CE 103: Surveying

Lecture 9: Height and distance

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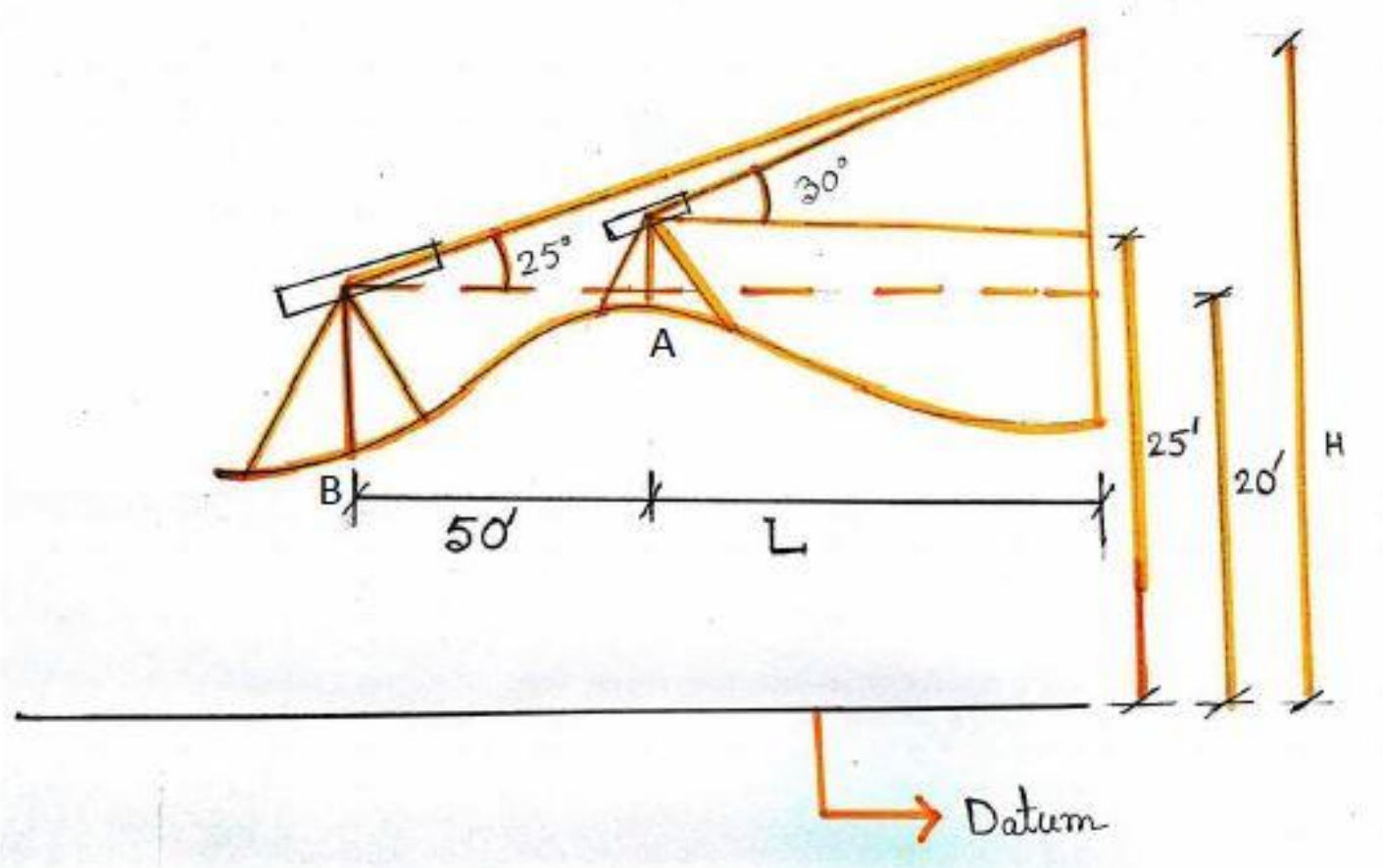
Outline

- ❑Tower height measurement using theodolite
- ❑Trigonometry for measurement
- ❑Aerial distance in 3D
- ❑Aerial distance math problem

Mathematical Problem 01

A tower structure is located at point P .Readings are taken with two theodolite from two points A and B 90 ft apart. The R.L. of instrument centre at A & B are 25.0ft and 20.0ft respectively. The vertical angle readings from A and B to top tower at P are 30° and 25° respectively. Determine R.L. of top of tower and the distance of the tower from point A.



$$\tan 30° = \frac{H - 25'}{L}$$

$$\Rightarrow 0.57735\,L = H - 25$$

$$\Rightarrow H - 0.57735\,L = 25 \quad \text{.....(i)}$$

Again,

$$\tan 25° = \frac{H - 20'}{50' + L}$$

$\Rightarrow 23.3154 + 0.4663\ L = H - 20$

$\Rightarrow H - 0.4663\ L = 23.3154 + 20$

$\Rightarrow H - 0.4663\ L = 43.3154$ .....(ii)

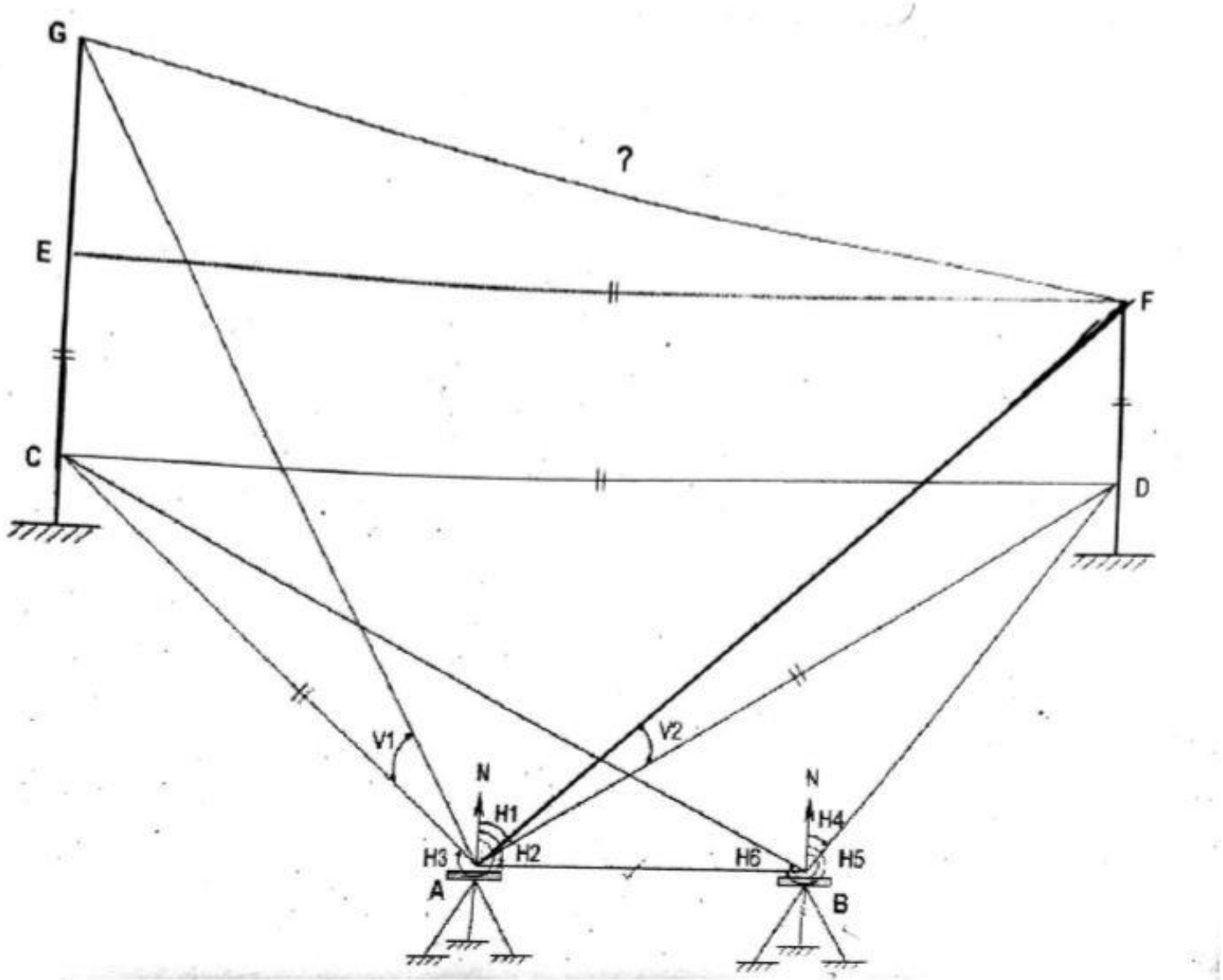
Solving (i) and (ii),

$H = 120.2'$

$L = 164.93'$

Aerial Distance in 3D

- Instrument Stations A & B
- Points A,B,C,D in same horizontal plane.
- Determine horizontal distance EF using AB & horizontal Angles H1, H2, H3, H4 etc.
- Determine vertical distance GE using vertical angles V1, V2


G
?
E
F
C
D
V1
V2
N
H1
H3
H2
A
N
H4
H6
H5
B

Mathematical Problem 02

A & B are Theodolite Stations, 100 ft apart R.L. of Instrument at A & B are 25.2 & 20.4 ft. Vertical angles from A to tower top at P & Q are 30°& 25°. Plan view is given in Figure 1. Determine aerial distance between Tower P and Q.

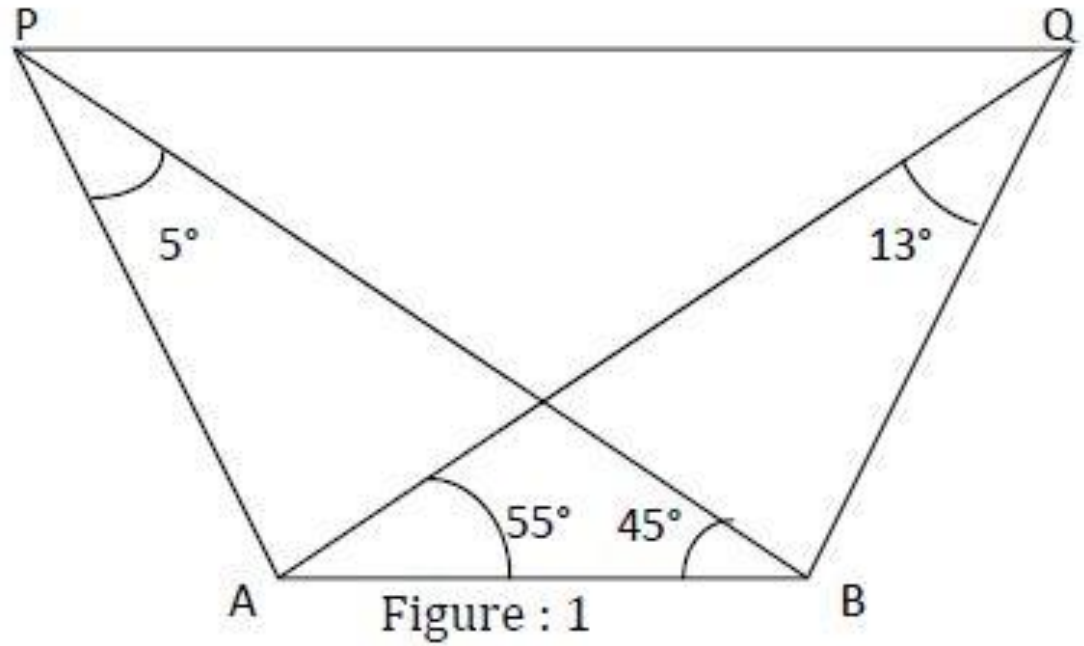


Figure : 1

$\triangle APB$:-

$\angle BAP = 180° - (5° + 45°)$

$= 130°$

From $\triangle APB$,

$$\frac{AP}{\sin \angle ABP} = \frac{AB}{\sin \angle APB}$$

$$\therefore \quad AP = \frac{100'}{\sin 5^\circ} \times \sin 45^\circ$$

$$= 811.31'$$

From $\triangle ABQ$,

$$\frac{AQ}{\sin \angle ABQ} = \frac{AB}{\sin \angle AQB}$$

$$\therefore \quad AQ = \frac{100'}{\sin 13^\circ} * \sin \{180^\circ - (55^\circ + 13^\circ)\}$$

$$= \frac{100'}{\sin 13^\circ} * \sin 112^\circ$$

$$= 412.17'$$

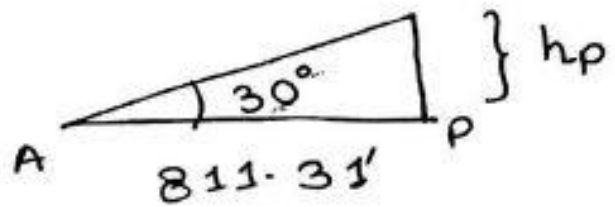
$\triangle PAQ -$

$\angle PAQ = 130° - 55° = 75°$

$\triangle PAQ -$

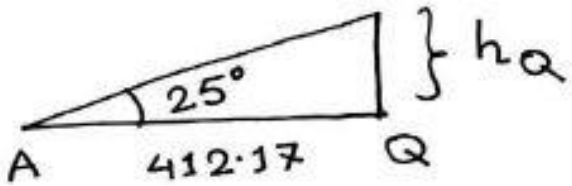
$PQ^2 = AP^2 + AQ^2 - 2.AP.AQ.\cos \angle PAQ$

$\therefore PQ = 809.33'$



$h_P = (811.31) \tan 30^\circ$

$= 468.41'$

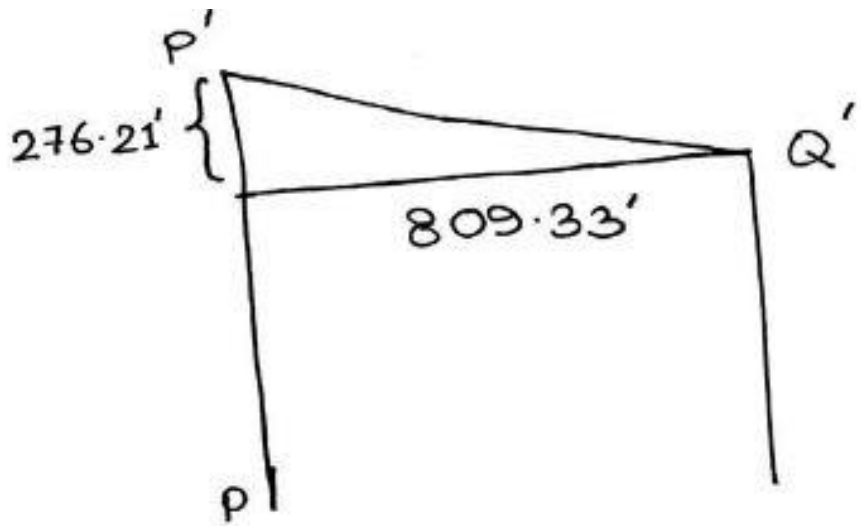


$h_Q = (412.17) \tan 25^\circ$

$= 192.20'$

Difference in height between two towers $= h_P - h_Q$

$= 276.21'$



Aerial Distance, $P'Q'$

$= \sqrt{(276.21)^2 + (809.33)^2}$

$= 855.16$ ft