In Exercises 1–4, use the diagram shown.

1. Identify the center of polygon ABCDE.  
2. Identify the radius of the polygon.  
3. Identify a central angle of the polygon.  
4. Identify a segment whose length is the apothem.

5. In a regular polygon, how do you find the measure of each central angle? Divide 360° by the number of sides.

6. What is the area of an equilateral triangle with 3 inch sides? \( \frac{9\sqrt{3}}{4} \approx 3.9 \text{ in.}^2 \)

STOP SIGN The stop sign shown is a regular octagon. Its perimeter is about 80 inches and its height is about 24 inches.

7. What is the measure of each central angle? 45°

8. Find the apothem, radius, and area of the stop sign. about 12 in., about 13 in., about 480 in.²

### Practice and Applications

**Finding Area** Find the area of the triangle.

9. \( \frac{25\sqrt{3}}{4} \approx 10.8 \text{ sq. units} \)  
10. \( \frac{121\sqrt{3}}{4} \approx 52.4 \text{ sq. units} \)  
11. \( \frac{245\sqrt{3}}{4} \approx 106.1 \text{ sq. units} \)

**Measures of Central Angles** Find the measure of a central angle of a regular polygon with the given number of sides.

12. 9 sides 40°  
13. 12 sides 30°  
14. 15 sides 24°  
15. 180 sides 2°

**Finding Area** Find the area of the inscribed regular polygon shown.

16. 128 sq. units  
17. \( 108\sqrt{3} \approx 187.2 \text{ sq. units} \)  
18. \( 600\sqrt{3} \approx 1039.2 \text{ sq. units} \)

**Perimeter and Area** Find the perimeter and area of the regular polygon.

19. \( 30\sqrt{3} \approx 52.0 \text{ units} \)  
20. \( 16\sqrt{2} \text{ units; } 32 \text{ sq. units} \)  
21. 150 tan 36° \( \approx 109.0 \text{ units} \)  
   1125 tan 36° \( \approx 817.36 \text{ sq. units} \)
PERIMETER AND AREA  In Exercises 22–24, find the perimeter and area of the regular polygon.

22. \[
\begin{array}{c}
\text{Area} = A \approx 673.179 \text{ in.} \\
\text{Perimeter} = P \approx 129.9 \text{ in.}
\end{array}
\]

23. \[
\begin{array}{c}
\text{Area} = A \approx 5 \tan 54° \\
\text{Perimeter} = P \approx 234 \text{ sq. units}
\end{array}
\]

24. \[
\begin{array}{c}
\text{Area} = A = 166.3 \text{ in.} \\
\text{Perimeter} = P = 32 \tan 67.5° \approx 77.3 \text{ units}
\end{array}
\]

25. \[
\begin{array}{c}
\text{Area} = A \approx 60 \tan 75° \approx 96 \sin 15° \cdot \cos 15° \approx 972 \text{ sq. units} \\
\text{Perimeter} = P = 6 \cdot 4 \tan 67.5° \approx 342.24 \text{ sq. units}
\end{array}
\]

26. \[
\begin{array}{c}
\text{Area} = A \approx 6 \cdot \frac{1}{2} aP \approx 6 \cdot \left( \frac{1}{2} \cdot \frac{3}{2} \right) \cdot 6s \approx \frac{3}{4} \cdot \frac{3}{2} s^2 \approx 3s^2 \cdot \frac{3}{2}.
\end{array}
\]

The two results are the same.

27. True; let θ be the measure of a central angle, n the number of sides, r the radius, and P the perimeter. As n grows bigger, θ will become smaller, so the apothem, which is given by \(r \cos \frac{\theta}{n}\), will get larger. The perimeter of the polygon, which is given by \(n \cdot 2r \sin \frac{\theta}{n}\), will grow larger, too. Although the factor involving the sine will get smaller, the increase in n more than makes up for it. Consequently, the area, which is given by \(\frac{1}{2} aP\), will increase.

28. True; the apothem is a leg length in a right \(\triangle\) of which the radius is the length of the hypotenuse.

29. False; for example, the radius of a regular hexagon is equal to the side length.

30. Area is \(16\sqrt{3}\). 31. Area is \(4 \tan 67.5°\). 32. Area is \(\tan 54°\).

33. USING THE AREA FORMULAS  Show that the area of a regular hexagon is six times the area of an equilateral triangle with the same side length.

\[
A = \frac{1}{2} aP = \frac{1}{2} \left( \frac{3}{2} \cdot 6 \cdot s \right) = 96 \cdot \frac{1}{2} \cdot \frac{3}{2} \cdot s \approx 166.3 \text{ in.}^2
\]

34. BASALTIC COLUMNS  Suppose the top of one of the columns along the Giant’s Causeway (see p. 659) is in the shape of a regular hexagon with a diameter of 18 inches. What is its apothem? \(4.5\sqrt{3} \approx 7.8\) in.

35–37. CHECK DRAWINGS. Draw \(AB\) with a length of 1 inch. Open the compass to 1 inch and draw a circle with that radius.

36. Using the same compass setting, mark off equal parts along the circle.

37. Connect the six points where the compass marks and circle intersect to draw a regular hexagon.

38. What is the area of the hexagon? \(\frac{3\sqrt{3}}{2} \approx 2.60 \text{ in.}^2\)

39. Writing  Explain how you could use this construction to construct an equilateral triangle. Draw segments connecting 3 of the compass marks, skipping every second mark.
In Exercises 40–44, use a straightedge and a compass to construct a regular pentagon as shown in the diagrams below.

40. Draw a circle with center $Q$. Draw a diameter $AB$. Construct the perpendicular bisector of $AB$ and label its intersection with the circle as point $C$.

41. Construct point $D$, the midpoint of $QB$.

42. Place the compass point at $D$. Open the compass to the length $DC$ and draw an arc from $C$ so it intersects $AB$ at a point, $E$. Draw $CE$.

43. Open the compass to the length $CE$. Starting at $C$, mark off equal parts along the circle.

44. Connect the five points where the compass marks and circle intersect to draw a regular pentagon. What is the area of your pentagon?

In Exercises 45 and 46, use the following information.

The Hobby-Eberly Telescope in Fort Davis, Texas, is the largest optical telescope in North America. The primary mirror for the telescope consists of 91 smaller mirrors forming a hexagon shape. Each of the smaller mirror parts is itself a hexagon with side length 0.5 meter.

45. What is the apothem of one of the smaller mirrors? \( \frac{1}{4}\sqrt{3} \approx 0.43 \text{ m} \)

46. Find the perimeter and area of one of the smaller mirrors. \( 3.0 \text{ m}, \text{about} 0.65 \text{ m}^2 \)

In Exercises 47–49, use the following information.

You are tiling a bathroom floor with tiles that are regular hexagons, as shown. Each tile has 6 inch sides. You want to choose different colors so that no two adjacent tiles are the same color.

47. What is the minimum number of colors that you can use? 3 colors

48. What is the area of each tile? \( 54\sqrt{3} \approx 93.5 \text{ in.}^2 \)

49. The floor that you are tiling is rectangular. Its width is 6 feet and its length is 8 feet. At least how many tiles of each color will you need? about 25 tiles
**Quantitative Comparison** In Exercises 50–52, choose the statement that is true about the given quantities.

- **A** The quantity in column A is greater.
- **B** The quantity in column B is greater.
- **C** The two quantities are equal.
- **D** The relationship cannot be determined from the given information.

<table>
<thead>
<tr>
<th></th>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.</td>
<td>$m \angle APB$</td>
<td>$m \angle MQN$</td>
</tr>
<tr>
<td>51.</td>
<td>Apothem $r$</td>
<td>Apothem $s$</td>
</tr>
<tr>
<td>52.</td>
<td>Perimeter of octagon with center $P$</td>
<td>Perimeter of heptagon with center $Q$</td>
</tr>
</tbody>
</table>

**Challenge**

53. **Using Different Methods** Find the area of $ABCDE$ by using two methods. First, use the formula $A = \frac{1}{2}aP$, or $A = \frac{1}{2}a \cdot ns$. Second, add the areas of the smaller polygons. Check that both methods yield the same area.

\[
\frac{1}{2}aP \approx \frac{1}{2}(3.44)(25) \approx 43; \quad \frac{1}{2}a \cdot ns \approx \frac{1}{2}(3.44)(5)(5) \approx 43;
\]

area of $\triangle ABE$ + area of $EDCB \approx 11.9 + 31.1 \approx 43$

54. $\frac{x}{6} = \frac{11}{12}$
55. $\frac{20}{4} = \frac{15}{x}$
56. $\frac{12}{x + 7} = \frac{13}{x}$
57. $\frac{x + 6}{9} = \frac{x}{11}$

**Mixed Review**

**Solving Proportions** Solve the proportion. (Review 8.1 for 11.3)

54. $x = \frac{11}{12}$
55. $\frac{20}{4} = \frac{15}{3}$
56. $\frac{12}{x + 7} = \frac{13}{x}$
57. $\frac{x + 6}{9} = \frac{x}{11}$

**Using Similar Polygons** In the diagram shown, $\triangle ABC \sim \triangle DEF$. Use the figures to determine whether the statement is true. (Review 8.3 for 11.3)

58. $\frac{AC}{BC} = \frac{DF}{EF}$ true
59. $\frac{DF}{AC} = \frac{EF + DE + DF}{BC + AB + AC}$ true
60. $\angle B \equiv \angle E$ true
61. $\overline{BC} \equiv \overline{EF}$ false

**Finding Segment Lengths** Find the value of $x$. (Review 10.5)

62. $x = \frac{7}{12}$
63. $x = \frac{9}{10}$
64. $x = \frac{8}{14}$

**Additional Test Preparation**

1. **Open Ended** Draw a regular polygon and show how to find its area. Check student’s work.
2. **Writing** Explain why you might use the Pythagorean Theorem when finding the area of a regular polygon.

Sample answer: If you know the radius and side length of the regular polygon, you can use the Pythagorean Theorem with the radius and half the side length to find the apothem.