

MATHEMATICS • CLASS 11

CHAPTER 3

Trigonometric Functions

CHAPTER NOTES



ANGLES AND DIRECTED ROTATION

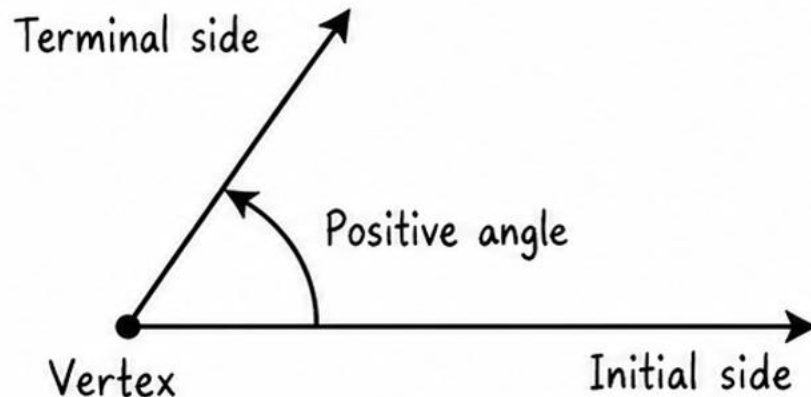
Trigonometry is the study of angle-based relationships. It is useful in navigation, surveying and periodic phenomena because many real-life situations involve measurements and relationships between angles and lengths.

Angle

An angle is the rotation of a ray about its vertex. The ray in its original position is called the initial side and the ray in its new position is called the terminal side. The fixed point about which the ray rotates is the vertex.

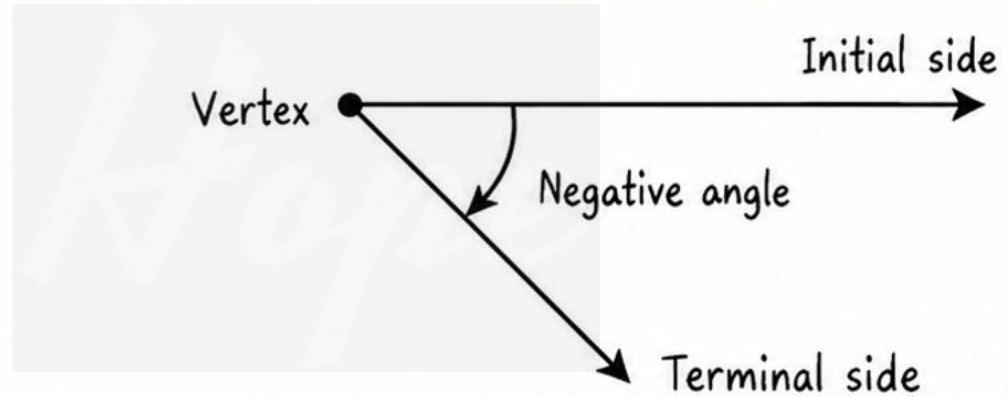
Positive rotation

A rotation in the anticlockwise direction is taken as positive. The diagram shows a positive angle.



Negative rotation

A rotation in the clockwise direction is taken as negative. The diagram shows a negative angle.



Amount of rotation

The amount of rotation measures the angle. Angles are measured in degrees or in radians. One full turn is a revolution, which is a rotation of three hundred and sixty degrees, or equivalently two pi radians.

$$360^\circ = 2\pi \text{ radians}$$

DEGREE MEASURE

An angle can be measured in degrees. One complete revolution is divided into 360 equal parts. Each part is one degree. Smaller units, called minutes and seconds, are subdivisions of a degree. These are subdivisions of angle, not of time.

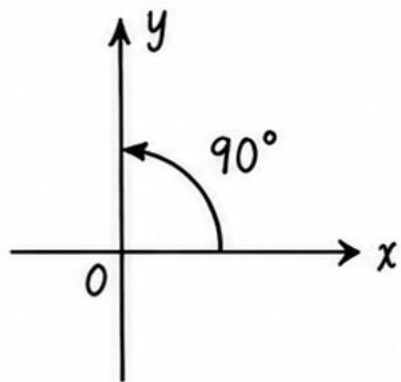
$$1 \text{ revolution} = 360^\circ \quad 1^\circ = \frac{1}{360} \text{ of a turn} \quad 1^\circ = 60' \quad 1' = 60'' \quad \text{hence } 1^\circ = 3600''.$$

The symbol ' denotes a minute and the symbol '' denotes a second. Minutes and seconds are smaller units used to express angles more precisely. They are not units of time.

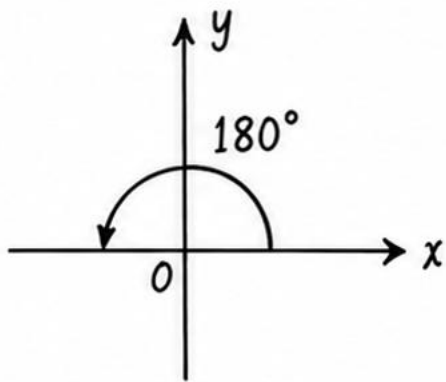
Standard angles

The following diagrams show some important angles in standard position.

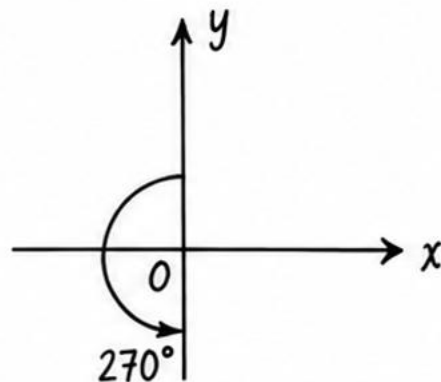
Ninety degrees



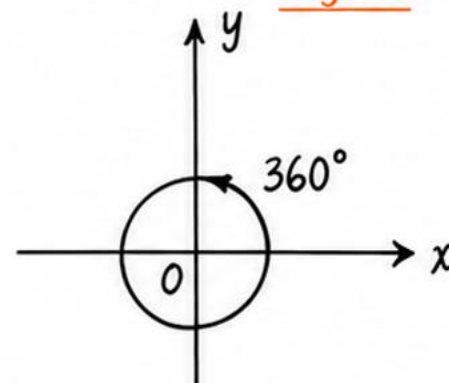
One hundred and eighty degrees



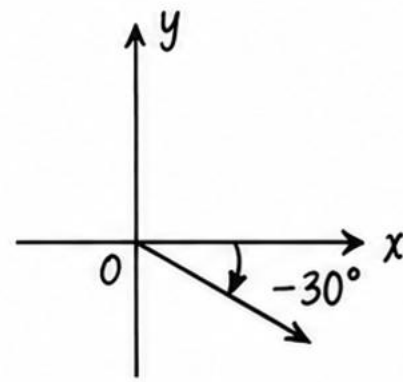
Two hundred and seventy degrees



Three hundred and sixty degrees



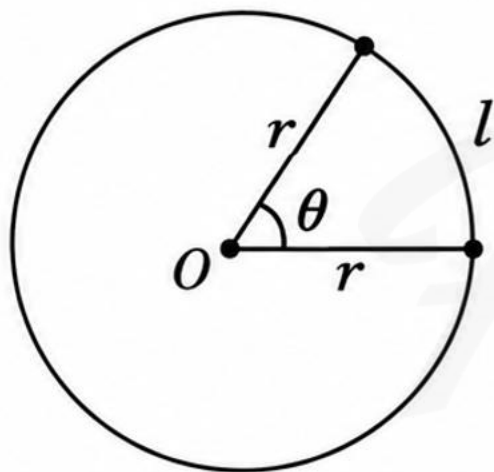
Negative thirty degrees



RADIAN MEASURE AND ARC LENGTH

Definition

One radian is the measure of a central angle subtended by an arc equal in length to the radius of the circle.



$$\theta = \frac{l}{r} \text{ rad}$$

when the arc length and the radius are expressed in the same unit of length.

$$l = r\theta$$

In this formula, the angle must be in radians.

Arc length formula

For a circle of radius r , the length of an arc subtended by a central angle θ (in radians) is

$$l = r\theta$$

Complete turn

One complete turn corresponds to an angle of 2π rad because the circumference of a circle of radius r is

$$2\pi r.$$

Hence, 1 complete turn = 2π rad.

Direction of angles

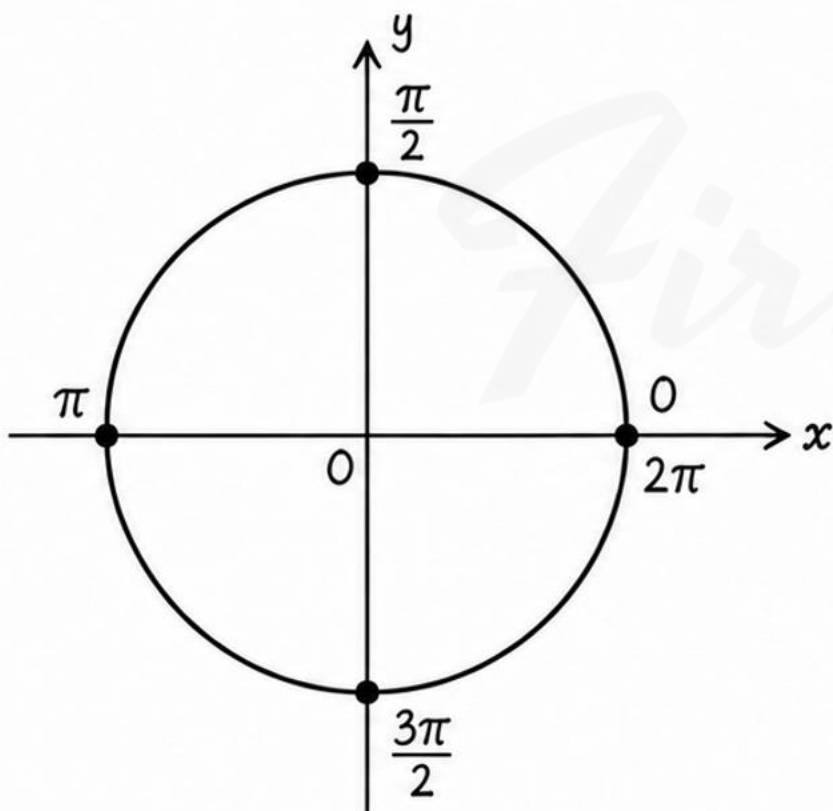
Angles are taken to be positive in the anticlockwise direction and negative in the clockwise direction.

Important note

A degree measure must not be substituted directly into the formula $l = r\theta$. It must first be converted to radians.

RADIANS AND REAL NUMBERS

Consider the unit circle, which is a circle of radius one and centre at the origin. Its circumference is 2π , so one radian is the measure of the central angle that subtends an arc of length one on a circle of radius one.



Mapping real numbers to the circle

Let A be a fixed starting point on the unit circle, chosen to be the point $(1, 0)$ on the positive x -axis, which corresponds to 0 . For any real number t , map t to a directed arc of length $|t|$ starting from A . Move anticlockwise when $t > 0$ and clockwise when $t < 0$. The point at which the arc ends is the terminal position of t on the circle.

More than one turn

The real number can be any value, so more than one complete turn around the circle is allowed. If t differs from another real number by an integer multiple of the circumference 2π , then they end at the same point. In particular,

$$t + 2\pi \neq t$$

but the two angle measures have the same terminal point.

Angle measure and terminal position

The real number t is called the angle measure. It records the signed length of the directed arc from the starting point A . The terminal position is the point on the circle where the arc ends. Different real numbers can have the same terminal position, but they have different angle measures.



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