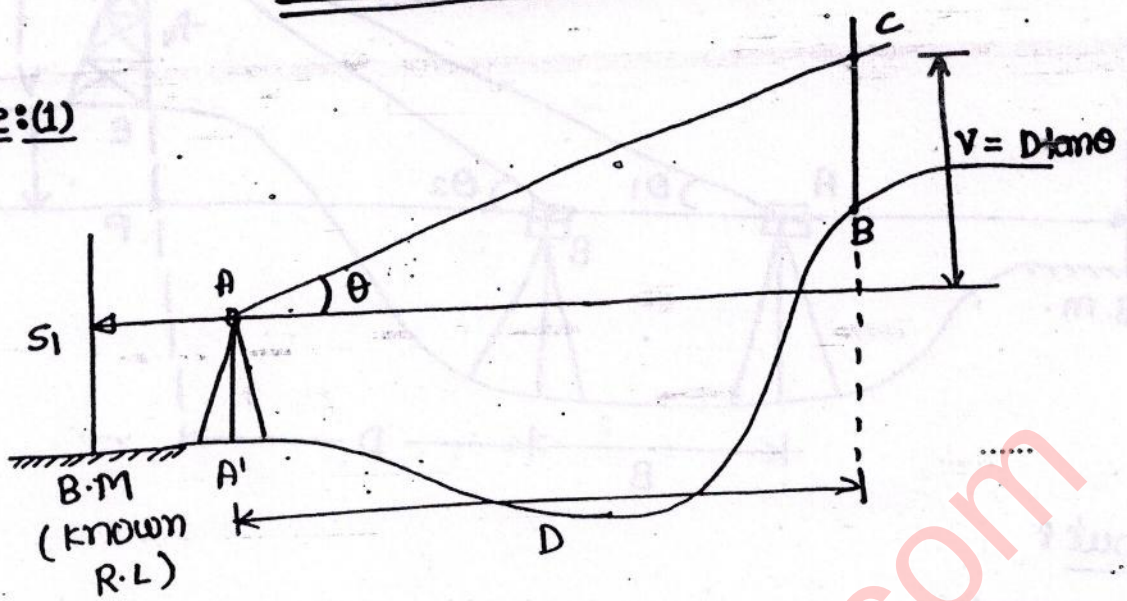
TRIGONOMETRICAL LEVELLING

Case:(1)



Vertical height ⇒

$$V = D \tan\theta$$

Known values :-

(i) R·L of B·M.

(ii) Staff Reading B·M = S_1

(iii) Angle = θ

(iv) Distance = D

Find out R·L of C -

R·L of C :-

$$\boxed{\text{R·L of C} = \text{R·L of B·M} + S_1 + V + C}$$

$$\boxed{C = 0.0673 d^2}$$ correction due to curvature and refraction.

Case: (2) : If distance 'D' can not be measured :

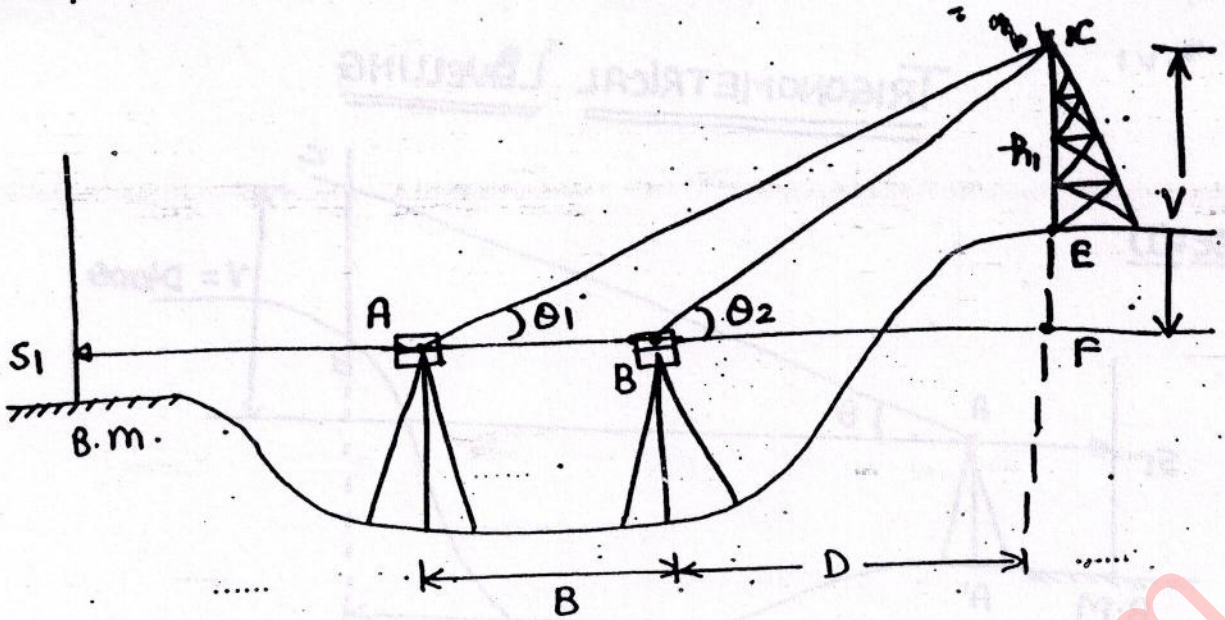
Known values

(i) R·L of B·M.

(ii) Staff reading at BM = S_1

(iii) Angle θ_1 & θ_2

(iv) Distance B.



Find out :

(1) Distance 'D'

(2) V

(3) R.L of C/E point

In Δ ACF

$$\tan\theta_1 = \frac{V}{B+D}$$

$$V = (B+D)\tan\theta_1 \quad \text{---} (1)$$

In Δ BCF

$$\tan\theta_2 = \frac{V}{D}$$

$$V = D\tan\theta_2 \quad \text{---} (2)$$

Put (2) in (1)

$$D\tan\theta_2 = (B+D)\tan\theta_1$$

$$D(\tan\theta_2 - \tan\theta_1) = B\tan\theta_1$$

$$D = \frac{B\tan\theta_1}{(\tan\theta_2 - \tan\theta_1)} \quad -(A)$$

$$V = D\tan\theta_2$$

$$V = \frac{B\tan\theta_1 \cdot \tan\theta_2}{(\tan\theta_2 - \tan\theta_1)} \quad \text{—— (B)}$$

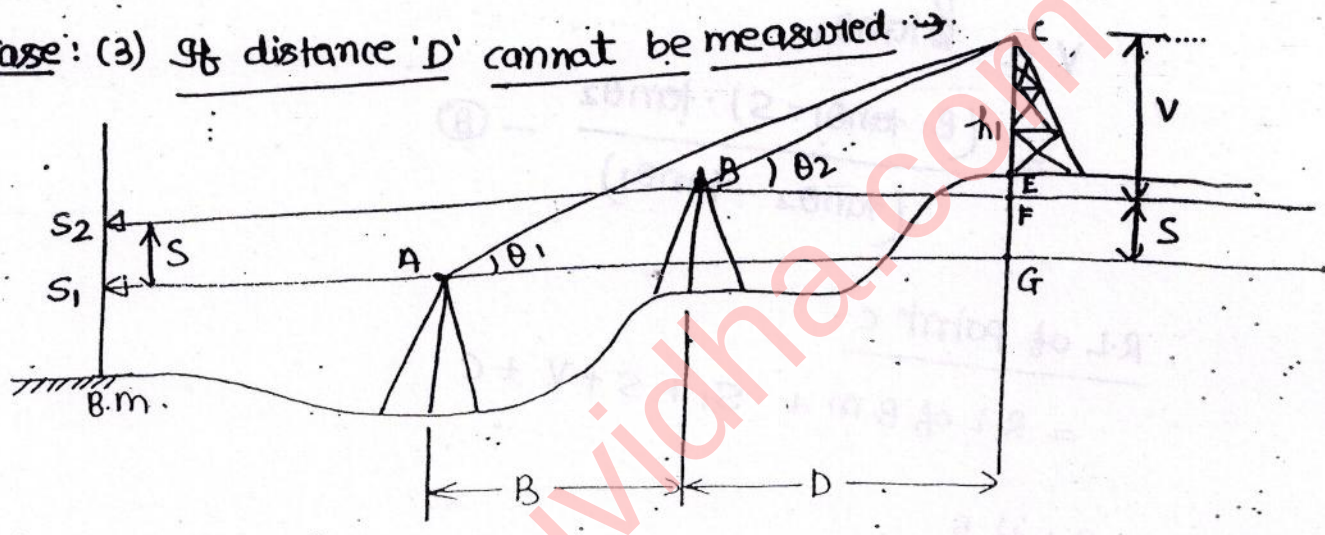
R.L of point C

= R.L of Bm + S_1 + V. + C

R.L of E

= R.L of C − h_1

Case: (3) If distance 'D' cannot be measured →



Known Value

(1) R.L of B.m.

(2) Staff Reading at Bm = S_1/S_2

(3) Angle θ_1 & θ_2

(4) Distance 'B'

Find out

(1) Distance 'D'

(2) 'V'

(3) R.L of C/E point

In Δ ACG

$$\tan\theta_1 = \frac{V+S}{B+D}$$

$$(V+S) = (B+D)\tan\theta_1 \quad \text{—— (1)}$$

In ΔBCF

$$\tan\theta_2 = \frac{V}{D} \Rightarrow V = D\tan\theta_2 \quad \text{— (2)}$$

Put (2) in (1)

$$D\tan\theta_2 + S = (B+D)\tan\theta_1$$

$$D(\tan\theta_2 - \tan\theta_1) = B\tan\theta_1 - S$$

$$D = \frac{B\tan\theta_1 - S}{(\tan\theta_2 - \tan\theta_1)}$$

$$V = {}^{D}B\tan\theta_2$$

$$= \frac{(B\cdot\tan\theta_1 - S)\cdot\tan\theta_2}{(\tan\theta_2 - \tan\theta_1)} \quad \text{---} (B')$$

R.L of point C

= R.L of B.m + S_1 + S + V + C

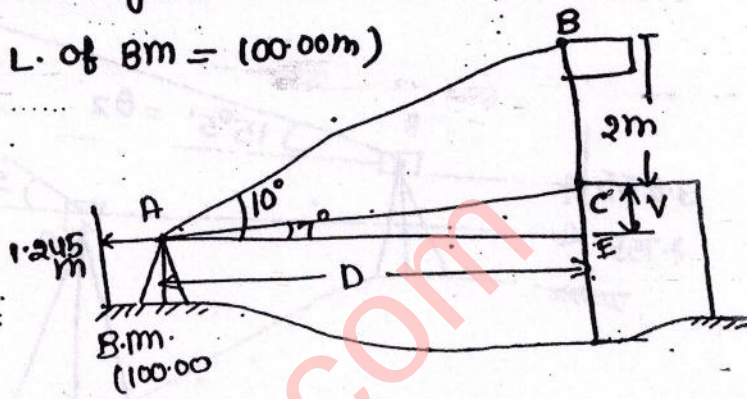
R.L of E

= R.L of C - h_1

01/01/2014

ES-2005 3(a)

Ques: (1) A flag post of ht. 2m was erected on top of a building. Find the R.L of top of flag post. If the vertical angle to bottom and top of it were measured as 7° and 10° resp. from a point. Staff reading on a B.M from the same pt. at 0°0'0" was 1.245 m (R.L. of Bm = 100.00m)



$\tan 7° = \frac{V}{D}$ .....

$V = D \cdot \tan 7°$ —(1)

$\tan 10° = \frac{V+2}{D}$

$V + 2 = D \tan 10°$ —(2)

$D \tan 7° + 2 = D \tan 10°$

$\boxed{D = 37.35\ m}$

$V = D \tan 7°$

$V = 37.35 \tan 7°$

$\boxed{V = 4.59\ m}$

R.L. of top of the flag :-

= RL of Bm + S_1 + V + 2

= 100 + 1.245 + 4.59 + 2.0

= 107.83m.

Ques: (ES-2001) In order to determine the elevation of top of 6(b)) a signal on a hill observations were made from 2 points P & R. All three points are in same vertical plane.

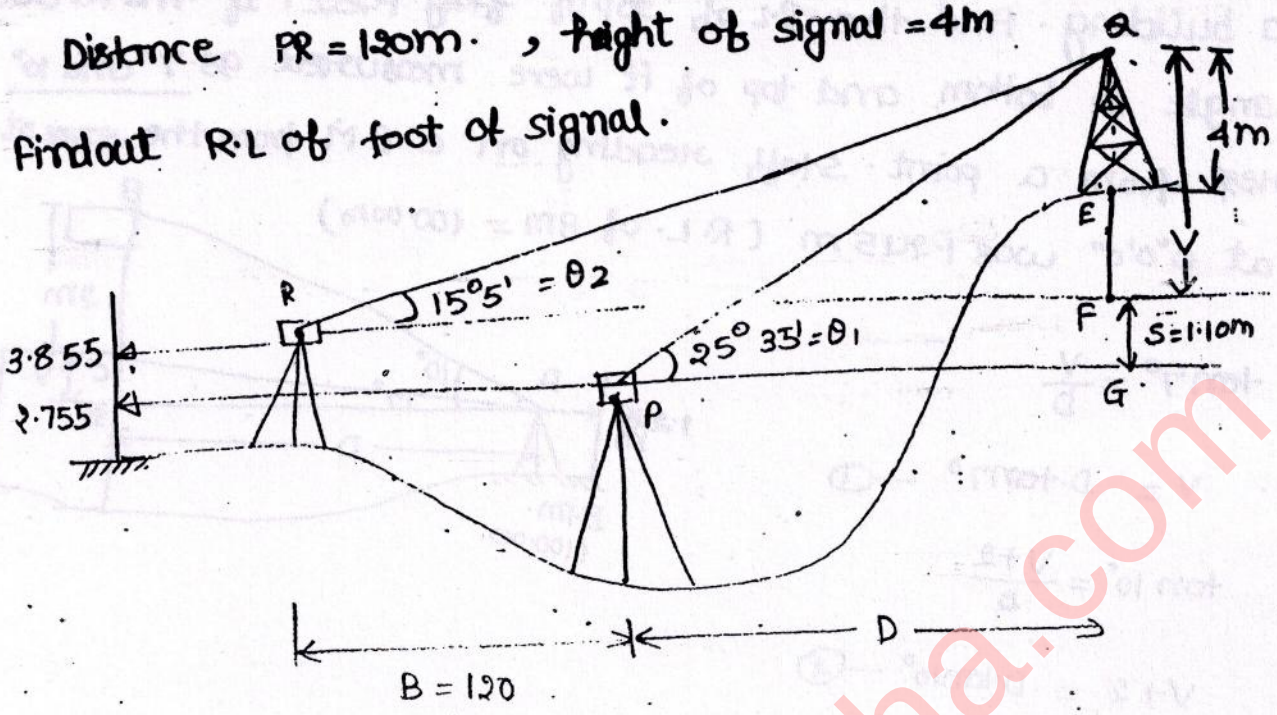
Angle of elevation to Q | from P = 25°35'
R = 15°5'

Staff reading at B.M | from P = 2.755m
from R = 3.855 m.

R.L = 105.42 m.

Distance PR = 120m. , height of signal = 4m

Findout R.L of foot of signal.



$$\tan\theta_1 = \frac{V+S}{D}$$

$$V+S = D\tan\theta_1 \quad \text{— (1)}$$

$$\tan\theta_2 = \frac{V}{B+D}$$

$$V = (B+D)\tan\theta_2 \quad \text{— (2)}$$

Put in 1.

$$(B+D)\tan\theta_2 + S = D\tan\theta_1$$

$$D = \frac{B\tan\theta_2 + S}{\tan\theta_1 - \tan\theta_2}$$

$$= \frac{120\tan 15°5' + 1.10}{\tan 25°35' - \tan 15°5'}$$

$$\boxed{D = 159.81\text{m}}$$

∴ in eqn (1)

$V = (B+D)\tan\theta_2$

$= (120 + 159.8)\tan 15°51'$

$\boxed{V = 75.41m}$

R.L of foot of signal —

$= R.L \text{ of } B.M + S_2 + V - 4.0$

$= 105.42m + 3.855 + 75.41 - 4.0$

$= 180.68\ m$

ES-1992
Que (5(b)) Determine the R.L of a church spire at C from the following observations taken from two stations.

A & B 50 m apart $\angle BAC = 60°$, $\angle ABC = 50°$

Angle of elevation to top of spire from A $= 30°$

" B $= 29°$.

Staff reading on a B.M. of R.L $= 25.0m$ from A $= 2.5m$

from B $= 0.50m$

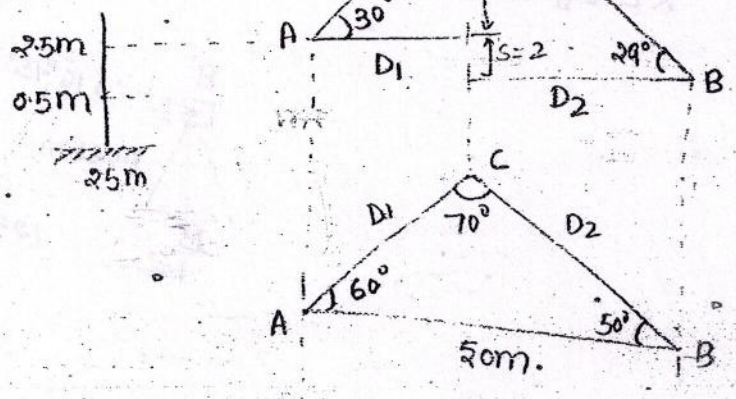
In plan :—

In $\triangle ABC$

$\frac{D_1}{\sin 50°} = \frac{D_2}{\sin 60°} = \frac{50}{\sin 70°}$

$\boxed{D_1 = 40.76\ m}$

$\boxed{D_2 = 46.08\ m}$



$V = D_1 \tan 30°$

$= 40.76 \tan 30°$

$\boxed{V = 23.53m}$

R.L. of C = R.L of BM + 2.5 + V

= 25 + 2.5 + 23.53

R.L. of C = 51.03m

$V + S = D_2 \tan 29°$

$V = 46.08 \tan 29° - 2.0$

V = 23.54m

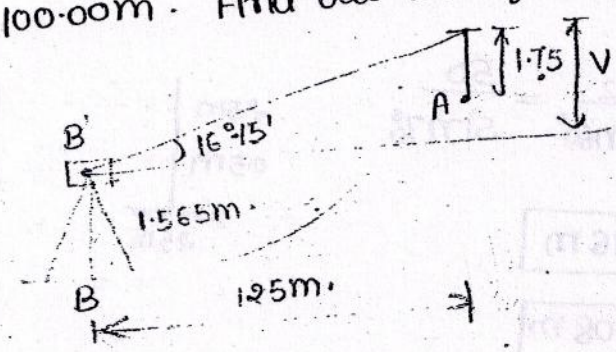
R.L. of C = 25.0 + 2.50 + 23.54

R.L. of C. = 51.04m

Ques ES-2004 8- The top of a stack was sighted from 2 stations A & B 125m apart & are in same vertical plan with top of the stack. Angle of the elevation of top of stack — from A = 35°20', from B = 22°28'

The angle of elevation from B to a vane 1.75m above the foot of staff held at station A was 16°15' If instrument height at A = 1.856m & at B = 1.565m.

R.L. of station B = 100.00m. Find out R.L. of top of the stack.



$V = D \tan 16°15'$

$V = 125 \tan 16°15'$

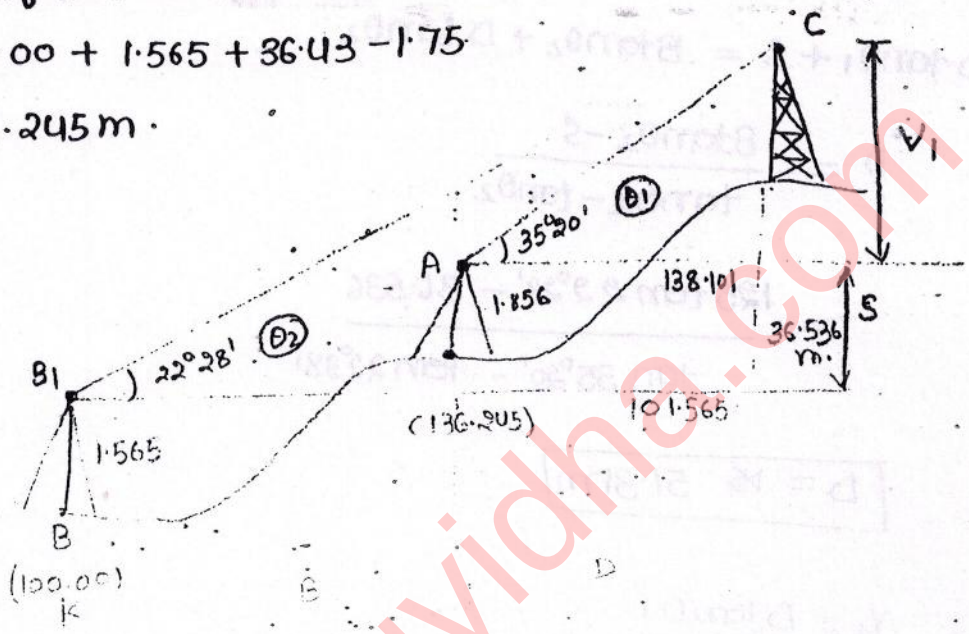
$\boxed{V = 36.43 \text{ m}}$

R.L. of A →

$= \text{R.L of B} + 1.565 + V - 1.75$

$= 100.00 + 1.565 + 36.43 - 1.75$

$= 136.245 \text{ m}$



(II) R.L. of A = 136.245 m

H.I. of A = 136.245 + 1.856

= 138.101 m

(III) R.L. of B = 100.00

H.I. of B = 100.00 + 1.565

= 101.565 m

$S = \text{H.I. of A} - \text{H.I of B}$

$= 138.101 - 101.565$

$\boxed{S = 36.536 \text{m}}$

$$\tan\theta_1 = \frac{V_1}{D}$$

$$\boxed{V_1 = D\tan\theta_1} \quad \text{—— (1)}$$

$$\tan\theta_2 = \frac{V+S}{B+D}$$

$$V+S = (B+D)\tan\theta_2$$

$$D\tan\theta_1 + S = B\tan\theta_2 + D\tan\theta_2$$

$$D = \frac{B\tan\theta_2 - S}{\tan\theta_1 - \tan\theta_2}$$

$$= \frac{125\tan 22°28' - 36.536}{\tan 35°20' - \tan 22°38'}$$

$$\boxed{D = 51.31\text{m}}$$

$$V_1 = D\tan\theta_1$$

$$= 51.31 \times \tan 35°20'$$

$$\boxed{V_1 = 36.37\text{m}}$$

R.L. of C

$$= \text{R.L. of A} + 1.856 + V_1$$

$$= 136.245 + 1.856 + 36.37$$

$$= 174.47\text{m}.$$