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Geometry Lesson 1 Introduction to Geometry (Grades 9-12)

Instruction 1-5 Definitions of Figures

Quadrilaterals

Quadrilaterals are closed four-sided figures. The interior angles of a quadrilateral always total 360° . Quadrilaterals classified in two groups: **Trapeziums** and **Trapezoids**.

In a **trapezium**, there is no pair of parallel sides (Figure 1.25). In a trapezoid, at least one pair of opposite sides are parallel (Figure 1.26).

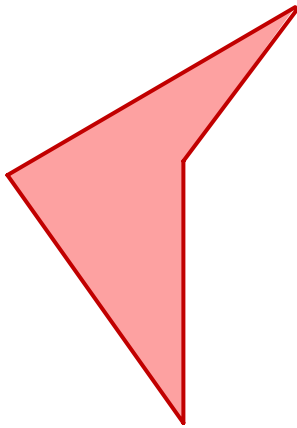


Figure 1.25

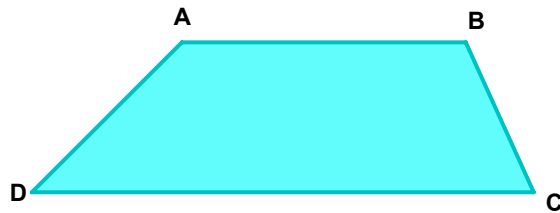


Figure 1.26

Parallelogram

When the opposite sides of a quadrilateral are parallel, the figure is called a **parallelogram**. In a parallelogram, the opposite sides are congruent too (Figure 1.27)

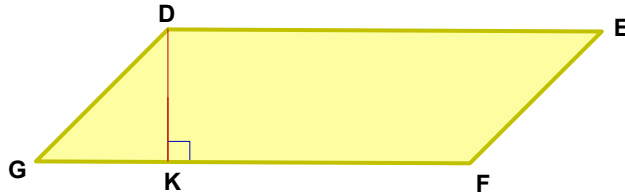


Figure 1.27

Rhombus

If in a parallelogram two adjacent sides are congruent, it is called a **rhombus** (Figure 1.28).

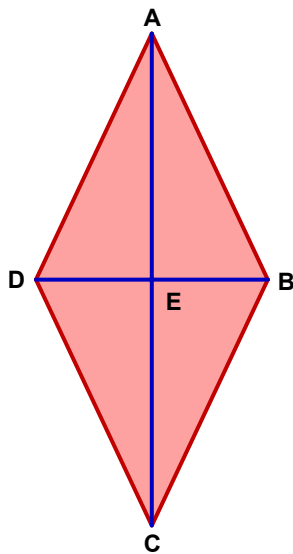


Figure 1.28

Rectangle

If in a parallelogram, one of the interior angles is 90° , it is called a **rectangle**. As a result of having one interior angle equal to 90° , all the interior angles are 90° too (Figure 1.29).

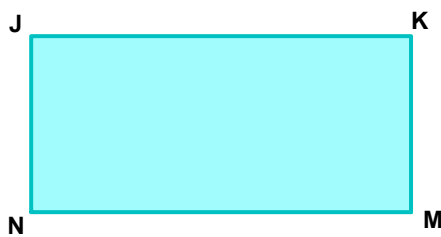


Figure 1.29



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Square

If in a rectangle two adjacent sides are congruent, it is called a **square** (Figure 1.30).

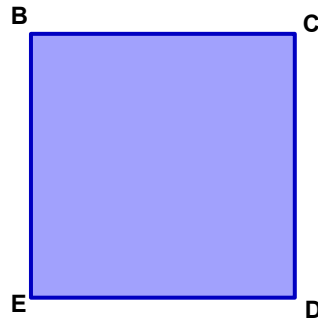


Figure 1.30

Trapezoid

If in a quadrilateral only one pair of the opposite sides are parallel, it is called a **trapezoid**. The parallel sides are called the *bases* and the non-parallel sides are called the **legs** of the trapezoid. In figure 1.31, $ABCD$ is a trapezoid where, $\overline{AB} \parallel \overline{CD}$.

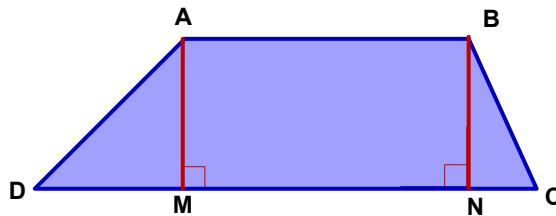


Figure 1.31

If in trapezoid the legs are congruent, it is called an **isosceles trapezoid**. In Figure 1.32, $\overline{AB} \parallel \overline{CD}$ and $\overline{AD} \cong \overline{BC}$ make quadrilateral $ABCD$ an isosceles trapezoid.

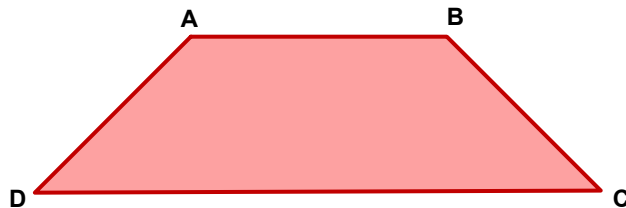


Figure 1.32

Kite

A quadrilateral is called a **kite** if:

1. the opposite sides are not congruent
2. each of the two opposite sides is congruent to one of its adjacent sides.

In Figure 1.33, we are given $\overline{AD} \cong \overline{AB}$, $\overline{CD} \cong \overline{BC}$, and $\overline{AD} \not\cong \overline{BC}$. That is, in $ABCD$, the opposite sides are not congruent, but each of a pair of opposite sides is congruent to one of its adjacent sides. Therefore, $ABCD$ is a kite.

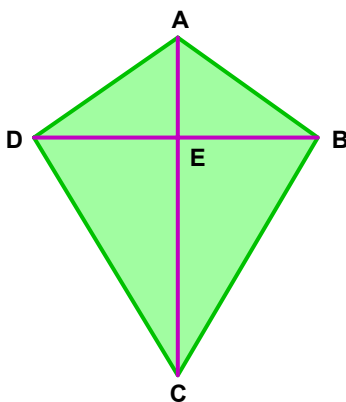


Figure 1.33

Other "Sided" Figures

A **polygon** is any closed figure that is made up of line segments. All n -sided figures including triangles and quadrilaterals are polygons. But, we conventionally consider those closed sided figures as polygons that have more than four sides.

Polygons are classified based on the lengths and the directions of their sides. Any polygon is either **regular** or **irregular**. In a regular polygon, all the sides are congruent (Figure 1.34). In an irregular polygon, at least two sides are not congruent. In Figure 1.35, $\overline{AB} \cong \overline{AH} \cong \overline{GH} \cong \overline{GF} \cong \overline{EF}$, but $\overline{BC} \not\cong \overline{CD}$. Therefore, $ABCDEFGH$ is an irregular polygon with eight sides.

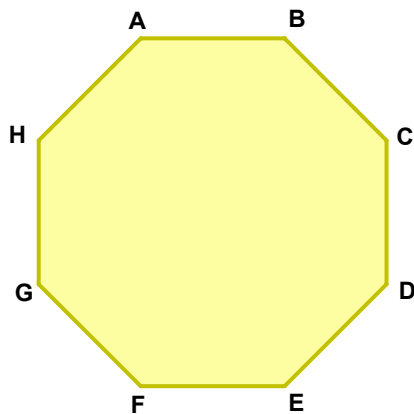


Figure 1.34

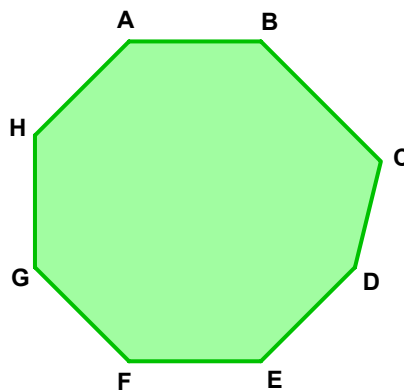


Figure 1.35

Polygons are classified based on the directions of their sides into two groups; **concave** polygons and **convex** polygons.

If in a polygon the extension of any side does not include any interior points of the polygon, it is called a **convex** polygon. In Figure 1.36, all the sides of the polygon are extended from the both ends. No extension includes any interior point of the polygon. Therefore, the polygon in Figure 1.36 is a convex polygon. In a convex regular polygon, all the interior angles are congruent.

In Figure 1.37, \overline{BC} , the extension of \overline{AB} , passes through interior of the polygon. It contains some interior points. Therefore, the given polygon is concave.

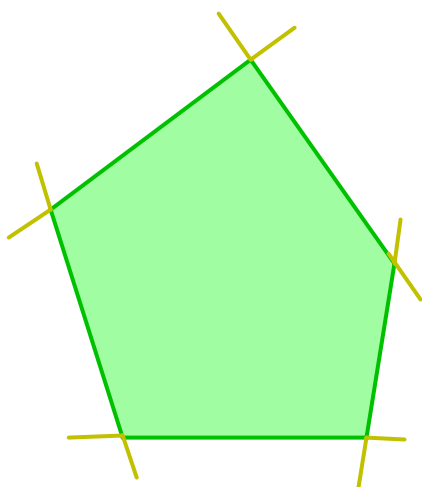


Figure 1.36

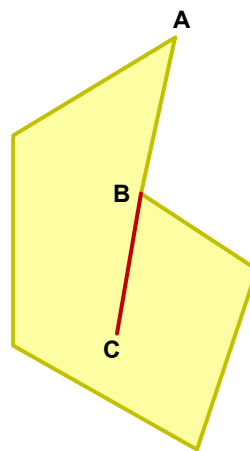


Figure 1.37



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Polygons are named based on the number of their sides. A polygon with five sides is called a **pentagon**. In a concave regular polygon, only the sides are congruent, not the interior angles (Figure 1.38). But in a regular convex polygon, both the sides and the interior angles are congruent (Figure 1.39).

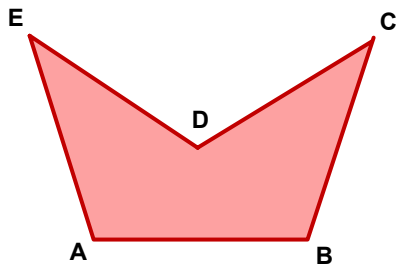


Figure 1.38

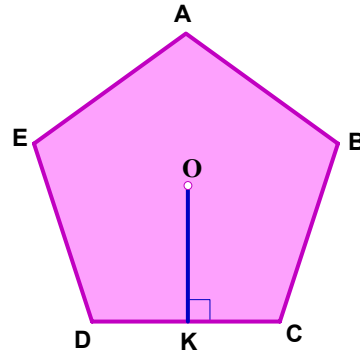


Figure 1.39

A polygon with six sides is called a **hexagon**. In a regular concave hexagon, only sides are congruent and some of the interior angles have measures different from the others (Figure 1.40). In a regular convex hexagon, all the sides and the interior angles are congruent (Figure 1.41).

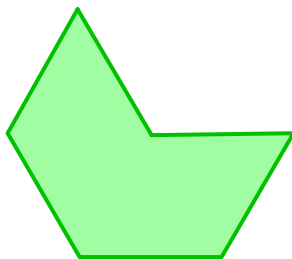


Figure 1.40

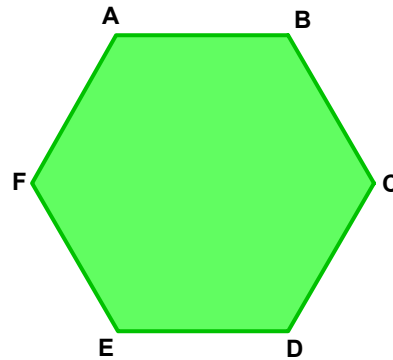


Figure 1.41



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Pentagons and hexagons are the most frequently used polygons in geometry. Here are some other polygons with their names and the number of their sides.

Name of Polygon	Number of Sides
Heptagon	7
Octagon	8
Nonagon	9
Decagon	10
Dodecagon	12
<i>n</i> -gon	<i>n</i>