180^\circ$$

$$= 2 \cdot 180^\circ$$

$$= 360^\circ$$

$$x + 122 + 134 + 46 = 360$$

$$x + 302 = 360$$

$$x = 58$$

The measures of the interior angles are  $58^\circ$ ,  $122^\circ$ ,  $134^\circ$ , and  $46^\circ$ .

4. The polygon has 7 sides.

$$S = (n - 2) \cdot 180^\circ$$

$$= (7 - 2) \cdot 180^\circ$$

$$= 5 \cdot 180^\circ$$

$$= 900^\circ$$

$$x + 130 + 140 + 120 + 115 + 154 + 115 = 900$$

$$x + 774 = 900$$

$$x = 126$$

The measures of the interior angles are  $126^\circ$ ,  $130^\circ$ ,  $140^\circ$ ,  $120^\circ$ ,  $115^\circ$ ,  $154^\circ$ , and  $115^\circ$ .

5. The polygon has 5 sides.

$$S = (n - 2) \cdot 180^\circ$$

$$= (5 - 2) \cdot 180^\circ$$

$$= 3 \cdot 180^\circ$$

$$= 540^\circ$$

$$x + 40 + 4x + 40 + 110 = 540$$

$$5x + 190 = 540$$

$$5x = 350$$

$$x = 70$$

The measures of the interior angles are  $70^\circ$ ,  $40^\circ$ ,

$$4(70)^\circ = 280^\circ, 40^\circ, \text{ and } 110^\circ.$$

6.  $115 + 2r + 100 + (r + 25) = 360$

$$3r + 240 = 360$$

$$3r = 120$$

$$r = 40$$

The measures of the exterior angles are  $115^\circ$ ,

$$2(40)^\circ = 80^\circ, 100^\circ, \text{ and } (40 + 25)^\circ = 65^\circ.$$

7.  $90 + 90 + x + 2x = 360$

$$3x + 180 = 360$$

$$3x = 180$$

$$x = 60$$

The measures of the exterior angles are  $90^\circ$ ,

$$2(60)^\circ = 120^\circ, 90^\circ, \text{ and } 60^\circ.$$

8.  $x + 46 + 95 = 180$

$$x + 141 = 180$$

$$x = 39$$

The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

9.  $x + 40 + 51 = 180$

$$x + 91 = 180$$

$$x = 89$$

The triangles do not have two pairs of congruent angles. So, the triangles are not similar.

10.  $S = (n - 2) \cdot 180^\circ$

$$4140 = (n - 2) \cdot 180^\circ$$

$$23 = n - 2$$

$$25 = n$$

The polygon has 25 sides.



# Chapter 3

11. a. Angles  $W$  and  $Z$  are right angles, so they are congruent. Angles  $WXY$  and  $ZXY$  are vertical angles, so they are congruent. Because two angles in  $\triangle VWX$  are congruent to two angles in  $\triangle YXZ$ , the third angles are also congruent and the triangles are similar.

b. 
$$\frac{60}{30} = \frac{100}{\ell}$$
$$60\ell = 3000$$
$$\ell = 50$$

The distance across the patch of swamp is 50 feet.

## Chapter 3 Review

1. The  $140^\circ$  angle and  $\angle 8$  are alternate exterior angles. They are congruent. So, the measure of  $\angle 8$  is  $140^\circ$ .
2. The  $140^\circ$  angle and  $\angle 5$  are corresponding angles. They are congruent. So, the measure of  $\angle 5$  is  $140^\circ$ .
3. The  $140^\circ$  angle and  $\angle 3$  are supplementary. So, the measure of  $\angle 3$  is  $180^\circ - 140^\circ = 40^\circ$ .  $\angle 3$  and  $\angle 7$  are corresponding angles. They are congruent. So, the measure of  $\angle 7$  is  $40^\circ$ .
4. The  $140^\circ$  angle and  $\angle 2$  are supplementary. So, the measure of  $\angle 2$  is  $180^\circ - 140^\circ = 40^\circ$ .
5.  $x + 49 + 90 = 180$   
 $x + 139 = 180$   
 $x = 41$   
The measures of the interior angles are  $49^\circ$ ,  $41^\circ$ , and  $90^\circ$ .
6.  $x + 35 + 110 = 180$   
 $x + 145 = 180$   
 $x = 35$   
The measures of the interior angles are  $35^\circ$ ,  $110^\circ$ , and  $35^\circ$ .
7.  $50 + 75 = s$   
 $125 = s$   
The measure of the exterior angle is  $125^\circ$ .
8.  $(t + 10) + t + (t + 20) = 180$   
 $3t + 30 = 180$   
 $3t = 150$   
 $t = 50$   
The measure of the exterior angle is  $180^\circ - (50 + 20)^\circ = 110^\circ$ .

9. The polygon has 4 sides.

$$\begin{aligned} S &= (n - 2) \bullet 180^\circ \\ &= (4 - 2) \bullet 180^\circ \\ &= 2 \bullet 180^\circ \\ &= 360^\circ \\ 60 + 128 + 95 + x &= 360 \\ 283 + x &= 360 \\ x &= 77 \end{aligned}$$

So, the measures of the interior angles are  $60^\circ$ ,  $128^\circ$ ,  $95^\circ$ , and  $77^\circ$ .

10. The polygon has 7 sides.

$$\begin{aligned} S &= (n - 2) \bullet 180^\circ \\ &= (7 - 2) \bullet 180^\circ \\ &= 5 \bullet 180^\circ \\ &= 900 \\ 135 + 125 + 135 + 105 + 150 + 140 + x &= 900 \\ 790 + x &= 900 \\ x &= 110 \end{aligned}$$

So, the measures of the interior angles are  $135^\circ$ ,  $125^\circ$ ,  $135^\circ$ ,  $105^\circ$ ,  $150^\circ$ ,  $140^\circ$ , and  $110^\circ$ .

11. The polygon has 6 sides.

$$\begin{aligned} S &= (n - 2) \bullet 180^\circ \\ &= (6 - 2) \bullet 180^\circ \\ &= 4 \bullet 180^\circ \\ &= 720^\circ \\ 100 + 120 + 60 + 2x + 65 + x &= 720 \\ 3x + 345 &= 720 \\ 3x &= 375 \\ x &= 125 \end{aligned}$$

So, the measures of the interior angles are  $100^\circ$ ,  $120^\circ$ ,  $60^\circ$ ,  $2(125)^\circ = 250^\circ$ ,  $65^\circ$ , and  $125^\circ$ .

12.  $135 + 100 + y = 360$

$$\begin{aligned} 235 + y &= 360 \\ y &= 125 \end{aligned}$$

So, the measures of the exterior angles are  $135^\circ$ ,  $100^\circ$ , and  $125^\circ$ .

13.  $6z = 360$

$$z = 60$$

So, the measures of the 6 exterior angles are  $60^\circ$  each.

## Chapter 3

14. yes;  $x + 68 + 90 = 180$   
 $x + 158 = 180$   
 $x = 22$

The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

15. yes;  $x + 30 + 100 = 180$   
 $x + 130 = 180$   
 $x = 50$

The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

### Chapter 3 Test

- $\angle 1$  and the  $47^\circ$  angle are supplementary. So, the measure of  $\angle 1$  is  $180^\circ - 47^\circ = 133^\circ$ .
- $\angle 1$  and the  $47^\circ$  angle are supplementary. So, the measure of  $\angle 1$  is  $180^\circ - 47^\circ = 133^\circ$ .  $\angle 1$  and  $\angle 8$  are alternate exterior angles. They are congruent. So, the measure of  $\angle 8$  is  $133^\circ$ .
- $\angle 4$  and the  $47^\circ$  angle are supplementary. So, the measure of  $\angle 4$  is  $180^\circ - 47^\circ = 133^\circ$ .
- $\angle 1$  and the  $47^\circ$  angle are supplementary. So, the measure of  $\angle 1$  is  $180^\circ - 47^\circ = 133^\circ$ .  $\angle 1$  and  $\angle 5$  are corresponding angles. They are congruent. So, the measure of  $\angle 5$  is  $133^\circ$ .
- $x + 23 + 129 = 180$   
 $x + 152 = 180$   
 $x = 28$   
So, the measures of the interior angles are  $23^\circ$ ,  $28^\circ$ , and  $129^\circ$ .
- $x + 44 + 68 = 180$   
 $x + 112 = 180$   
 $x = 68$   
So, the measures of the interior angles are  $68^\circ$ ,  $68^\circ$ , and  $44^\circ$ .
- $x + x + x = 180$   
 $3x = 180$   
 $x = 60$   
So, the measures of the interior angles are  $60^\circ$ ,  $60^\circ$ , and  $60^\circ$ .
- $j = 90 + 40$   
 $j = 130$   
So, the measure of the exterior angle is  $130^\circ$ .

9.  $(2p + 15) = p + (p + 15)$   
 $2p + 15 = 2p + 15$

The exterior angle can have any measure greater than  $15^\circ$  and less than  $180^\circ$ .

10. The polygon has 5 sides.

$$\begin{aligned} S &= (n - 2) \cdot 180^\circ \\ &= (5 - 2) \cdot 180^\circ \\ &= 3 \cdot 180^\circ \\ &= 540^\circ \end{aligned}$$

$$125 + 90 + 125 + 2x + 2x = 540$$

$$4x + 340 = 540$$

$$4x = 200$$

$$x = 50$$

So, the measures of the interior angles are  $125^\circ$ ,  $90^\circ$ ,  $125^\circ$ ,  $2(50)^\circ = 100^\circ$ , and  $2(50)^\circ = 100^\circ$ .

11.  $y + 111 + (y + 17) + 90 = 360$

$$2y + 218 = 360$$

$$2y = 142$$

$$y = 71$$

So, the measures of the exterior angles are  $71^\circ$ ,  $111^\circ$ ,  $90^\circ$ , and  $(71 + 17)^\circ = 88^\circ$ .

12. no;  $x + 61 + 70 = 180$

$$x + 131 = 180$$

$$x = 49$$

The triangles do not have two pairs of congruent angles. So, the triangles are not similar.

13. yes;  $x + 35 + 90 = 180$

$$x + 125 = 180$$

$$x = 55$$

The triangles have two pairs of congruent angles. So, the third angles are congruent, and the triangles are similar.

14. *Sample answer:*

- The  $65^\circ$  angle and  $\angle 3$  are supplementary, so  $\angle 3$  is  $180^\circ - 65^\circ = 115^\circ$ ;  $\angle 3$  and  $\angle 5$  are alternate interior angles. They are congruent. So, the measure of  $\angle 5$  is  $115^\circ$ .
- The  $65^\circ$  angle and  $\angle 8$  are alternate exterior angles. They are congruent. So, the measures of  $\angle 8$  is  $65^\circ$ .  $\angle 5$  and  $\angle 8$  are supplementary, so  $\angle 5$  is  $180^\circ - 65^\circ = 115^\circ$ .

## Chapter 3

15. The triangles are similar, so the ratios of the corresponding side lengths are equal.

$$\frac{d}{105} = \frac{80}{140}$$

$$140d = 8400$$

$$d = 60$$

The distance across the pond is 60 meters.

### Chapter 3 Standards Assessment

1. 147; Find the sum of the interior angle measures.

$$S = (n - 2) \cdot 180^\circ = (11 - 2) \cdot 180^\circ = 1620^\circ$$

Divide the sum by the number of interior angles, 11.

$$1620^\circ \div 11 \approx 147^\circ$$

The measure of each interior angle is about  $147^\circ$ .

2. B;  $C = 11 + 1.6t$

$$C - 11 = 1.6t$$

$$\frac{C - 11}{1.6} = t$$

3. I;  $5(x - 4) = 3x$

$$5(x) - 5(4) = 3x$$

$$5x - 20 = 3x$$

$$\begin{array}{r} + 20 \\ + 20 \end{array}$$

$$5x = 3x + 20$$

$$\begin{array}{r} - 3x \\ - 3x \end{array}$$

$$2x = 20$$

$$\frac{2x}{2} = \frac{20}{2}$$

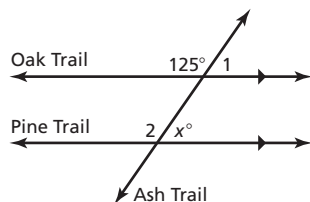
$$x = 10$$

4. C;  $\frac{12 \text{ cm}}{16 \text{ cm}} = \frac{x \text{ cm}}{18 \text{ cm}}$

$$16x = 216$$

$$x = 13.5$$

5. 55;



The  $125^\circ$  and  $\angle 1$  are supplementary. So, the measure of  $\angle 1$  is  $180^\circ - 125^\circ = 55^\circ$ .  $\angle 1$  and the  $x^\circ$  angle are corresponding angles. They are congruent. So, the value of  $x$  is 55.

6. F;  $-\frac{2}{5}(10x - 15) = -30$

$$\left(-\frac{5}{2}\right) \cdot -\frac{2}{5}(10x - 15) = -30 \left(-\frac{5}{2}\right)$$

$$10x - 15 = 75$$

$$10x = 90$$

$$x = 9$$

7. B;

Reflection in the  $y$ -axis:  $(x, y) \rightarrow (-x, y)$

$$X(-6, -1) \rightarrow X'(6, -1)$$

$$Y(-3, -5) \rightarrow Y'(3, -5)$$

$$Z(-2, -3) \rightarrow Z'(2, -3)$$

8. Part A:

$$S = (n - 2) \cdot 180^\circ$$

Part B:

A quadrilateral has 4 sides.

$$S = (n - 2) \cdot 180^\circ$$

$$= (4 - 2) \cdot 180^\circ$$

$$= 2 \cdot 180^\circ$$

$$= 360^\circ$$

$$x + 100 + 90 + 90 = 360$$

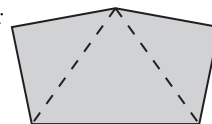
$$x + 280 = 360$$

$$x = 80$$

The measure of the fourth angle is  $80^\circ$ .

Part C:

Sample answer:



Divide the pentagon into 3 triangles. Because the sum of the interior angle measures of each triangle is  $180^\circ$ , the sum of the interior angle measures of the pentagon is  $3 \cdot 180^\circ = 540^\circ$ .

