

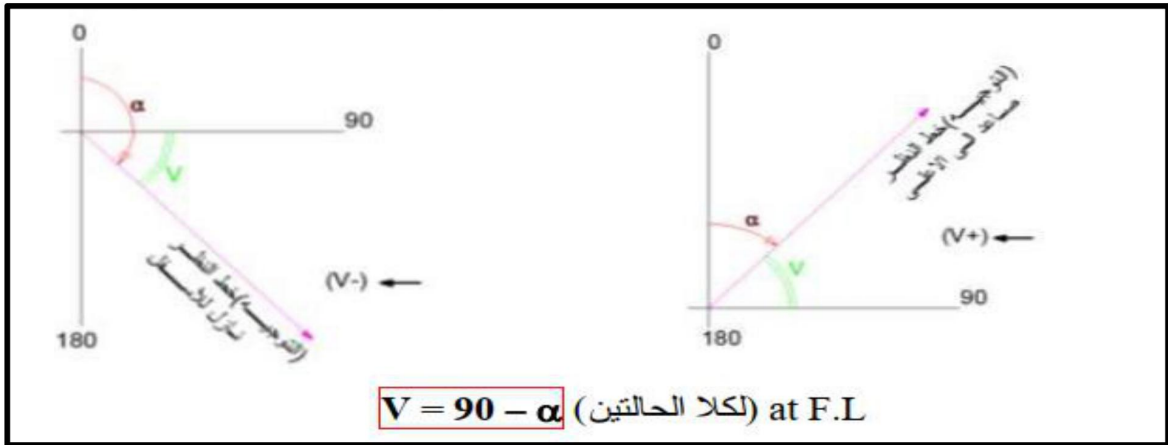


Method of measuring vertical angle

The angle enclosed between the horizontal line and the direction of the sighting line is not directly measured by a theodolite. Instead, a specific reading, denoted as (α) and called reading of vertical circle obtained from the vertical circle, and this reading is used to determine the vertical angle. The value of the vertical angle is dependent on the instrument's position during observation (face left or face right) . This can be described as follows:

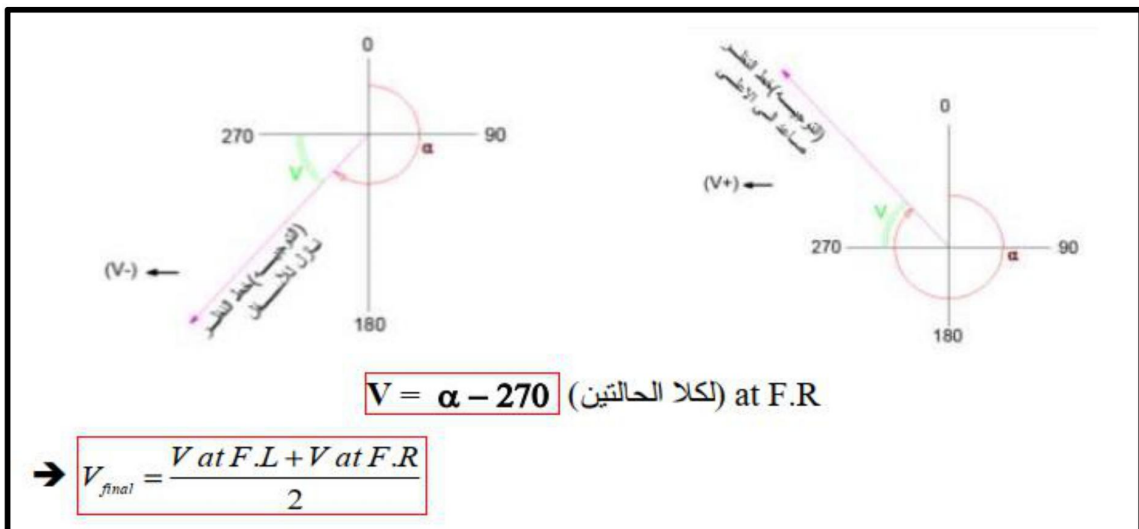
For the face left position (F.L)

The case of a vertical angle is as follows



For the face right position (F.L)

When the device is in face right, we have the following conditions





Example: the vertical angle was measured from station A to station B C D as shown in the following table:

محطة الجهاز	النقطة المرصودة	قراءة الزاوية العمودية	
		F.L	F.R
A	B	85° 14' 10"	274° 45' 10"
	C	93° 27' 14"	266° 32' 36"
	D	97° 18' 50"	262° 41' 18"

If the height of the theodolite at point A = 1.5 m and the level of point A is 30 metres, calculate the levels of points B, C and D if you know that the horizontal distances of these points are 50, 100 and 150, respectively.

Solution:

الحل: الخط AB

$$V \text{ at F.L} = 90 - \alpha = 90 - 85^\circ 14' 10'' = 4^\circ 45' 50''$$

$$V \text{ at F.R} = \alpha - 270 = 274^\circ 45' 10'' - 270 = 4^\circ 45' 10''$$

$$V_{final} = \frac{V \text{ at F.L} + V \text{ at F.R}}{2} = \frac{4^\circ 45' 50'' + 4^\circ 45' 10''}{2} = +4^\circ 45' 30'' \quad \text{زاوية الارتفاع}$$

$$\text{Elev. B} = \text{Elev. A} + \text{H.I} + H$$

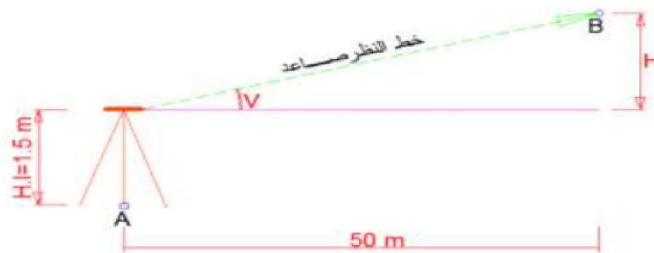
$$\text{But } H = 50 \tan V$$

$$= 50 \tan 4^\circ 45' 30''$$

$$= 4.162 \text{ m}$$

$$\text{Elev. B} = 30 + 1.5 + 4.162$$

$$= 35.622 \text{ m}$$



الخط CA

$$V \text{ at F.L} = 90 - \alpha = 90 - 93^\circ 27' 14'' = -3^\circ 27' 14''$$

$$V \text{ at F.R} = \alpha - 270 = 266^\circ 32' 36'' - 270 = -3^\circ 27' 24''$$

$$V_{final} = \frac{V \text{ at F.L} + V \text{ at F.R}}{2} = \frac{-3^\circ 27' 14'' + (-3^\circ 27' 24'')}{2} = -3^\circ 27' 19'' \quad \text{زاوية الانخفاض}$$

$$\text{Elev. C} = \text{Elev. A} + \text{H.I} - H$$

$$\text{But } H = 100 \tan V = 100 \tan -3^\circ 27' 19'' = -6.038 \text{ m}$$

$$\text{Elev. C} = 30 + 1.5 - 6.038 = 25.462 \text{ m}$$

الخط DA

$$V \text{ at F.L} = 90 - \alpha = 90 - 97^\circ 18' 50'' = -7^\circ 18' 50''$$

$$V \text{ at F.R} = \alpha - 270 = 262^\circ 41' 18'' - 270 = -7^\circ 18' 42''$$

$$V_{final} = \frac{V \text{ at F.L} + V \text{ at F.R}}{2} = \frac{-7^\circ 18' 50'' + (-7^\circ 18' 42'')}{2} = -7^\circ 18' 46'' \quad \text{زاوية الانخفاض}$$

$$\text{Elev. D} = \text{Elev. A} + \text{H.I} - H$$

$$\text{But } H = 150 \tan V = 150 \tan (-7^\circ 18' 46'') = -19.249 \text{ m}$$

$$\text{Elev. D} = 30 + 1.5 - 19.249 = 12.25 \text{ m}$$



Example: What is the height of a building if it was monitored using a theodolite device, and the meteorological results were as follows

موقع الجهاز	النقطة المرصودة	قراءة الزاوية العمودية		المسافة الأفقية من الجهاز إلى البناية
		F.L	F.R	
M	A في أعلى البناية	54° 12' 36"	305° 47' 30"	20 m
	B في أسفل البناية	93° 14' 53"	266° 45' 19"	

الحل: الخط MA الموجه إلى قمة البناية:

$$V \text{ at F.L} = 90 - \alpha = 90 - 54^\circ 12' 36'' = 35^\circ 47' 24''$$

$$V \text{ at F.R} = \alpha - 270 = 305^\circ 47' 30'' - 270 = 35^\circ 47' 30''$$

$$V_{final} = \frac{V \text{ at F.L} + V \text{ at F.R}}{2} = \frac{35^\circ 47' 24'' + 35^\circ 47' 30''}{2} = 35^\circ 47' 27'' \quad \text{زاوية الارتفاع}$$

الخط MB الموجه إلى قمة البناية:

$$V \text{ at F.L} = 90 - \alpha = 90 - 93^\circ 14' 53'' = -3^\circ 14' 53''$$

$$V \text{ at F.R} = \alpha - 270 = 266^\circ 45' 19'' - 270 = -3^\circ 14' 41''$$

$$V_{final} = \frac{V \text{ at F.L} + V \text{ at F.R}}{2} = \frac{-3^\circ 14' 53'' + (-3^\circ 14' 41'')}{2} = -3^\circ 14' 47'' \quad \text{زاوية الانخفاض}$$

$$\text{ارتفاع البناية (H)} = H_1 + H_2$$

$$H_1 = 20 \tan V_1$$

$$= 20 \tan 35^\circ 47' 27'' = 14.42 \text{ m}$$

$$H_2 = 20 \tan V_2$$

$$= 20 \tan (-3^\circ 14' 47'') = 1.134 \text{ m}$$

$$H = H_1 + H_2 = 14.42 + 1.134 = 15.554 \text{ m}$$

