

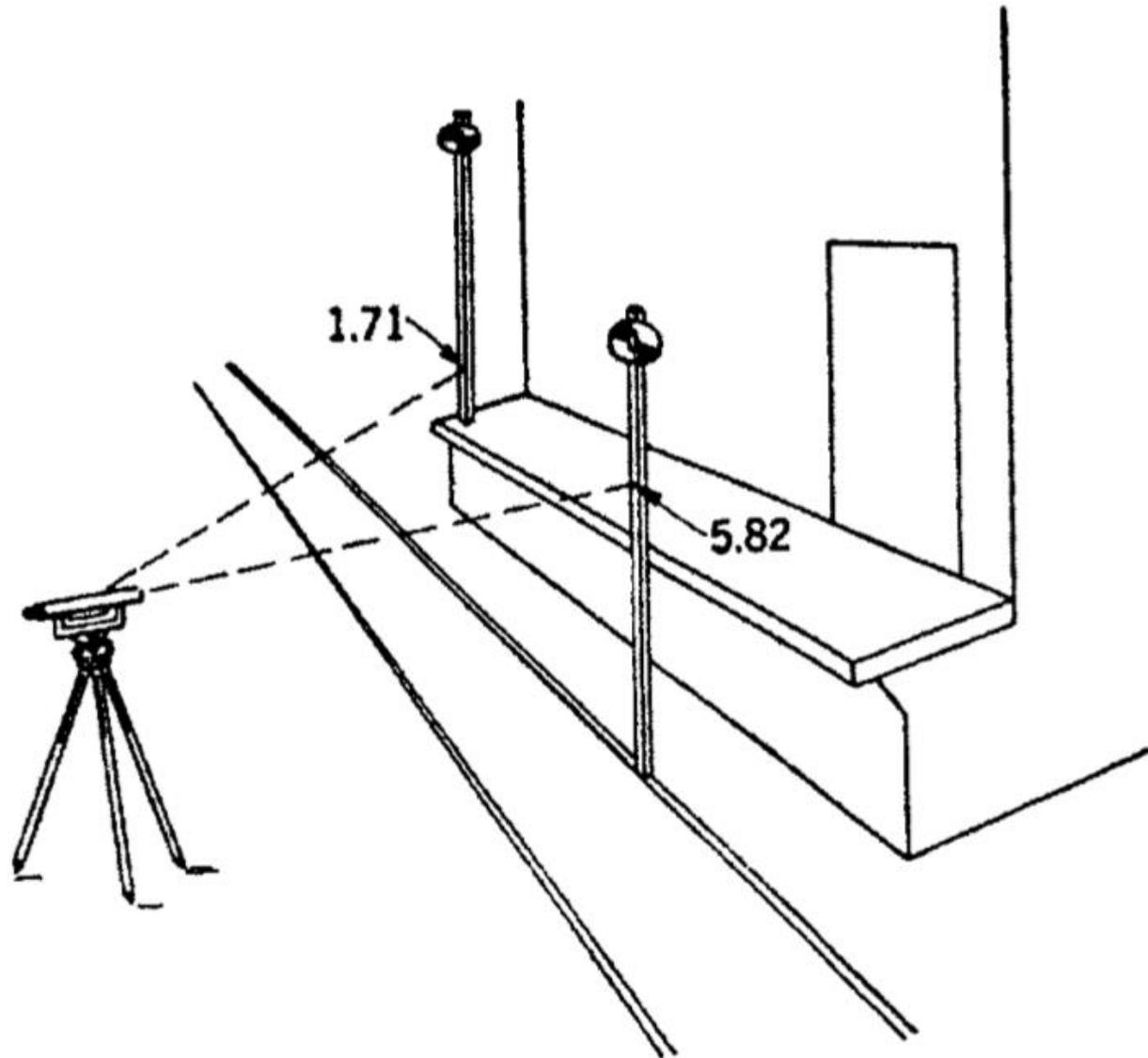
Leveling: definitions, methods of leveling, leveling instruments

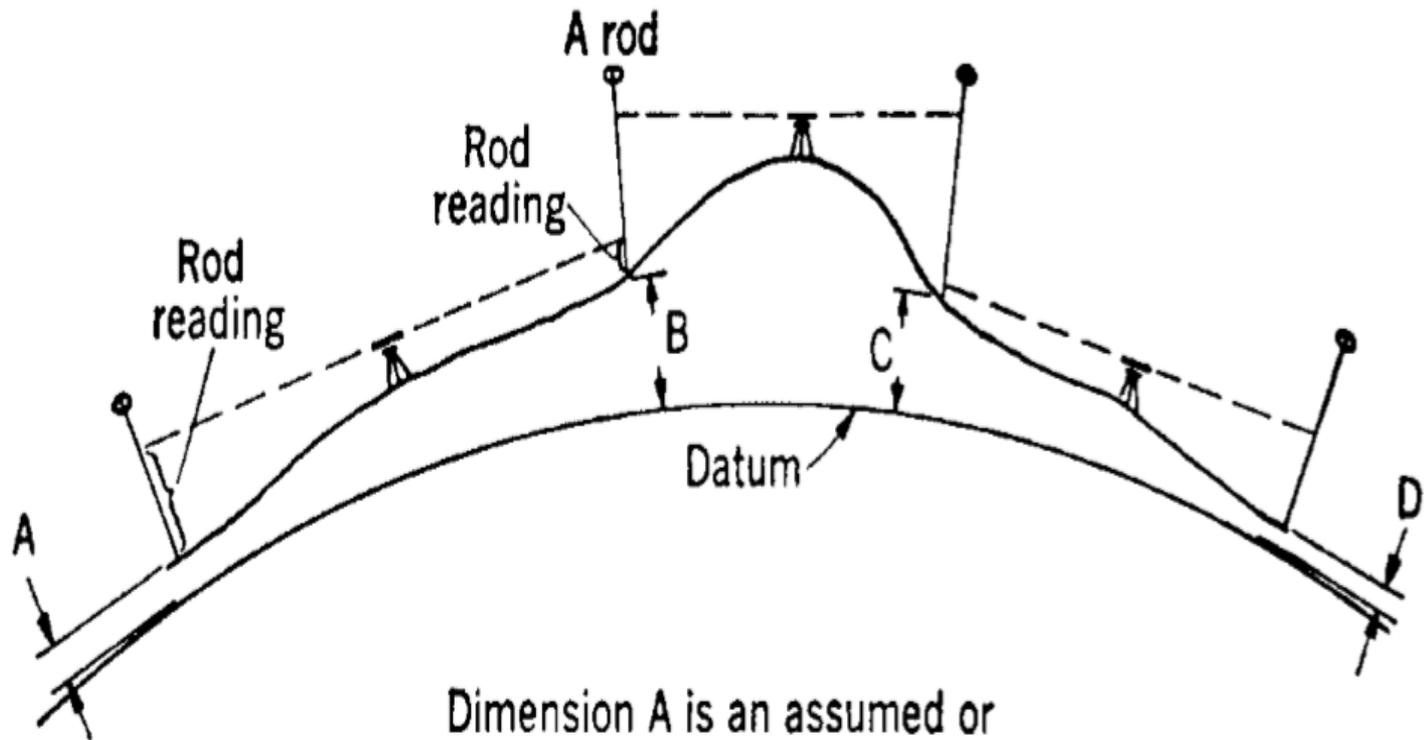
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Measuring Vertical distances (Leveling)

- ❑ **Syllabus**:- Definition, methods of leveling, leveling instruments, terms and abbreviations, types of spirit leveling.
- Vertical distances are usually measured with wooden or fiberglass rods held vertically and graduated in centimeters or hundredths of a foot.
- An instrument called a level is used to observe the rod at different points.

- The instrument can be turned in various directions around a stationary vertical axis.
- The difference in the readings on the rod at two points is equivalent to the difference in height or elevation between the points.
- Because most level rod observations are made with relatively short line-of-sight distances (less than about 300 ft or 90 m), the effect of the earth's curvature is not at all noticeable.
- The relative vertical positions of several points separated by long distances can be determined by a continuous series of level rod observations. This procedure is called **leveling**.





Dimension A is an assumed or previously measured elevation

Dimensions B, C, D are computed from the rod readings by addition and subtraction and are known as elevations

The relative vertical positions of two or more points are determined by leveling.

- **Datum:** An assumed surface used as a reference for the measurement of heights and depths.
- Any reference point on site which has had a height assigned to it is known as a **bench mark**.

- The vertical distance of a point above or below a given reference surface is called the **elevation** of the point.
- The most commonly used reference surface for vertical distance is **mean sea level (MSL)**.
- The words **altitude and height** are sometimes used in place of elevation.
- Vertical distances are measured by the surveyor to determine the elevations of points, in a process called running levels or simply leveling.

Types of leveling

- Traditional methods include **barometric leveling**, **trigonometric leveling**, and **differential leveling**.
- Two advanced and sophisticated techniques include **inertial surveying** and **global positioning systems**.
- By using special **barometers** (altimeters) to measure air pressure (which decreases with increasing elevation), the elevations of points on the Earth's surface can be determined to within ;1 m, or ;3 ft.
- This method is useful for doing a reconnaissance survey of large areas in rough country and for obtaining preliminary topographic data.

- **Trigonometric leveling** is an indirect procedure; the vertical distances are computed from vertical angle and horizontal or slope distance data.
- It is also applied for topo work over rough terrain or other obstacles.
- Inertial and global positioning methods, which depend on space-age electronic technology, are applied for certain large-scale geodetic control surveys; they are generally not used for ordinary surveying.

- By far the most common leveling method, and the one most surveyors are concerned with, is differential leveling.
- It may also be called spirit leveling because the basic instrument used comprises a telescopic sight and a sensitive spirit bubble vial.

Differential leveling

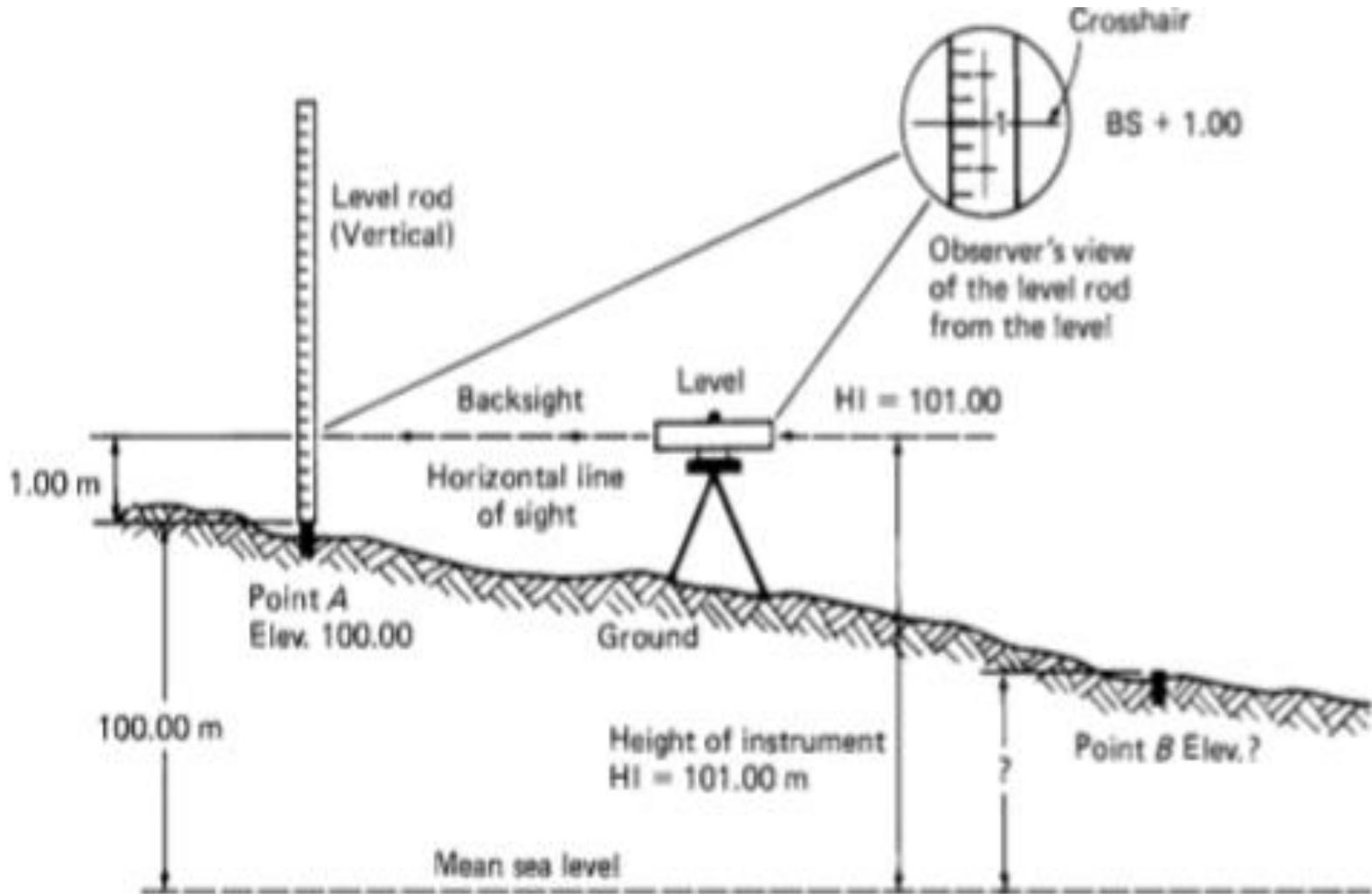
- Generally, the elevation of point A is already known; otherwise, it is assumed.
- The rod reading on a point of known elevation is termed a **backsight (BS) reading**.
- It is also often called a **plus sight (+S)** reading because it generally must be added to the known elevation of point A to determine the **elevation of the line of sight**.

- The elevation of the horizontal line of sight through the level is called the height of instrument (HI).
- Height of instrument = known elevation + backsight

$$\text{or HI} = \text{ElevA} + \text{BS}$$

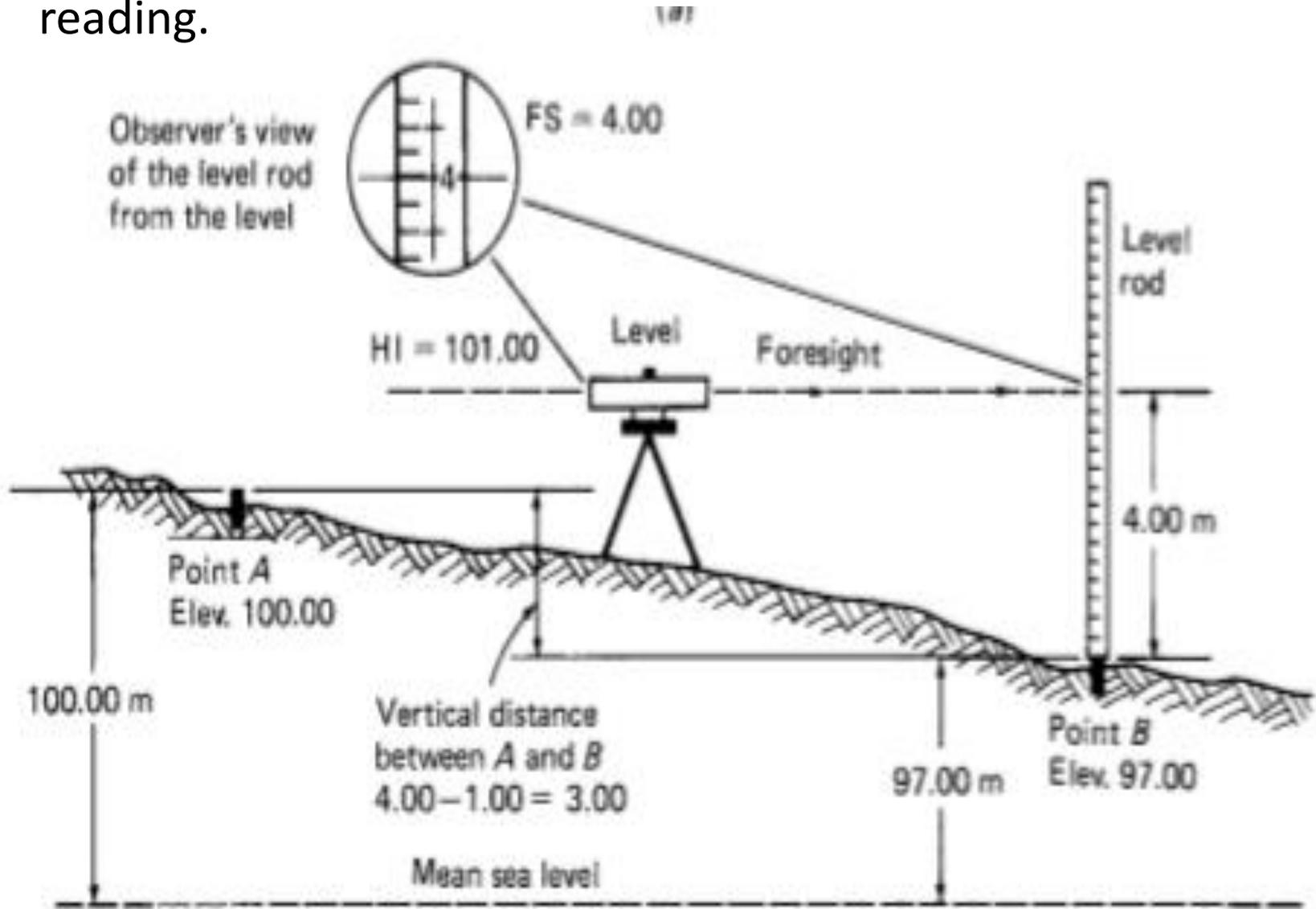
New elevation = height of instrument - foresight
or $\text{ElevB} = \text{HI} - \text{FS}$

Step 1: Take a backsight rod reading on point A.



(a)

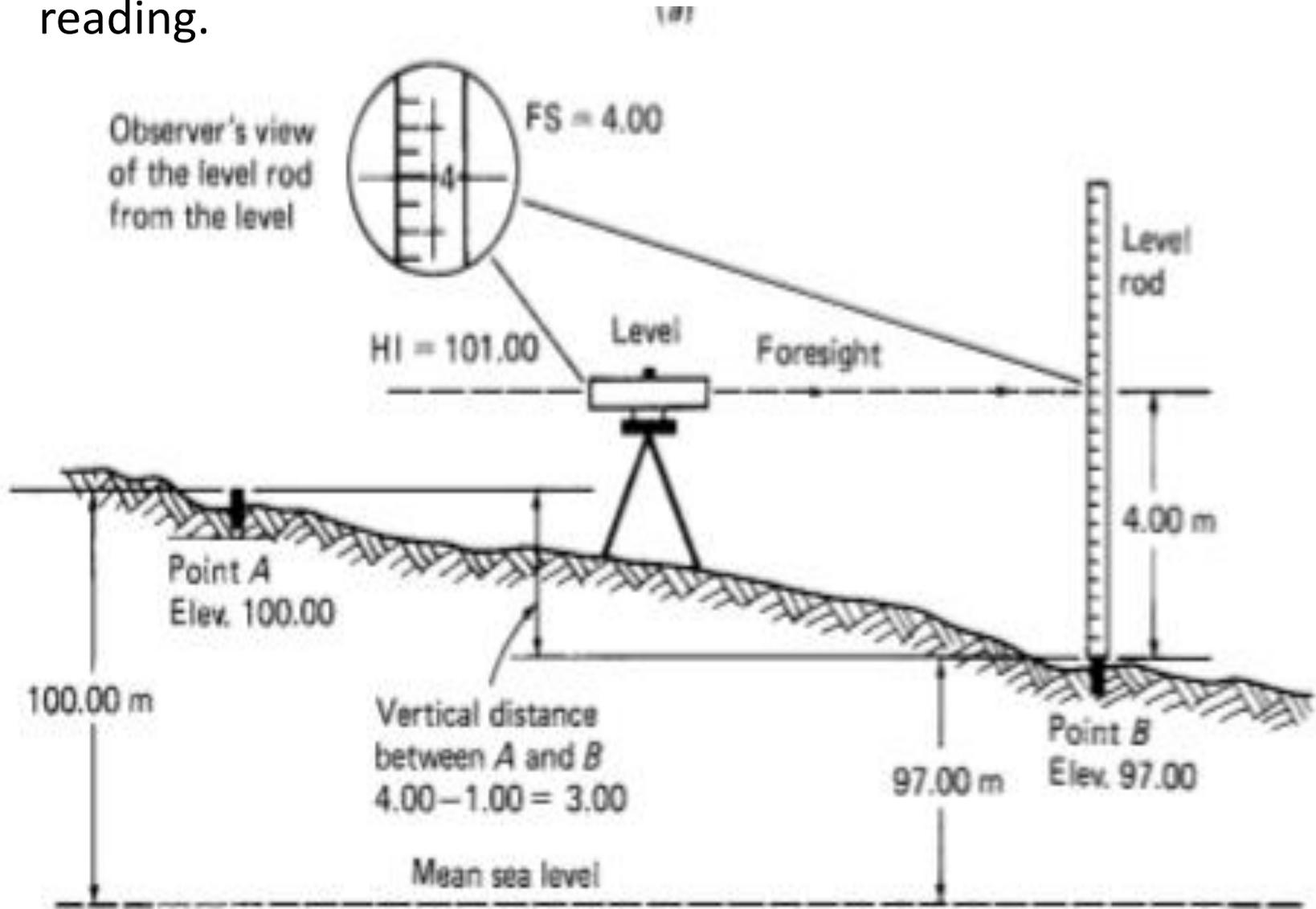
Step 2: Rotate the telescope toward point B and take a foresight rod reading.



- A process called **running levels** is used to determine the elevations of two or more widely separated points.
- It simply involves several cycles or repetitions of the basic differential leveling operation previously described.
- More specific terms for this are benchmark, profile, and topographic leveling.

- A secure and permanent point of known elevation is called a **benchmark (BM)**.
- Suppose it is necessary to determine the elevation of point C relative to point A.
- But it is not possible to set up the level so that both points A and C are visible from one position (due to either physical obstacles or excessive distance).
- The line of levels can be carried forward toward C by establishing a convenient and temporary turning point (TP) somewhere between A and C. The selected TP serves merely as an intermediate reference point.

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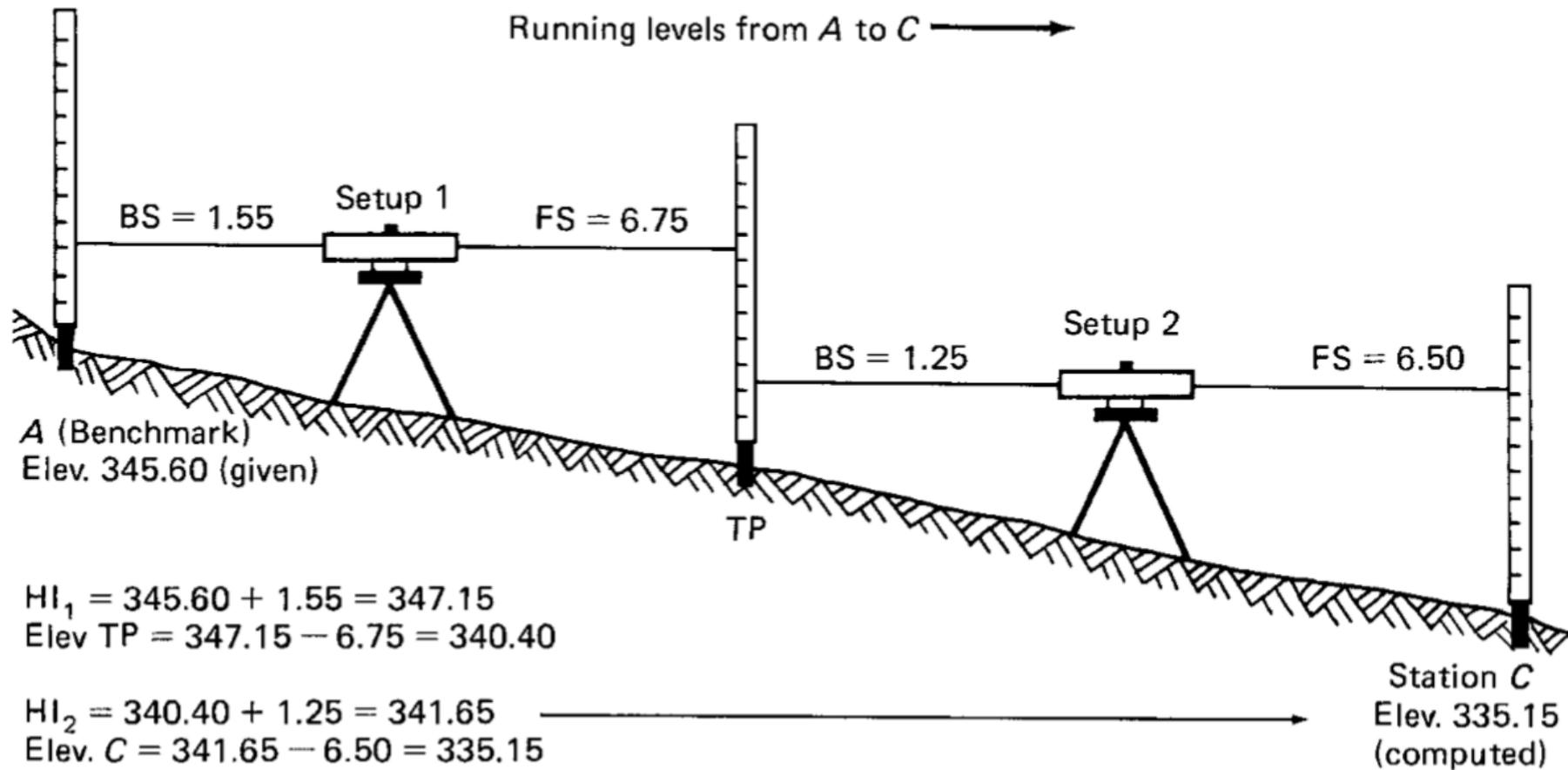


FIGURE 5-2. Temporary turning points are used to carry a line of levels from a benchmark to some other station or benchmark; the process of differential leveling is repeated at each instrument setup.

Record the given elevation of A.

Read BS on A;
compute HI for
first setup.

(Numbers in
parentheses
upper left indicate
order of data entry.)

Station	BS "+"	HI	FS "-"	Elevation
BM A	⁽²⁾ 1.55	⁽³⁾ 347.15		⁽¹⁾ 345.60

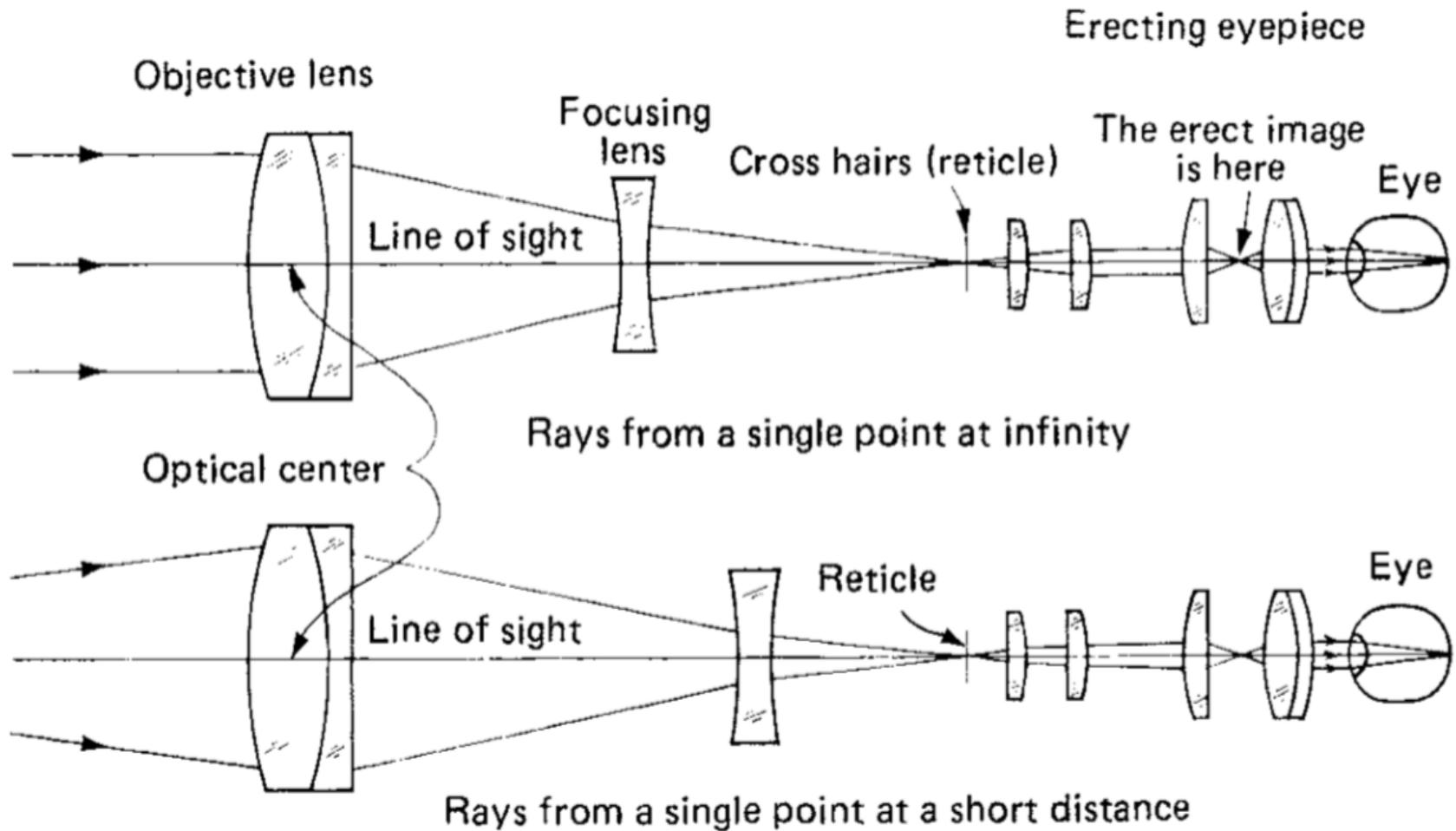
Instrument used in leveling

- Surveying levels and level rods.
- Levels give only horizontal line of sight in all directions.
- As mentioned earlier, a surveying level basically consists of a telescope and a sensitive spirit bubble vial.
- The telescope can be easily rotated about its standing axis (or azimuth axis) and pointed toward any direction of the compass.

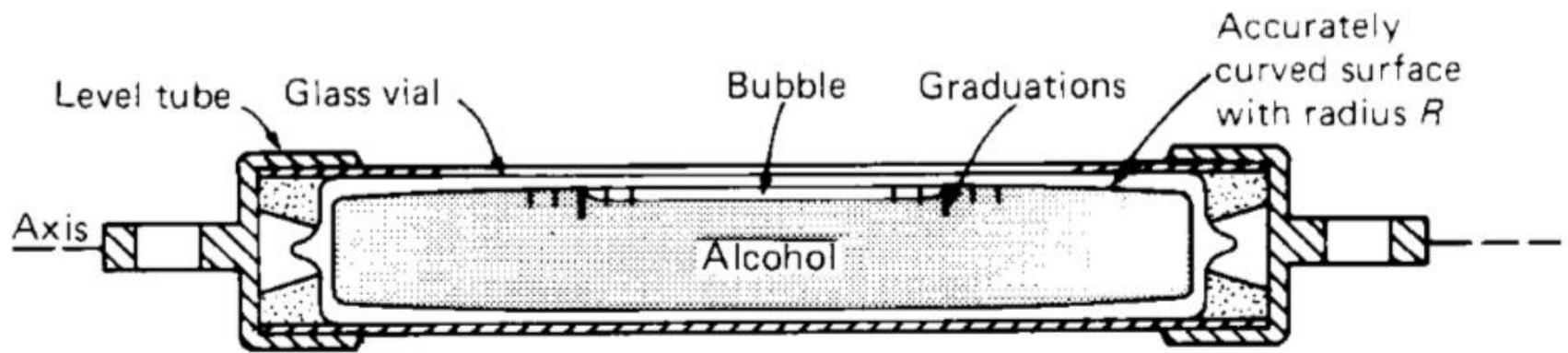
The Telescopic Sight

- The modern telescopic sight consists of the following components:
- 1. A **reticle** (or reticule), which provides the cross hairs, near the rear of the telescope tube
- 2. A **microscope** or eyepiece that magnifies the cross hairs, and that must be focused on them according to the eyesight of the observer.

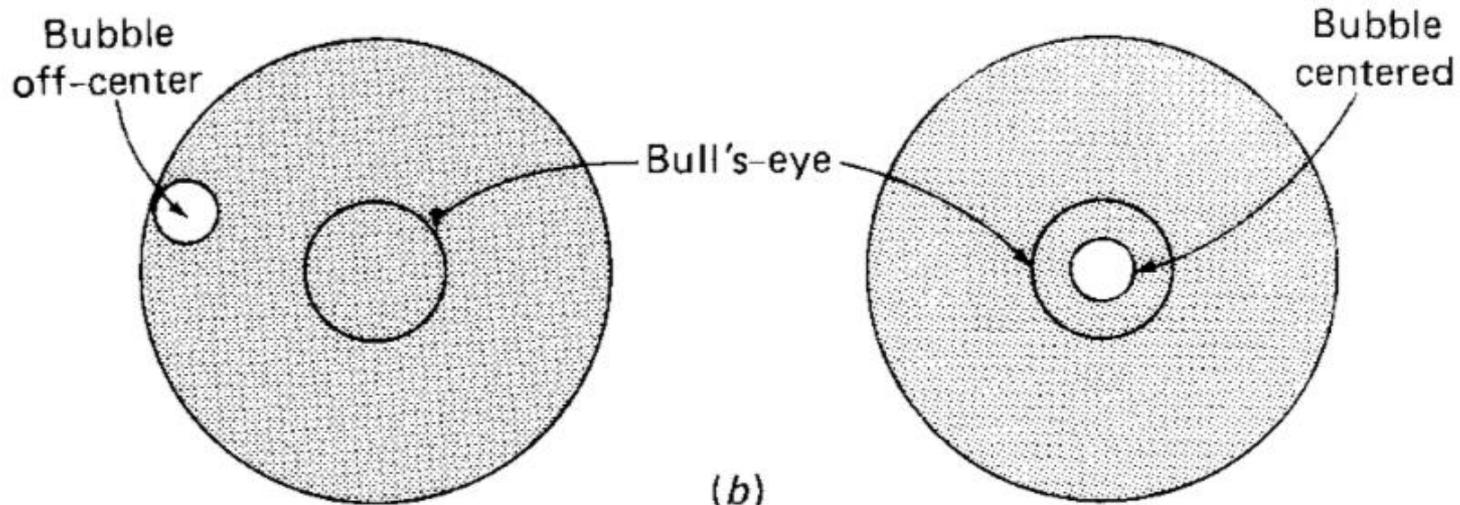
- 3. An **objective** lens at the forward end of the telescope, which forms an image of the sighted target within the telescope tube.
- 4. A **focusing lens**, which can be moved back and forth inside the scope to focus the image on the cross hairs.
- **Spirit bubble vial:-** A spirit bubble vial consists of a glass container that is partly filled with a clear, nonfreezing, very low viscosity liquid such as alcohol or ether for making instrument horizontal.



A modern telescopic sight with an internal focusing lens.



(a)



(b)

Cross section of a level tube showing the mounting of the vial. The axis is horizontal when the bubble is centered. (b) Circular (bull's-eye) spirit level.

Procedure of leveling

- Setting Up and Leveling the Instrument
- Handling the Level Rod
- Taking a Rod Reading