**Section 13.2: Perimeter and Area**

**Perimeter:** The *perimeter* of a figure composed of line segments is the sum of the measures of the line segments. In other words, perimeter is the distance around. Perimeter is measured in linear units.

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>PERIMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square with sides of length $s$</td>
<td>$4s$</td>
</tr>
<tr>
<td>Rhombus with sides of length $s$</td>
<td>$4s$</td>
</tr>
<tr>
<td>Rectangle with sides of lengths $a$ and $b$</td>
<td>$2a + 2b$</td>
</tr>
<tr>
<td>Parallelogram with sides of lengths $a$ and $b$</td>
<td>$2a + 2b$</td>
</tr>
<tr>
<td>Kite with sides of lengths $a$ and $b$</td>
<td>$2a + 2b$</td>
</tr>
<tr>
<td>Triangle with sides $a$, $b$, and $c$</td>
<td>$a + b + c$</td>
</tr>
</tbody>
</table>

**Example 1:** Find the perimeter of each figure.

**Circumference:** In every circle, the ratio of the circumference to the diameter is a constant, called $\pi$. If $r$ is the radius of the circle or $d$ is the diameter of the circle, then

$$C = 2\pi r = d\pi$$

**Example 2:** Find the circumference of each circle.
**Area:** The area of a plane figure is the measure of the surface covered by the figure. Area is measured in square units.

- **Rectangle:** area of a rectangle with perpendicular sides of length \( \ell \) and width \( w \) is

\[
A = (\text{length}) \cdot (\text{width}) = \ell \cdot w
\]

**Example 3:** Find the area of the following figure.

![Rectangle Diagram](image)

**Example 4:** Find the perimeter and area of the following figure. Assume all angles are right angles.

![Complex Figure Diagram](image)
• **Square**: Since every square is a rectangle, the formula will be the same with length = width.

\[ A = (\text{side})^2 = s^2 \]

• **Triangle**: Given the height \( h \) and the base \( b \), the area of a triangle is found using

\[ A = \frac{1}{2}(\text{base}) \cdot (\text{height}) = \frac{1}{2} b \cdot h \]

Some remarks about triangles:

* Any side can serve as the base. Once you have chosen the base, the perpendicular distance from the opposite vertex to the line containing the base is the height. Therefore, every triangle has three bases and three corresponding heights.

* In an obtuse triangle, the line segment used for the height may lie outside the triangle.

* The sum of the lengths of two sides of a triangle is always greater than the length of the third side.

**Example 5**: Find the area of the following triangle.
• **Parallelogram:** Given the height \( h \) and the base \( b \), the area of the parallelogram is given by

\[
A = (\text{base}) \cdot (\text{height}) = b \cdot h
\]

**Example 6:** Find the area of the following parallelogram.

![Parallelogram Diagram]

• **Trapezoid:** The area of the trapezoid with parallel bases of lengths \( b_1 \) and \( b_2 \) is given by

\[
A = \frac{1}{2} (\text{height}) \cdot (\text{sum of the bases}) = \frac{1}{2} h \cdot (b_1 + b_2)
\]

**Example 7:** Find the area of the following trapezoid.

![Trapezoid Diagram]

• **Circle:** The area of the circle with radius \( r \) is given by

\[
A = \pi r^2
\]

**Example 8:** Find the area of the following circle.

![Circle Diagram]
• **Pythagorean Theorem:** In a right triangle, if the legs have length $a$ and $b$ and the hypotenuse has length $c$, then $a^2 + b^2 = c^2$. Namely, in a right triangle

$$(\text{leg}_1)^2 + (\text{leg}_2)^2 = \text{hypotenuse}^2$$

**Example 9:** Find the perimeter and area of the following figure.

**Example 10:** Find the perimeter and area of the following figure.
Example 11: Find the area and perimeter of the following figures.

Example 12: Find the area and perimeter of the following figure.
- **Hero’s Formula (Heron’s Formula):** Let $a$, $b$, and $c$ be the lengths of the sides of a triangle. Let $s = \frac{a + b + c}{2}$. Then the area of the triangle is given by

$$A = \sqrt{s(s - a)(s - b)(s - c)}$$

**Example 13:** Find the area of the following triangle.

![Triangle with sides 13.7 cm, 15.8 cm, and 19.8 cm]