

**Salahaddin University- Erbil**  
**College of Agricultural Engineering Sciences**  
**Departments of Forestry, Soil and Water,**  
**Food Technology and Plant Protection**



**Surveying and Leveling- Practice**

**06<sup>th</sup> Lecture:**

# **Differential Leveling (Elevations)**

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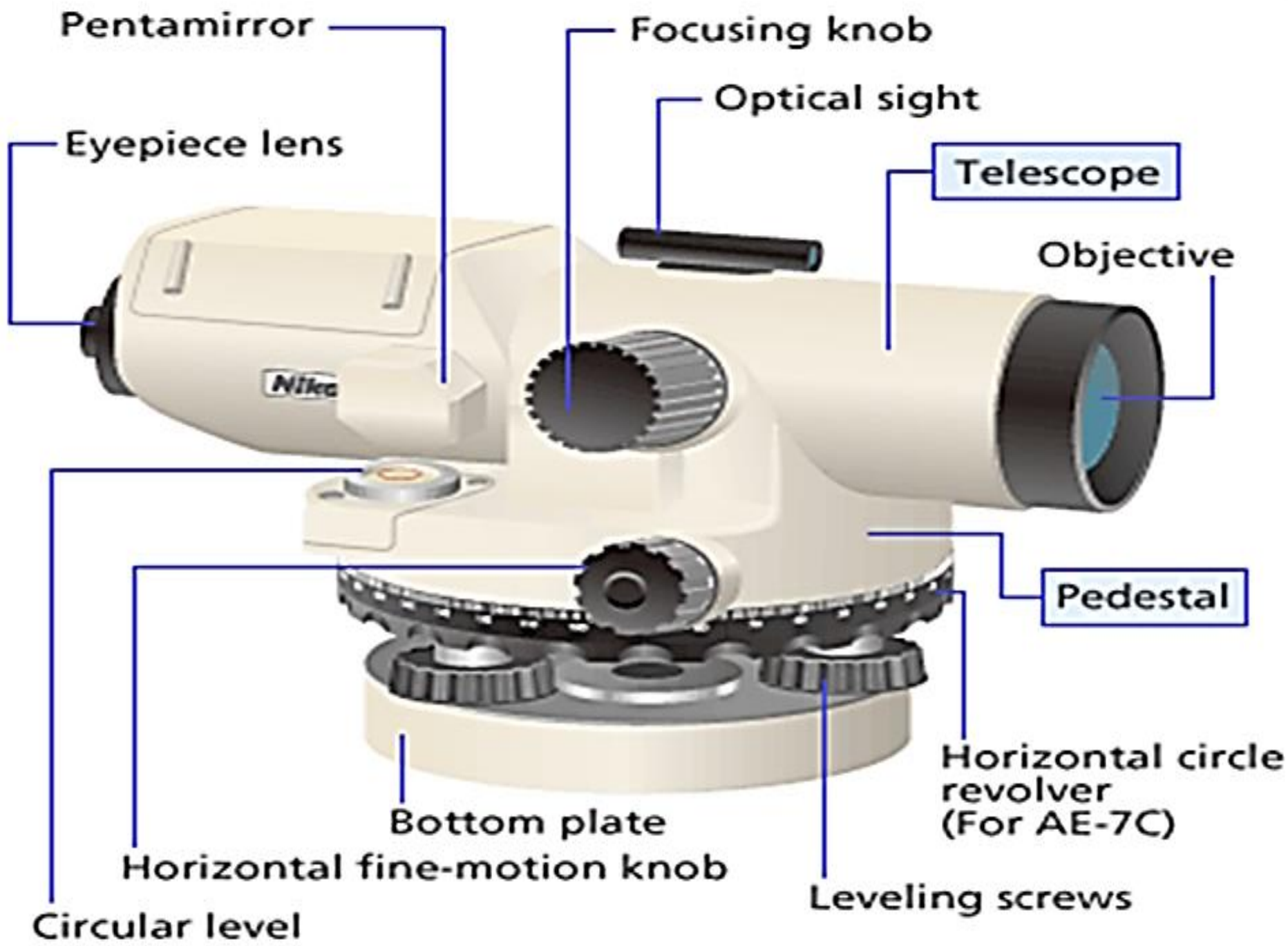
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# Previous Lecture:

- Introducing optical level
- Function of its parts
- Installing it on tripods
- And how to reading the staff by level instrument.

# Leveling Telescope



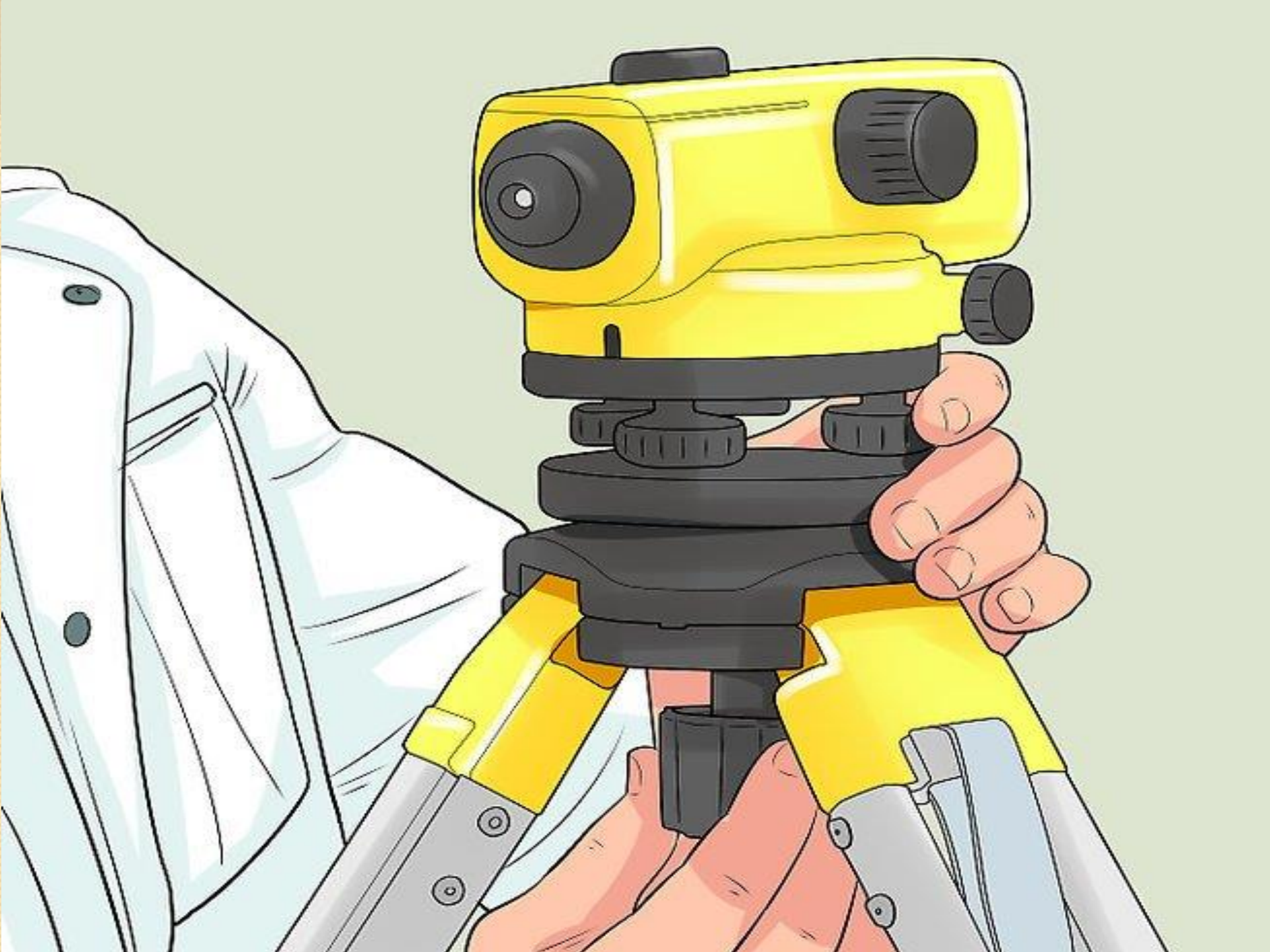


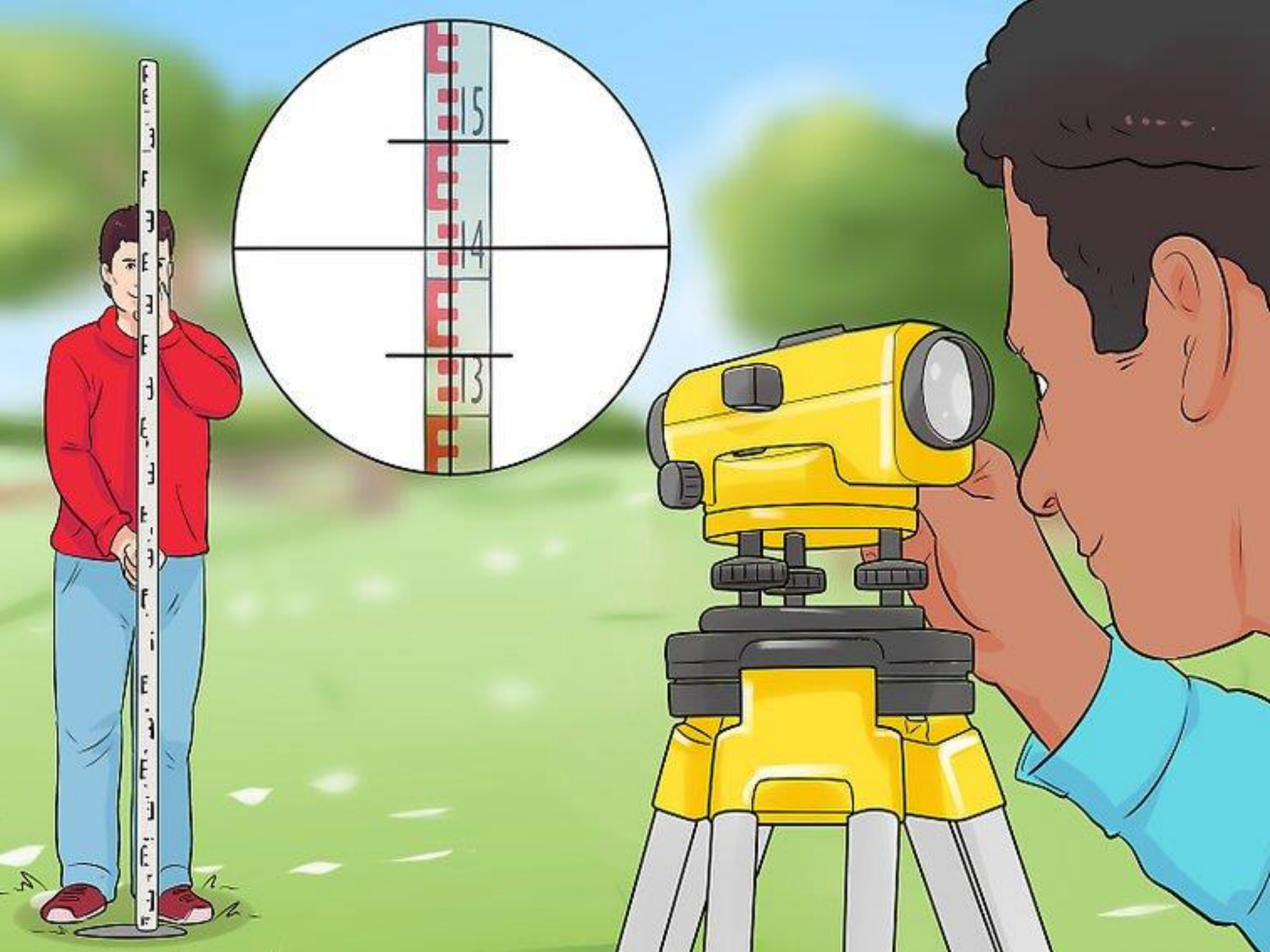
# Tripod



# Staff or Leveling Rod









## 6<sup>th</sup> Lecture: Differential Leveling (Elevations)

- Differential leveling is a technique used to determine differences in elevation between points that are remote from each other.
- Differential leveling is a very simple process based on the measurement of vertical distances from a horizontal line. Elevations are transferred from one point to another through the process of using a **leveling instrument** to read a staff held vertically on, first, a point of known elevation and, then, on the point of unknown elevation.

# Principles:

**Bench mark (BM):** it is a station or point on the ground of known elevation and of a permanent nature.

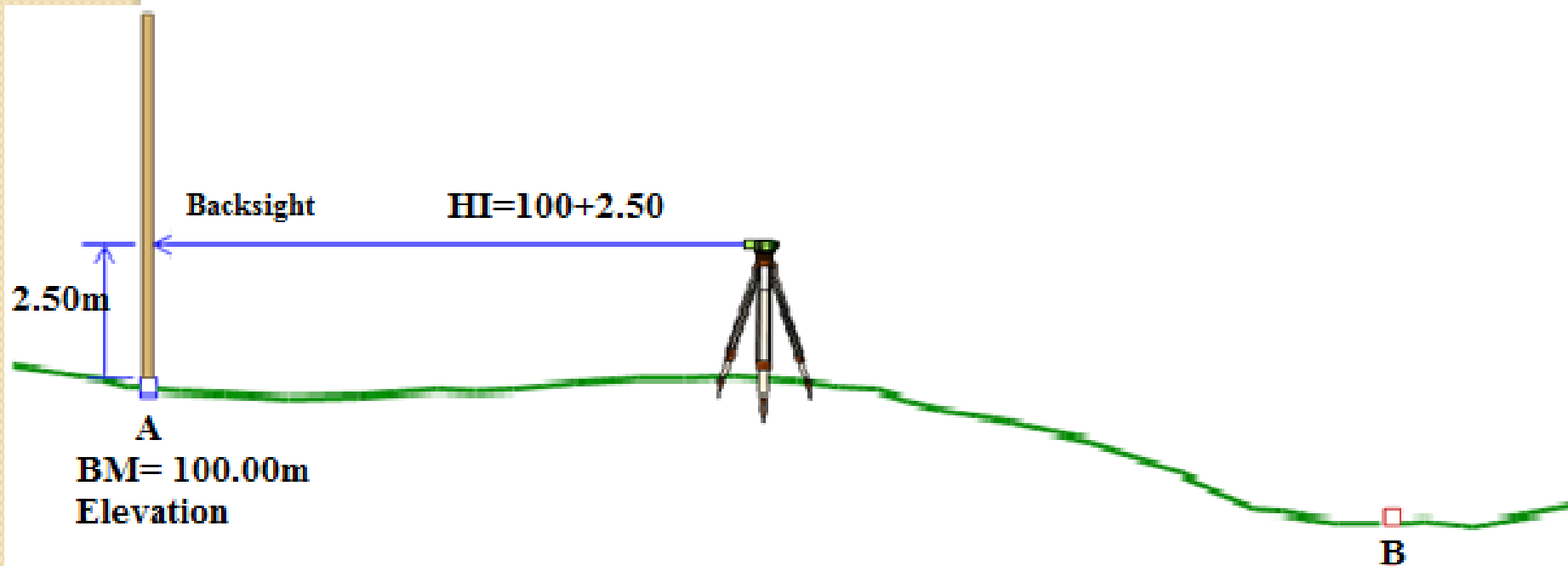
BM provides the reference elevation from which relative elevations for other stations are calculated.

A BM may be established on permanent objects/structure on wooden.

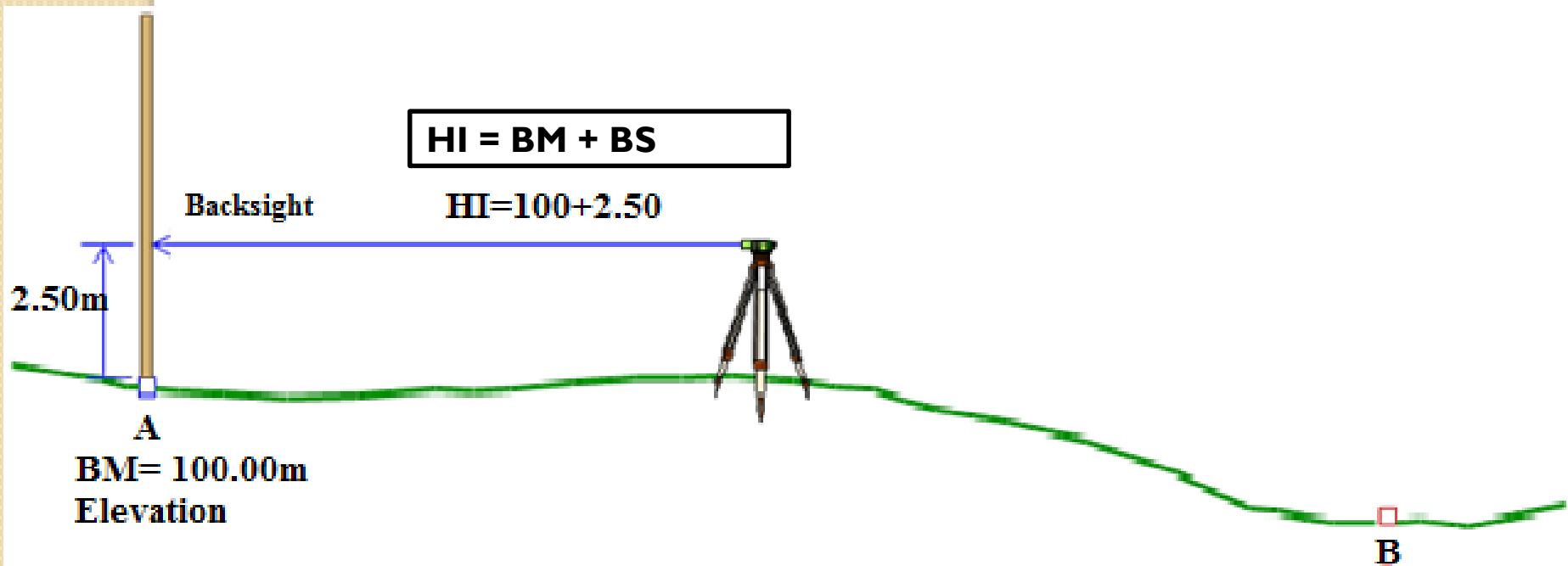


## Back sight or plus sight (BS)

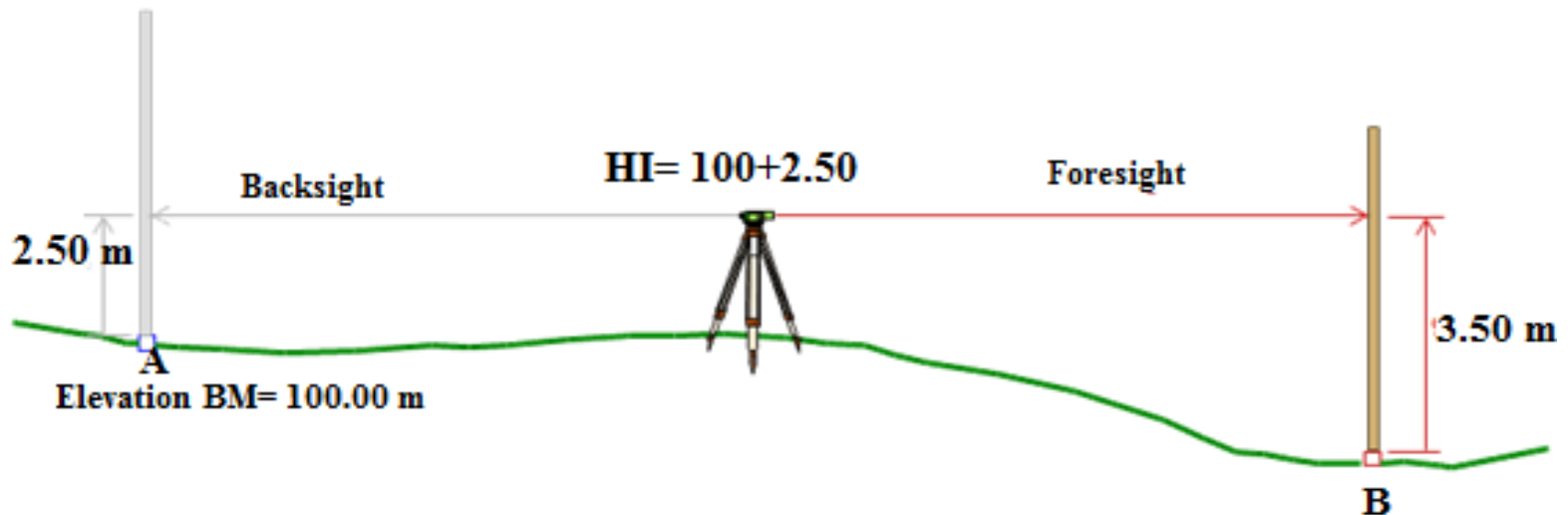
- a rod reading taken on point of known elevation. This is used for obtaining the level line of sight or HI. Also known as plus sight since it is always added.



- **Height of the instrument (HI):** is the relative elevation of the line of sight of the instrument as referred to the elevation of the datum plane, bench mark or turning point. ( $HI = \text{Elevation} + BS$ )



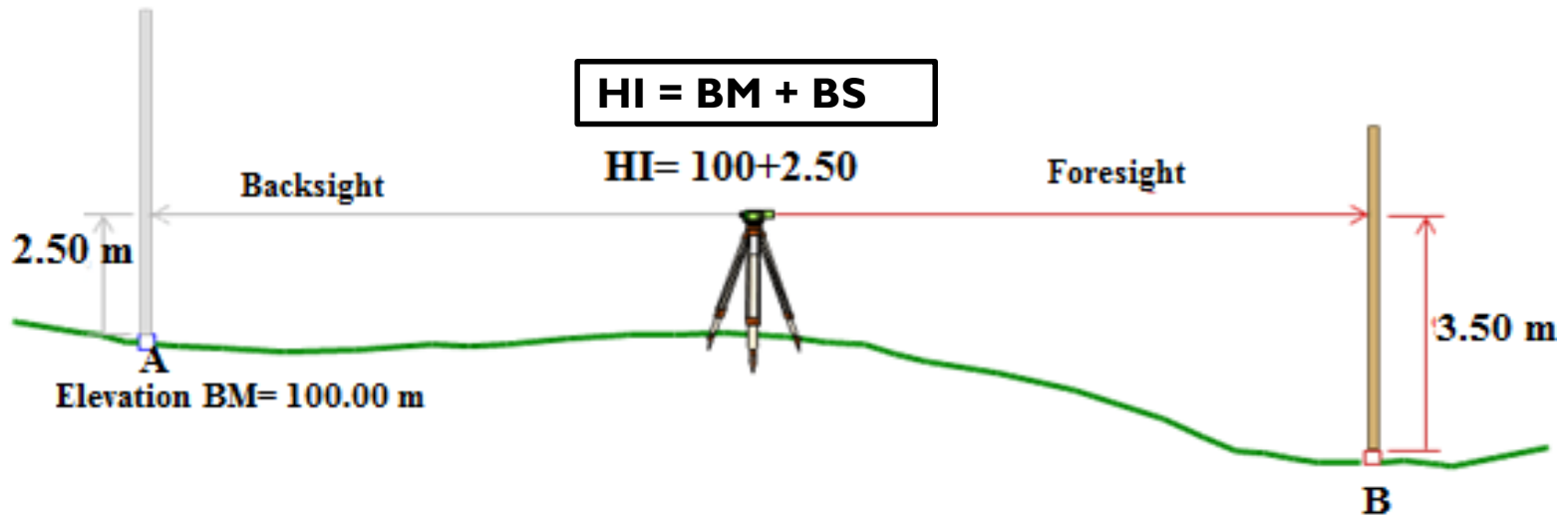
- **Foresight or minus sight (FS):** a rod reading taken on any point of unknown elevation. Also known as minus sight since it is always subtracted.



$$\begin{aligned} \text{Elevation} &= \text{HI} - \text{FS} \\ &= 102.5 - 3.50 \\ &= 99.00 \text{ m} \end{aligned}$$

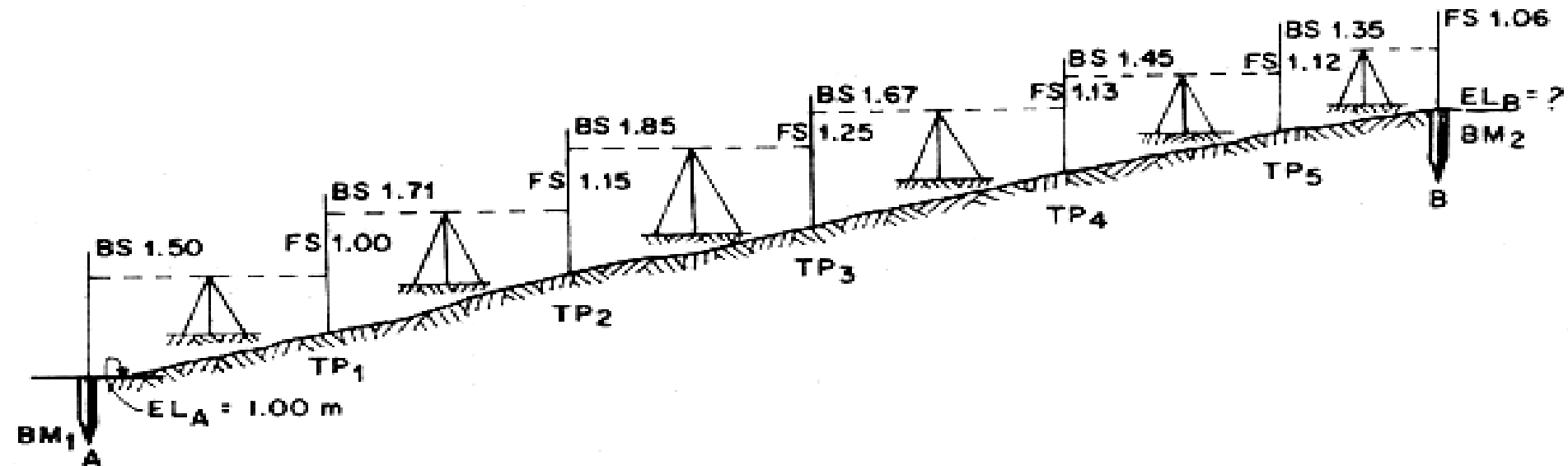
- **Elevation** — refers to the vertical distance of a ground point from the reference datum plane.

$$\text{Elevation} = \text{HI} - \text{FS}$$



$$\begin{aligned} \text{Elevation} &= \text{HI} - \text{FS} \\ &= 102.5 - 3.50 \\ &= 99.00 \text{ m} \end{aligned}$$

- **Turning point (TP)** — it is generally impossible to take all the readings along the direction of survey without moving the instrument. The TP is an intermediate station or reference point whenever the instrument is moved from one set-up to another. A point which is no longer needed after the necessary



Station	BS	HI	FS	ELEVATION, m
BM <sub>1</sub>				
TP <sub>1</sub>				
TP <sub>2</sub>				
TP <sub>3</sub>				
TP <sub>4</sub>				
TP <sub>5</sub>				
BM <sub>2</sub>				



- **HI = elevation or BM + BS**
- **Elevation = HI - FS**
- **Sum BS - Sum FS = Elev. BM<sub>2</sub> - Elev. BM<sub>1</sub>**

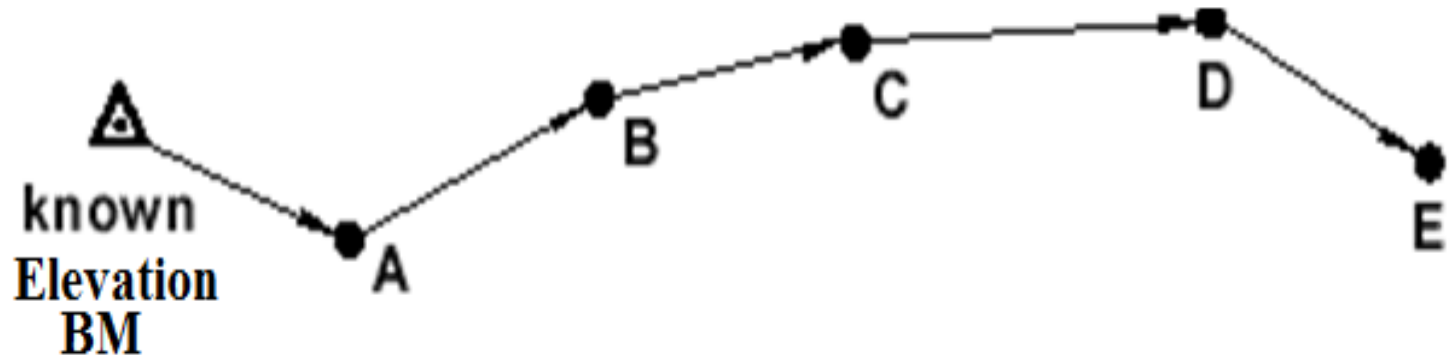
# Requirement Tools:

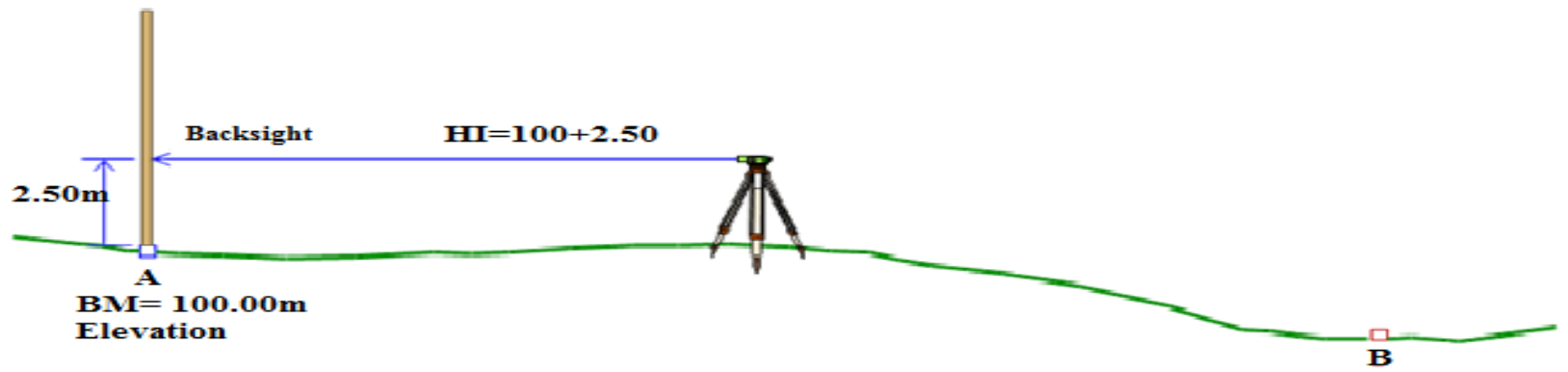
- Leveling instrument
- Tripod
- Staff/ Leveling Rod

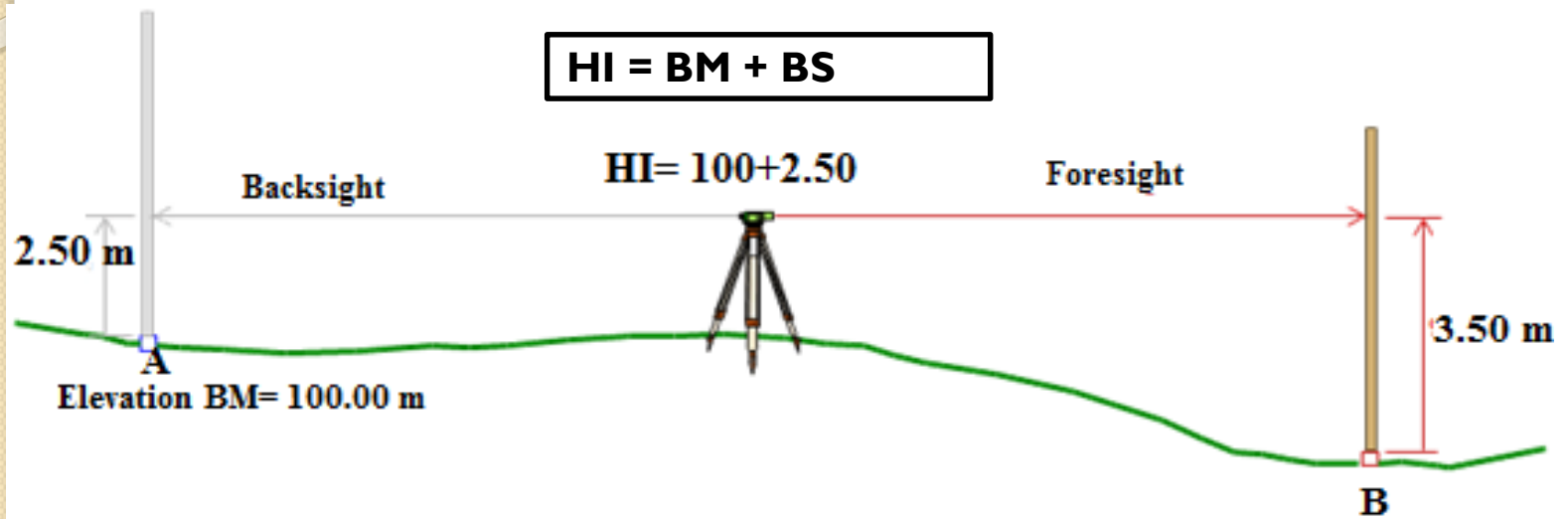
# Procedures:

1. Open level Traverse Differential Leveling
2. Closed loop level traverse

# Open level Traverse Differential Leveling







$$HI = BM + BS$$

$$HI = 100 + 2.50$$

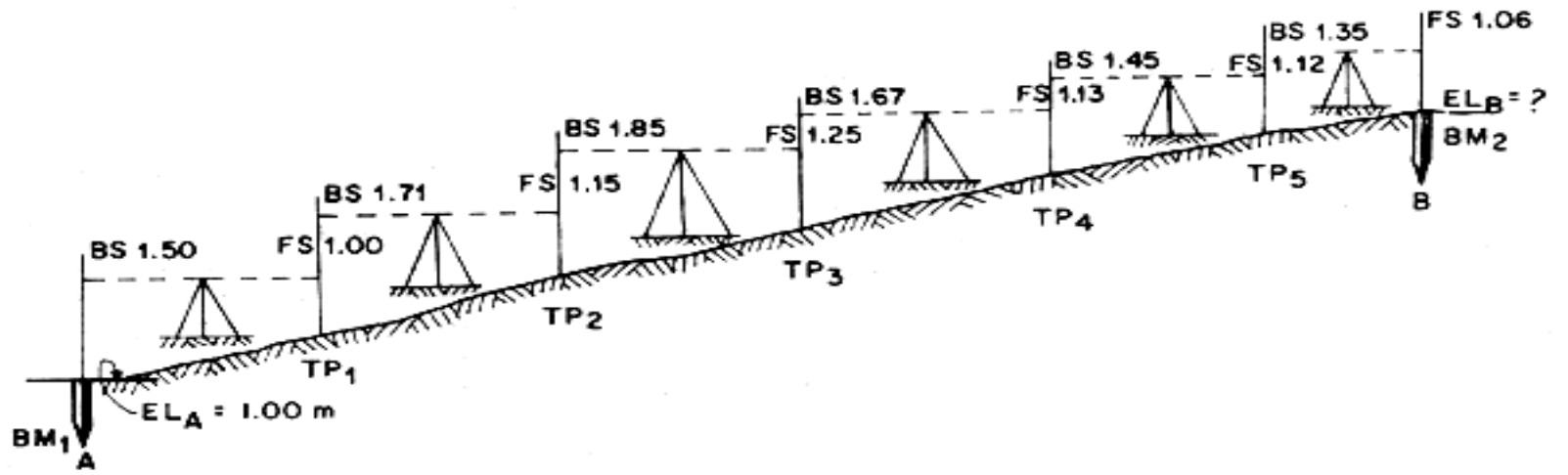
Foresight

3.50 m

2.50 m

Elevation BM = 100.00 m

$$\begin{aligned} \text{Elevation} &= HI - FS \\ &= 102.5 - 3.50 \\ &= 99.00 \text{ m} \end{aligned}$$



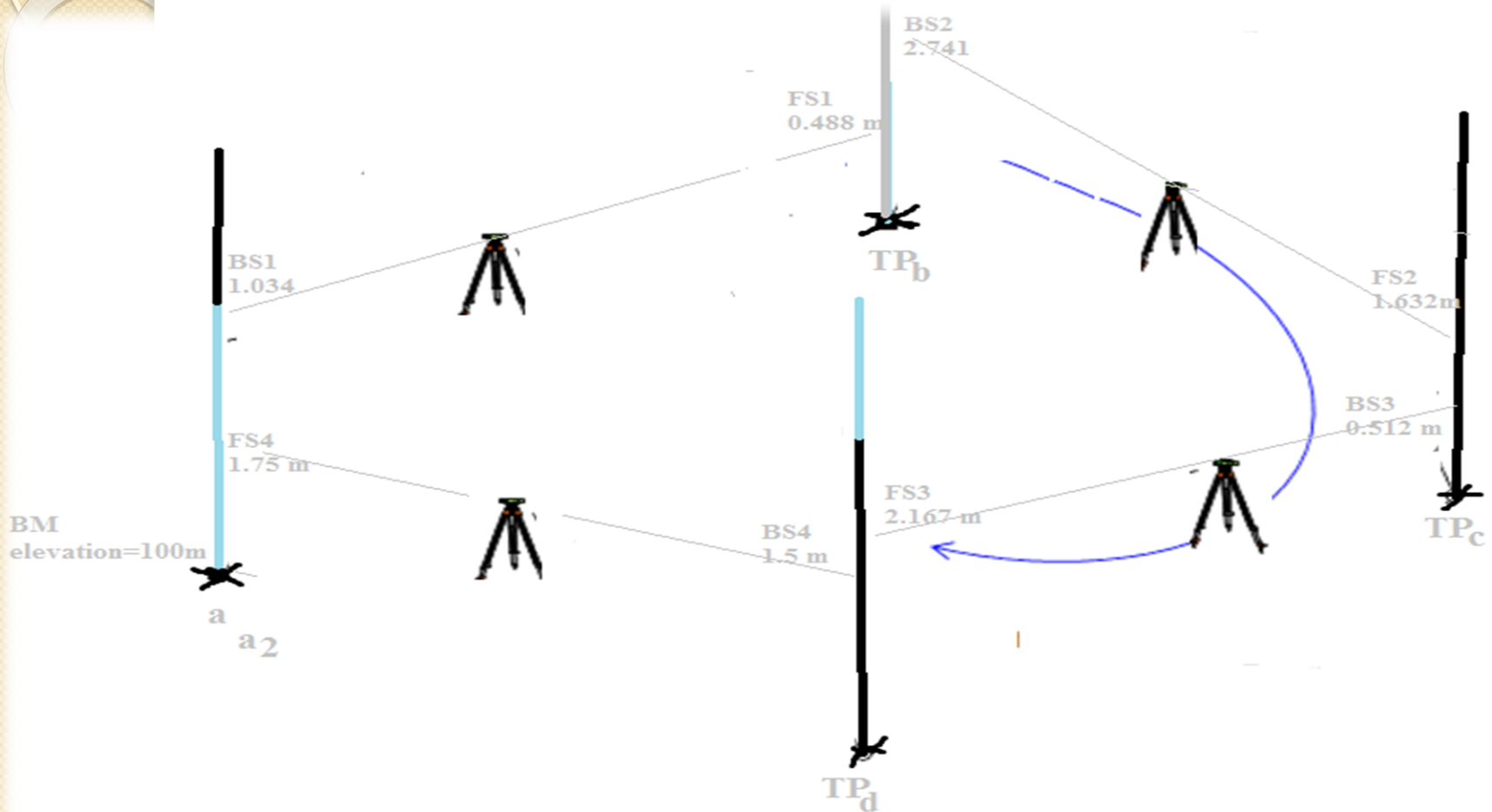
STA	BS	HI	FS	ELEVATION, m
BM <sub>1</sub>	1.50	3.00	-	1.50
TP <sub>1</sub>	1.71	3.71	1.00	2.00
TP <sub>2</sub>	1.85	4.41	1.15	2.56
TP <sub>3</sub>	1.67	4.83	1.25	3.16
TP <sub>4</sub>	1.45	5.15	1.13	3.70
TP <sub>5</sub>	1.35	5.38	1.12	4.03
BM <sub>2</sub>	-	-	1.06	4.32

## Procedure (2): Closed loop level traverse

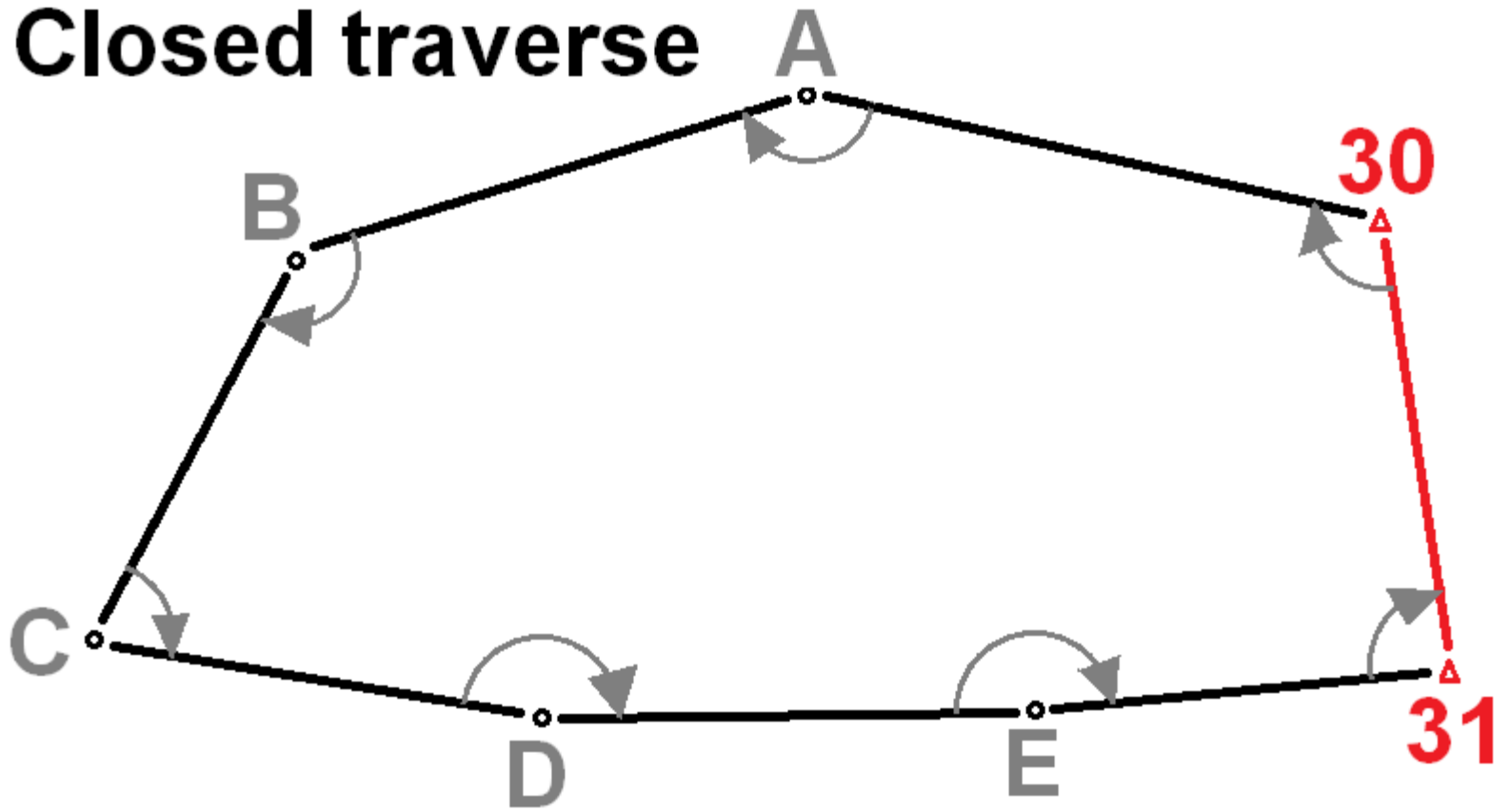
- An example for Closed loop level traverse:
- A differential level network is run from BM through ( a ), TPb and closes back on BM (a). so *Arithmetic check*, completion of the level note for HI's and elevations follow after the field work. To check for the accuracy of addition and subtraction, the difference in the sums of the backsights and foresights must be equal to the numerical difference in elevation between BM<sub>2</sub> and BM<sub>1</sub>, or:
  - **Sum BS - Sum FS = Elev. BM<sub>2</sub> - Elev. BM<sub>1</sub>**



## Procedure (2): Closed loop level traverse



# Closed traverse



<b>Point</b>	<b>BS</b>	<b>HI</b>	<b>FS</b>	<b>Elev</b>	
<b>BM a</b>	<b>1.034</b>	<b>101.034</b>		<b>100.00 m</b>	
<b>TPb</b>	<b>2.741</b>	<b>103.287</b>	<b>0.488</b>	<b>100.546</b>	
<b>TPc</b>	<b>0.512</b>	<b>102.167</b>	<b>1.632</b>	<b>101.655</b>	
<b>TPd</b>	<b>1.50</b>	<b>101.75</b>	<b>1.917</b>	<b>100.25</b>	
<b>BM a</b>		:	<b>1.75</b>	<b>100.00 m</b>	
			:		

# ***Arithmetic check:***

$$\text{Sum BS} - \text{Sum FS} = \text{Elev. BM}_2 - \text{Elev. BM}_1$$

$$\text{Summation BS} = 5.787$$

$$\text{Summation FS} = 5.787$$

$$\text{Elev. BM}_2 = 100.00$$

$$\text{Elev. BM}_1 = 100.00$$

$$\sum \text{BS} - \sum \text{FS} = \text{Elev. BM}_2 - \text{Elev. BM}_1$$

$$5.787 - 5.787 = 100.00 - 100.00$$

$$0 = 0$$



**Questions?**



**Thank you  
for your  
attention**