Basic Geometry Rules

Triangle
Definition: Triangles are closed geometrical figures that have three straight sides. Every triangle will, as a result, have three angles as well.

Figure 1: a triangle
\[ \theta_1 + \theta_2 + \theta_3 = 180 \text{ degrees} \]

The sum of the three angles in a triangle is always equal to 180 degrees (for definition of degree see subsection below on angles)

Special Triangles:

A. The Right Triangle: The right triangle is a triangle that has one 90° angle. Since the sum of the angles in a triangle must be 180°, this implies that the other two angles in a right triangle must add up to 90°. One of these relations is the so called Pythagorean Theorem. For the right triangle shown in figure 2, the relation is:

\[ a^2 + b^2 = c^2 \]

Figure 2: The Right Triangle

B. Isosceles Triangle: In this special type of triangle, two sides are equal to each other. One can prove that the angles opposite to these two equal sides are also equal to each other. Thus, let us say that we have a triangle in which two sides are 5.0 cm in length and the other side is - let's say - 2.0 cm in length, as in the figure below. This means that the two angles indicated with an arrow in the figure are equal.
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Figure 4: Isosceles Triangle, two sides equal.

B. Equilateral Triangle: This is a special type of isosceles triangle in which not just two, but all three sides, and as a result all three angles are equal. Since the sum of the angles in a triangle must be 180°, this means that for an equilateral triangle each angle is 60°.

Figure 3: Equilateral Triangle, all sides equal

Perimeter: The perimeter of a triangle is equal to the sum of the length of its three sides.
Area: The area of a triangle is equal to half its base times its height.
The height of a triangle is each of the perpendicular lines drawn from one vertex to the opposite side (or its extension).

Figure 5: Sample Triangle

Perimeter for Figure 5: \( P = a + b + c \)
where: \( P \) = Perimeter, \( a, b, c \) = (length of) sides

Area for Figure 5: \( A = \frac{1}{2} (h \times b) \)
where: \( A \) = Area, \( b \) = (length of) base, \( h \) = (length of) height
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**Circle**

**Definition:** A circle is a closed geometric figure as shown in the following figure:

![Circle Diagram](image)

\[ r = \text{radius, a constant value} \]

**Figure 7:** A Circle

It is defined such that all the points on the circle are at a constant distance from a *center*. This distance is called the *radius* of the circle, as indicated in the diagram above.

**Circumference:** The *circumference of a circle* depends very simply on the radius of the circle.

\[ C = 2 \times \pi \times r \]

where: \( C \) = Circumference, \( r \) = radius, and \( \pi = 3.1415 \ldots \)

**Area:** The *area of the circle* also depends on the radius of the circle. It is given by:

\[ A = \pi \times r^2 \]

where: \( A \) = Area, \( r \) = radius, and \( \pi = 3.1415 \ldots \)

**Parallelogram**

**Definition:** A parallelogram is a quadrilateral with two pairs of parallel sides.

![Parallelogram Diagram](image)

**Figure 8:** A Parallelogram

The opposite or facing sides of a parallelogram are of equal length and the opposite angles of a parallelogram are of equal measure.

**Perimeter:** The *perimeter of a triangle* equals the sum of the length of its four sides. In Figure 8,

\[ P = a + b + a + b = 2a + 2b \]

where: \( a, b \) = length of sides

**Area:** The *area of a triangle* is equal its base times its height. The *height of a triangle* is each of the perpendicular lines drawn from one vertex to the opposite side (or its extension). In Figure 8,

\[ A = b \times h \]

where: \( A \) = area, \( b \) = base, \( h \) = height
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Trapezoid
Definition: A trapezoid is a 4-sided flat shape with straight sides that has a pair of opposite sides parallel.

Isosceles trapezoid is a trapezoid when the sides that aren’t parallel are equal in length and both angles coming from a parallel side are equal.

Perimeter: The perimeter of a trapezoid equals the sum of the length of all its four sides. In Figure 9,

\[ P = a + b + c + d \]
where: \( a, b, c, d \) = length of sides

Area: The area of a trapezoid is equal half the sum of its base (or parallel sides) times height. In Figure 9,

\[ A = \frac{1}{2} \times (a + b) \times h \]
where: \( a, b \) = bases, \( h \) = height

Rectangle
Definition: A rectangle is a special parallelogram with straight sides where all interior angles are right angles (90°).

The opposite sides of a rectangle are parallel and of equal length. The longer sides are called length and the shorter sides are called width.

Perimeter: The perimeter of a rectangle equals the sum of the length of all its four sides. In Figure 10,

\[ P = l + w + l + w = 2l + 2w \]
where: \( l, w \) = length and width (four sides)

Area: The area of a rectangle equals its length times its width. In Figure 10,

\[ A = l \times w \]
where: \( l \) = length, \( w \) = width
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**Square**

**Definition:** A square is a special rectangular that all its four sides equal.

![Square Diagram]

Figure 11: A Square

**Perimeter:** The *perimeter of a square* equals the sum of the length of all its four sides. In Figure 11, 

\[ P = a + a + a + a = 4a \]

where: \( a \) = side

**Area:** The *area of a square* equals the length of the sides squared. In Figure 11, 

\[ A = a^2 \]

where: \( a \) = side

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**References** - The following work was referenced to during the creation of this handout: The University of Colorado Atlas Project, Analyze Math, Wolfram, Paul Bourke, and Trans4mind.