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Circular Sector and Segment

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Geometry is one of the ancient sciences that has been formed since the early stages of the development of human thought. Its roots go back to deep historical layers. Although geometry developed in different regions of the ancient world, it is clear that its formation began, especially in the countries of the East. The historical development of geometry is characterized by four main stages. However, it is difficult to determine these stages with strict years, because this process was complex and gradual.

The first stage of the science of geometry - that is, the period of its emergence - falls on the era before our era, in particular, on the cultures of ancient Egypt, Babylon and Greece. It was in these regions that the first land surveying works, practical geometry activities began to take shape. The term "geometry" itself goes back to the Greek language: "geo" means earth, "metrio" means to measure. So, the dictionary meaning of the word geometry is "land measurement".

According to the famous Greek historian Herodotus, who lived in the 5th century BC, the first knowledge of geometry began to take shape in ancient Egypt. According to legend, in Egypt, rulers divided land plots into regular rectangles and distributed them to farmers. Each landowner was taxed according to this area. However, as a result of the periodic flooding of the Nile River, the boundaries of land plots were violated, which required their re-measurement. In such conditions, the needs of determining areas, distributing land, fairly determining the amount of taxes, and constructing irrigation structures were the impetus for the development of practical geometry in ancient Egypt.

Thus, land surveying, which initially arose due to vital necessity, gradually laid the foundation for theoretical knowledge, and geometry took shape as an independent science. This science was later deeply studied on a scientific basis by Greek philosophers and widely developed.

Along with the deepening of the science of geometry, more complex forms related to the circle - such as a circular segment and a circular sector - gradually began to gain clarity. Although their initial formation was mainly due to the needs of practical life in the early stages of human development, over time these concepts were theoretically and scientifically based.

Initially, the circle played an important role in ancient civilizations - in particular, in Egypt, Babylon, and India. In these regions, the circle was widely used in astronomical observations, sundials, irrigation systems, and the construction of religious structures. Ziggurats, temples, and star maps built in the shape of a circle clearly prove this. However, it was in ancient Greece that the first scientific views on certain parts of a circle, that is, segments and sectors, arose. In this

regard, one of the great Greek mathematicians who lived in the 3rd century BC - Euclid plays an important role. In his famous fundamental work "Elements", he consistently outlined the basic geometric concepts of a circle: center, radius, diameter, arc, and central angles. The sector of any circle formed by radii emanating from the center and the arc between them was later called a sector. The sector bounded by a straight line connecting the ends of the arc of a circle was recognized as a segment.

As Greek mathematics developed, problems arose related to calculating the area of these shapes. Scientific answers to these problems were given by the famous mathematician and physicist Archimedes, who lived in the 1st–3rd centuries AD. Archimedes used the first analytical approach to calculating the areas of circles, sectors, and segments and developed their formulas.

Also, in the 9th–12th centuries, when the development of science was at its peak in the Islamic world, great scholars such as Al-Khwarizmi, Al-Biruni, Abu Nasr Al-Farabi, and Nasriddin Tusi deeply studied Greek science and made a great contribution to this field of geometry. In particular, Al-Biruni's astronomical observations and trigonometric calculations played an important role in the practical application of knowledge about the circle and its parts. He widely used circular sectors and segments in the fields of geography, astronomy, and geodesy.

That is, although the concepts of a circle segment and sector were initially created based on practical life needs, their theoretical explanation and mathematical foundations were formulated by the ancient Greeks, and scientists of the Islamic Renaissance enriched and deepened this knowledge.

In geometry, a circle is defined as a set of points equidistant from the center. The surface of a circle can be divided into different parts.¹

Also, if a complex geometric shape contains several simple figures and these simple figures are located adjacent to each other or separated in the general case, then the sum of the surfaces of these simple figures forms the surface of the general shape. If the surface of these simple figures is close to or equal to the value of S with any degree of accuracy, then the general figure is also considered to have a surface S . Through this geometric rule, the surface of complex figures is determined by dividing them into simple parts, which simplifies calculations.

The set of all points in a plane that are at a fixed distance from a given point is called a circle. This fixed central point is called the center of the circle, and the distance from the center to the boundary points is called the radius of the circle. A circle consists of two main parts: the inner surface (surface) and the outer boundary. The outer boundary is called the circumference, and it defines the boundary of the circle. A circle also has a center and a radius, which correspond exactly to the center and radius of the circle. Thus, a circle is a symmetrical and perfect figure in a plane that contains points that are equidistant in all directions from the center.

A circle is the set of all points in a plane that are equidistant from a point (the center).

1. Center – the middle point of a circle
2. Radius (r) – the distance from the center to the circumference
3. Diameter (d) – a straight line that passes through both edges of a circle ($d = 2r$)
4. Arc – a curved line that is part of a circle

The most basic of these are the circular sector and the circular segment. These two shapes are widely used in many practical problems, including technical drawings, geographic modeling, architecture, and physics.

Definition: A sector of a circle is a section of a circle bounded by two radii radiating from the center and an arc between them. It resembles a slice of a

¹ Musaev M. N., Geometriya asoslari, O'qituvchi nashriyoti, Toshkent, 2021.

pie or a fan.

Elements of a sector:

- ✓ Two radii (r)
- ✓ The central angle between them (θ – in degrees or radians)
- ✓ Arc (a segment of a circle)

Formula for the area of a sector:

If the angle is in degrees:

$$S = \pi r^2 \cdot (\theta / 360^\circ)$$

If it is in radians:

$$S = \frac{1}{2} \cdot r^2 \cdot \theta$$

The length of the arc of the sector:

$$L = 2\pi r \cdot (\theta / 360^\circ)$$

Example:

Radius = 10 cm, angle = 90°

$$S = \pi \cdot 10^2 \cdot (90 / 360) = \pi \cdot 100 \cdot \frac{1}{4} = 25\pi \approx 78.54 \text{ cm}^2$$

The part of a circle bounded by an arc and a chord (straight line) connecting the ends of this arc is called a circular segment.

The common part of a circle and a semi-plane is called a circular segment. That is, it is a part of a circle, which is a figure separated by two ends of a circular arc with radii drawn to the center. Simply put, a circular segment is a part of a circle that is located under an arc, but is smaller than a semicircle.

If a segment is not equal to a semicircle, its area is calculated using a special formula. The following elements are taken into account:

α (alpha) - the degree measure of the central angle formed between two radii drawn from the center of the circle. This angle includes the arc that forms the base of the segment.

The area of a triangle (S_t) - the surface of the triangle formed by the radii drawn between the ends of the arc that forms the segment and the center of the circle.

A segment is a part of a circular sector, the shape of which is the radius removed.

Segment surface formula:

$$S_{\text{segment}} = S_{\text{sector}} - S_{\text{suchburchak}}$$

Area of a triangle (if the central angle is θ in degrees):

$$S_{\text{suchburchak}} = \frac{1}{2} \cdot r^2 \cdot \sin(\theta)$$

In conclusion, a circular sector and a circular segment are important concepts in geometry, representing different parts of the surface of a circle. A circular sector is a part of a circle bounded by a central angle, while a circular segment is a part bounded by an arc and a chord connecting it. There are special formulas for calculating their areas, and these formulas are widely used in solving practical problems. A good study of this topic will help students not only to understand geometry more deeply, but also to use it in other disciplines and areas. Explanation using graphs makes the topic more understandable and interesting

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