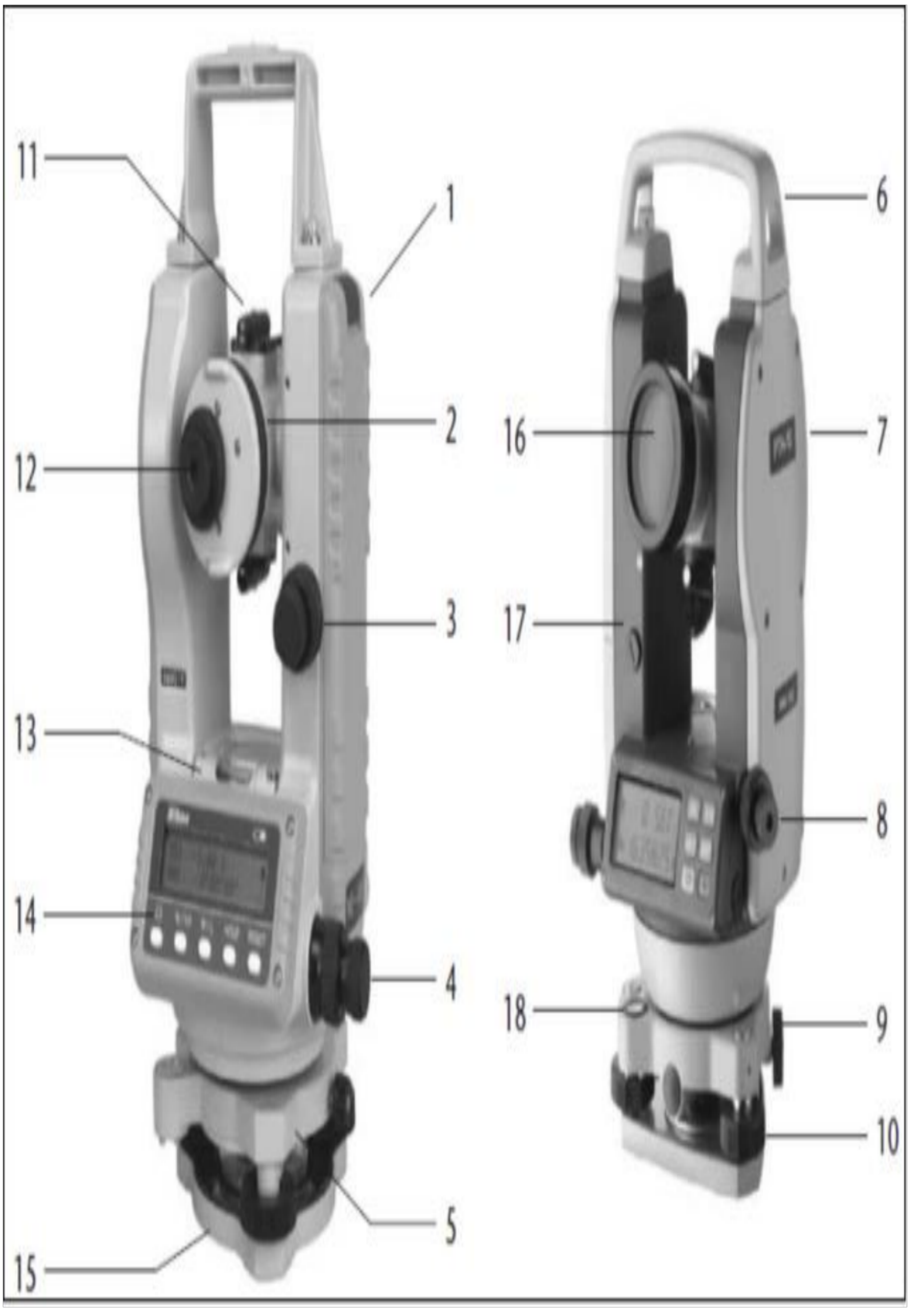
THEODOLITES

A theodolite is a precise instrument for measuring horizontal angles, angles of elevation and depression i.e., vertical angles, bearing and azimuth of a line



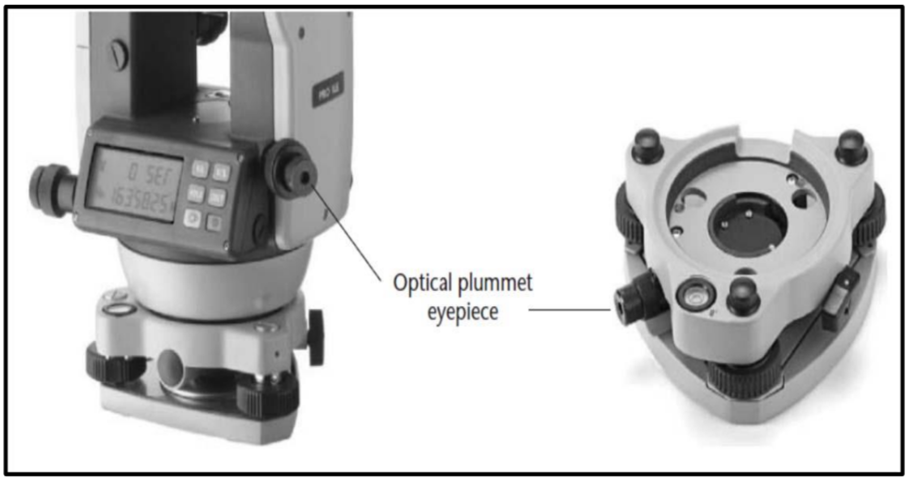
1 battery compartment;
2 telescope focus;
3 vertical clamp and tangent screw;
4 horizontal clamp and tangent screw;
5 tribrach;
6 carrying handle;
7 vertical circle;
8 optical plummet;
9 tribrach clamp;
10 foot screw;
11 collimator (sight);
12 eyepiece;
13 plate level;
14 keyboard and display;
15 trivet;
16 objective;
17 standard;
18 circular bubble

Main component of the theodolite

The Main Components of a Theodolite consists of three main parts, namely the upper part, the middle part, and the base.

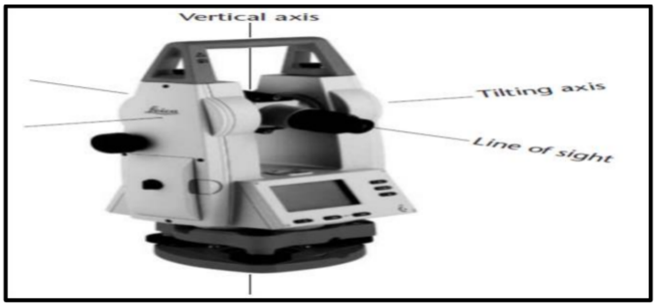
1. The Upper Part, also known as the alidade, includes the following elements:
    - The vertical circle.
    - The telescope or sighting scope.
    - Telescope handle.
    - Longitudinal leveling bubble.
    - Screen for reading the observed angles, where the horizontal angle is represented by the symbol H, and the vertical or azimuth angle is represented by the symbol V.

2. The Middle Part includes:
    - The horizontal graduated circle.
    - The optical plummet, used for adjusting the theodolite over the surveyed point.



3. The Base:
    - It is the lower part of the instrument that rests on the instrument stand. It features three leveling screws that allow the instrument to be made entirely horizontal using the instrument's bubble level.

Axes: One of the most important components of the theodolite is the vertical axis and the horizontal axis. The telescope rotates in the vertical plane, while the instrument itself can rotate in the horizontal plane for precise measurement of horizontal and vertical angles



Sources of error

Natural Errors

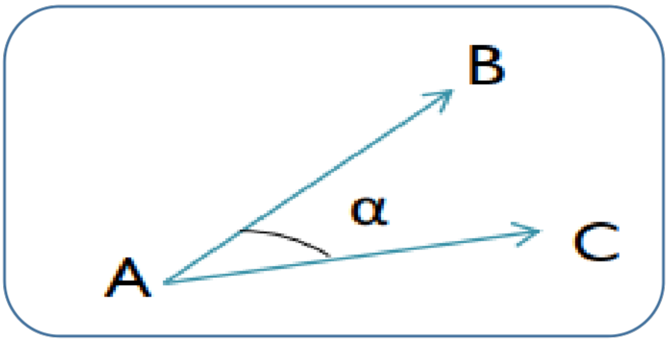
1. Wind. Wind vibrates the tripod that the theodolite instrument rests on.
2. Temperature effects. Temperature differentials cause unequal expansion of various parts of theodolite. This causes bubbles to run, which can produce erroneous observations.
3. Refraction. It is desirable to keep lines of sight well above the ground and avoid sights close to buildings, smokestacks, vehicles. In some cases, observations may have to be postponed until atmospheric conditions have improved

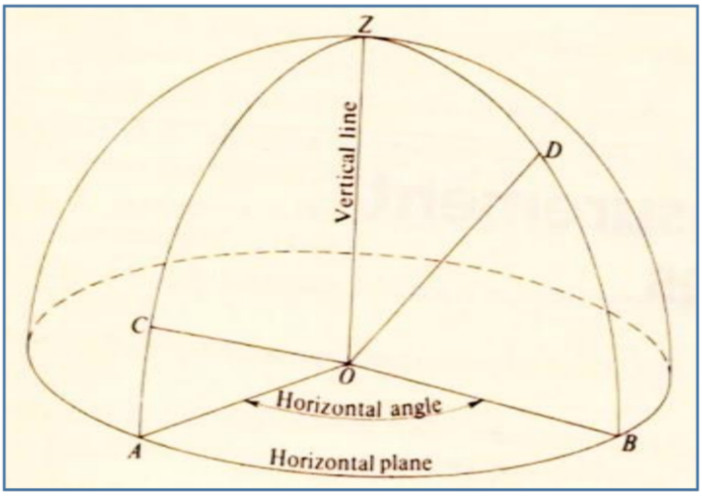
Personal Errors

1. Instrument not set up exactly over point.
2. Bubbles not centered perfectly.
3. Improper use of clamps and tangent screws.
4. Poor focusing (Parallax error). Parallax is the apparent motion of an object caused by a movement in the position of the observer's eye.
5. Overly careful sights. Beginners often want someone else to check their sights. This should never be done due to personal preferences, abilities, and physical limitations.

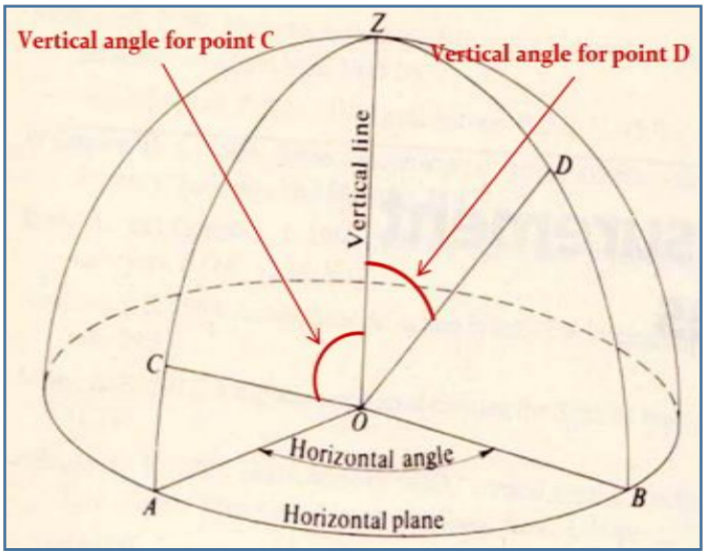
Angle

It is the measure of the space between two straight lines and is expressed in various systems such as the sexagesimal system (degrees), the





Horizontal angle is the angle between two intersected vertical planes, measured in horizontal plane. They are used to determine bearings and directions in Control surveys.

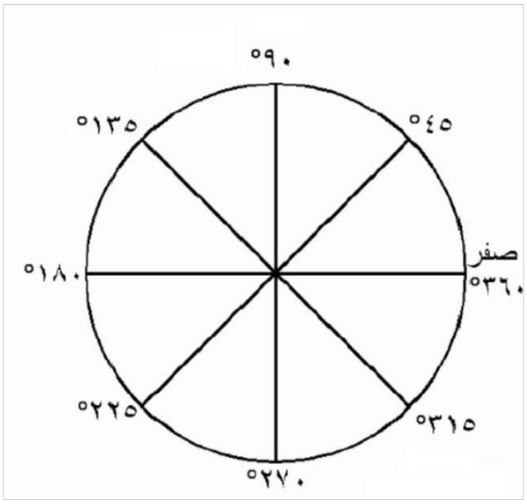


Vertical angle is the angle measured on vertical plane from zenith point to required point. Such as the angel between vertical line and line OD

Angle Measurement Systems

1- Sexagesimal System:

In this system, the circle is divided into 360 divisions, each called a degree (º), and each degree is further divided into 60 divisions, called minutes (′), and each minute is divided into 60 divisions, called seconds (″). So, one degree equals 60 minutes, and one minute equals 60 seconds.



For example:, 125 degrees , 50 minutes, 43 seconds can be calculated as follows:

$125^{\circ}\, 50'\, 43'' = 125 + (50 / 60) + (43 / 3600)$
$\longrightarrow 125.845278$

Convert 125.845278 to $125^{\circ}\, 50'\, 43''$

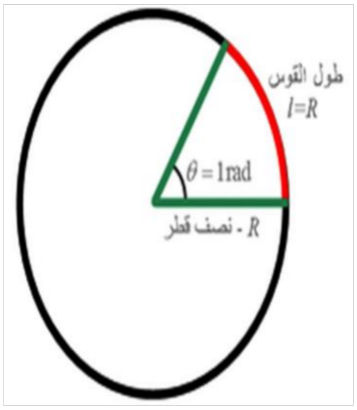
$125 \longrightarrow 125^{\circ}$

$0.845278 * 60 = 50.71668 \longrightarrow 50'$

$0.71668 * 60 = 43.0000 \longrightarrow 43''$

2-The Circular System (rad):

In this system, angular measurement is done using units called radians, represented by the symbol (r). A radian is defined as the central angle that subtends an arc length equal to the radius of the circle. In other words, it's the angle formed when you take an arc with a length equal to the radius of the circle.



The measure of any central angle in radians is determined by the ratio of the arc length to the radius of the circle. Mathematically, it can be expressed as:

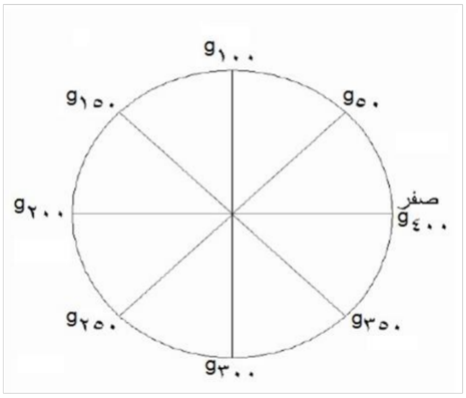
Angle in radians = Arc length / Radius of the circle

For example, a full circle has a measure of 360 degrees in the degree system, which corresponds to the entire circumference of the circle. In the radian system, this measure is 2π radians because the circumference of a circle is 2π times its radius ($C = 2\pi R$), and dividing this by the radius (R) yields 2π.

So, 360 degrees = 2π radians, which means that 1 radian is equivalent to $\pi/180$ degrees.

3- Centesimal System:

In this system, the circle is divided into 400 divisions, each called a degree centesimal or grad, represented by the symbol (g). Each degree centesimal is further divided into 100 divisions, called centesimal minutes (C), and each centesimal minute is divided into 100 divisions, called centesimal seconds (CC).



Therefore, 1 degree centesimal equals 100 centesimal minutes, which, in turn, equals 10,000 centesimal seconds