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SURVEYING ENGINEERING

CIVIL ENGINEERING

Date of Test : 30/09/2026

ANSWER KEY ➤

1. (c)	7. (b)	13. (c)	19. (c)	25. (c)
2. (b)	8. (b)	14. (c)	20. (a)	26. (c)
3. (b)	9. (b)	15. (d)	21. (c)	27. (b)
4. (a)	10. (a)	16. (b)	22. (a)	28. (b)
5. (b)	11. (c)	17. (d)	23. (b)	29. (b)
6. (c)	12. (d)	18. (d)	24. (d)	30. (b)

DETAILED EXPLANATIONS

1. (c)

2. (b)

Elevation difference between two points

$$= [\text{Last RL} - \text{First RL}] = [\Sigma BS - \Sigma FS]$$

$$= 21.68 - 29.32 = 7.64 \text{ m}$$

3. (b)

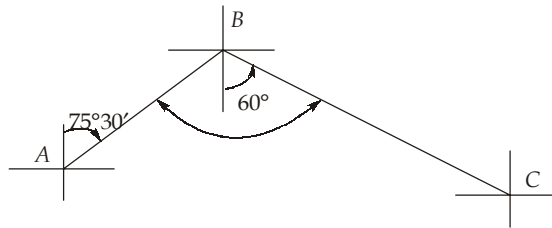
True bearing of sun at noon = 360°

$$TB = MB + \text{Declination}$$

$$\Rightarrow 360^\circ = 357^\circ + \text{declination}$$

$$\Rightarrow \text{Declination} = 360^\circ - 357^\circ = 3^\circ \quad (3^\circ \text{Eastwards})$$

4. (a)



$$\text{Internal angle} = 75^\circ 30' + 60^\circ = 135^\circ 30'$$

5. (b)

In order to help surveyors determine declination at a place, isogonic charts are published. These charts show:

- (a) Isogonic lines connecting places of equal declinations.
- (b) Agonic lines showing places having zero declination.
- (c) Lines connecting places having equal variations in declination.

6. (c)

If P , Q and R are the three stations whose plotted positions p , q and r are available on the plan and S is the station where the plane table is to be set up, then the accuracy with which the point s (plotted position of S on plane table) can be determined which is known as strength of fix. The strength of fix is good when

- (a) S lies within the triangle PQR .
- (b) The middle station is much nearer compared to the other two stations.
- (c) The angle subtended by PQ and QR at S is such that one is large while the other is small.

7. (b)

8. (b)

$$\text{Apex distance} = R \left(\sec \frac{\Delta}{2} - 1 \right)$$

$$R = 200 \text{ m}$$

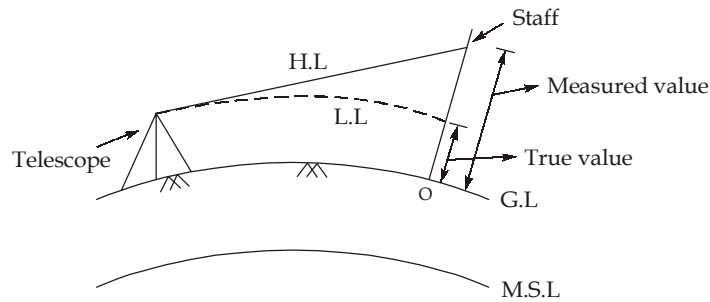
$$\Delta = 120^\circ$$

So,

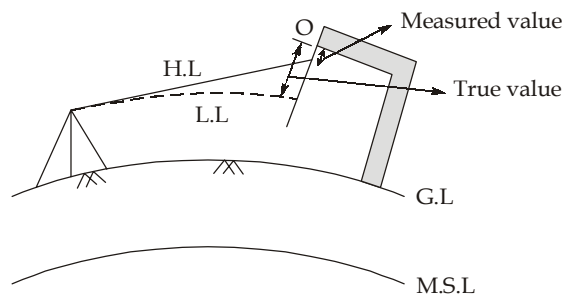
$$\begin{aligned} \text{Apex distance} &= 200 (\sec 60^\circ - 1) \\ &= 200 (2 - 1) = 200 \text{ m} \end{aligned}$$

9. (b)

$$\text{Correction} = \text{True value} - \text{Measured value}$$



H.L. → Horizontal line, L.L. → Level line, G.L. → Ground level
 M.S.L. → Mean sea level, O → Zero staff reading



For an inverted staff, magnitude of true value is more but as readings are taken with a negative sign, combined correction remains negative here also.

10. (a)

For anallatic tacheometer,

$$k = 100 \text{ and } c = 0$$

$$D = (kS + C)\cos\theta - h\sin\theta$$

$$\Rightarrow D = [100(3.480 - 1.110) + 0]\cos 8^\circ - 2.500 \sin 8^\circ$$

$$\Rightarrow D = 234.35 \text{ m}$$

11. (c)

$$\text{Using Simpson's } 1/3^{\text{rd}} \text{ rule, } A = \frac{h_1}{3}\{O_1 + O_3 + 4O_2\} + \frac{h_2}{3}\{O_3 + O_5 + 4O_4\}$$

$$\Rightarrow A = \frac{5}{3}\{2.5 + 8.4 + 4(3.8)\} + \frac{10}{3}\{8.4 + 10.5 + 4(7.6)\}$$

$$\Rightarrow A = (43.5 + 164.33) \text{ m}^2 = 207.83 \text{ m}^2$$

12. (d)

$$\Sigma BS - \Sigma FS = \text{Last RL} - \text{First RL}$$

$$\Rightarrow (2.310 + 0.880 + 1.000) - (0.190 + 1.340 + 2.500) = \text{Last RL} - 210.000$$

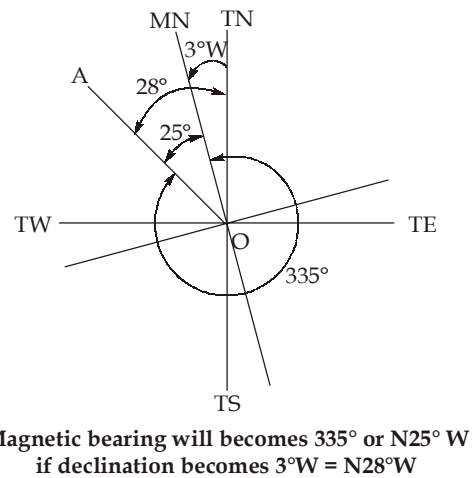
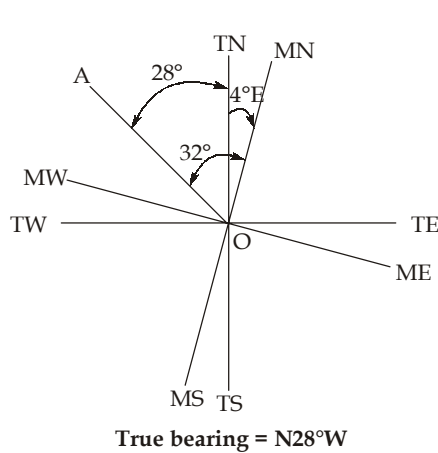
$$\Rightarrow \text{Last RL} = 210.160 \text{ m}$$

Alternatively,

S.No.	BS	IS	FS	HI	RL
1	2.310			212.31	210.000
2		1.180			211.13
3		-2.115			214.425
4	0.880		0.190	213.000	212.120
5	1.000		1.340	212.660	211.660
6			2.500		210.16

Check: $\Sigma BS - \Sigma FS = (2.310 + 0.880 + 1.000) - (0.190 + 1.340 + 2.500) = 0.16$
 Last RL - First RL = $210.16 - 210 = 0.16$ m

13. (c)

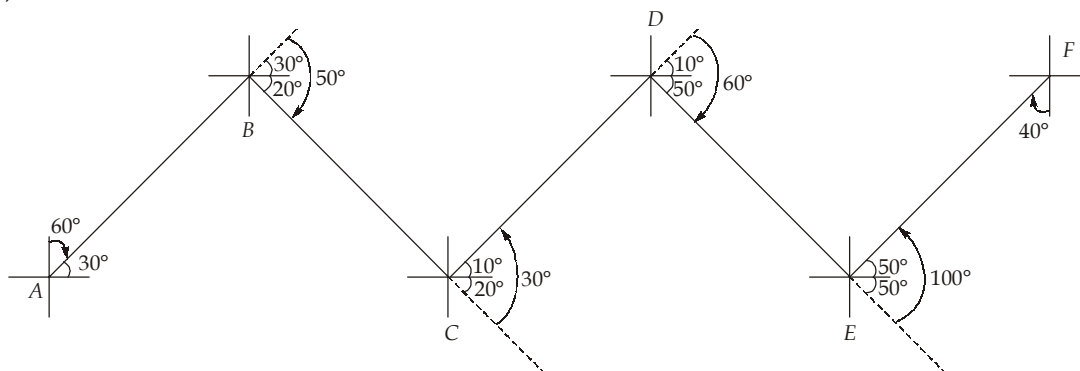


Final magnetic bearing of line = 335° = N25°W

Difference in declination angle = 7° towards west = 420 minutes (anti-clockwise)

$\therefore$ It will take $\frac{420}{7} = 60$ years to change direction of declination from 4°E to 3°W and when declination is 3°W, then the line will have its magnetic bearing as N25°W or 335°.

14. (c)



15. (d)

$l = 30$ m, $w = 1.8$ kg, $P_m = 10$ kg, $P_0 = 6$ kg

Sag correction when tape is standardised in catenary

$$C_{\text{sag}} = \left(\frac{C_{\text{sag at Std. pull}} - C_{\text{sag at Measured pull}} \right)$$

$$\begin{aligned}
 C_{\text{sag}} &= C_{\text{due to sag under standard pull}} - C_{\text{due to sag under measured pull}} \\
 &= \left[\frac{IW^2}{24P_0^2} - \frac{IW^2}{24P_m^2} \right] = \left(\frac{30 \times 1.8^2}{24 \times 6^2} - \frac{30 \times 1.8^2}{24 \times 10^2} \right) = 0.072 \text{ m}
 \end{aligned}$$

16. (b)

$$\text{Extended factor, } E_F = \frac{11.4}{10} = 1.14$$

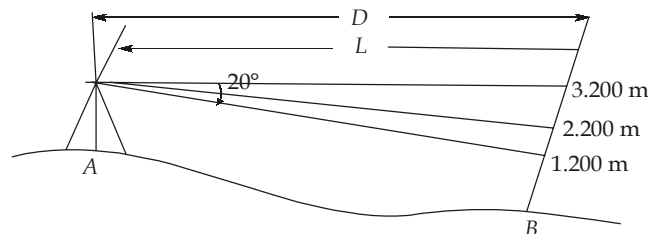
$$\text{Extended scale} = \text{Extended factor} \times \text{Original scale} = 1.14 \times \frac{1}{10} = \frac{1}{8.77193}$$

Area scale,

$$\Rightarrow 1 \text{ cm}^2 = 8.77193 \text{ m}^2$$

$$\therefore \text{True area of survey} = [8.77193^2 \times 100] = 7694.67 \text{ m}^2 \simeq 7694.7 \text{ m}^2$$

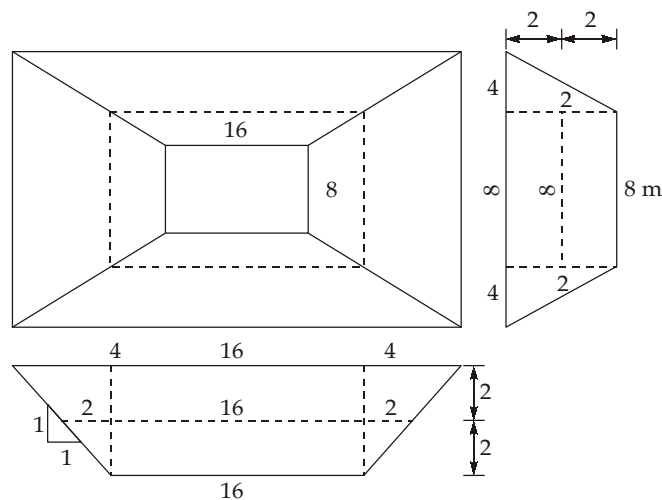
17. (d)



$$L = [kS + C] = 100 \times (3.2 - 1.2) + 4 = 204 \text{ m}$$

$$\begin{aligned}
 \text{Horizontal distance, } D &= [L \cos \theta - S_2 \sin \theta] \\
 &= 204 \cos 20^\circ - 2.2 \sin 20^\circ = 190.945 \text{ m}
 \end{aligned}$$

18. (d)



$$\text{Bottom} = (16 \times 8) = 128 \text{ m}^2$$

$$\begin{aligned}
 \text{Middle} &= [16 + 2 + 2] \times [8 + 2 + 2] \\
 &= (20 \times 12) = 240 \text{ m}^2
 \end{aligned}$$

$$\begin{aligned}
 \text{Top} &= [16 + 4 + 4] \times [8 + 4 + 4] \\
 &= (24 \times 16) = 384 \text{ m}^2
 \end{aligned}$$

$$d = 2 \text{ m}$$

$$\begin{aligned}\text{Volume} &= \frac{d}{3} [A_1 + 4A_2 + A_3] = \frac{2}{3} [128 + 4 \times 240 + 384] \\ &= 981.34 \text{ m}^3\end{aligned}$$

19. (c)

Correction for temperature:

$$\begin{aligned}\text{For first half (1000 m, } T = 20^\circ\text{C), } C_f &= \alpha(T_m - T_0)L \\ &= 12 \times 10^{-6}(20 - 15) \times 1000 \\ &= +0.06 \text{ m}\end{aligned}$$

For second half (1000 m, $T = 26^\circ\text{C}$)

$$C_f = 12 \times 10^{-6} \times (26 - 15) \times 1000 = +0.132 \text{ m}$$

$$\text{Correction for pull: } C_p = \frac{(P_m - P_0)L}{AE}$$

$$= \frac{(22 - 0) \times 2000 \times 10^{-4}}{3.75 \times 10^{-6} \times 2.11 \times 10^6} = +0.556 \text{ m}$$

Correction for Sag:

$$C_{\text{Sag}} = \frac{W^2 L}{24P^2}$$

$$\text{Weight of the tape} = \frac{7.7504 \times 10^{-3}}{10^{-6}} \times 3.75 \times 10^{-6} \times 50 = 1.4532 \text{ kg}$$

$$C_{\text{Sag}} = -\frac{(1.4532)^2 \times 2000}{24 \times 22^2} = -0.364 \text{ m}$$

$$\begin{aligned}\text{Total correction} &= 0.06 + 0.132 + 0.556 - 0.364 \\ &= +0.384 \text{ m}\end{aligned}$$

$$\text{Corrected total length} = 2000 + 0.384 = 2000.384 \text{ m}$$

20. (a)

$$\text{Hypotenusal allowance} = l(\sec\theta - 1)$$

$$\begin{aligned}\Rightarrow 0.1 &= 30(\sec\theta - 1) \\ \sec\theta &= 1.0033\end{aligned}$$

$$\therefore \tan\theta = \sqrt{\sec^2\theta - 1}$$

$$\Rightarrow \tan\theta = 0.0813 = \frac{1}{12.3}$$

21. (c)

$$(2.724 + c) - 1.425 = 2.504 - (1.429 + c)$$

$$\Rightarrow 2c = -0.224 \text{ m}$$

$$\Rightarrow c = -0.112 \text{ m}$$

$$\therefore \text{Error} = +0.112 \text{ m}$$

$$\begin{aligned}\text{Error due to curvature and refraction} &= +0.0673(1.15)^2 \\ &= +0.089 \text{ m}\end{aligned}$$

$$\therefore \text{Error due to collimation} = 0.112 - 0.089 = +0.023 \text{ m (inclined upwards)}$$

$$\text{Collimation error per 150 m} = \frac{0.023 \times 150}{1150} = 0.003 \text{ m}$$

22. (a)

$$\text{Distance to visible horizon, } D = \sqrt{\frac{h}{0.0673}} = \sqrt{\frac{75}{0.0673}} = 33.38 \text{ km}$$

$$\begin{aligned} \text{Dip of horizon} &= (206265) \times \frac{D}{R} \text{ sec} \\ &= 206265 \times \frac{33.38}{6370} \\ &= 1080.87 \text{ sec} \approx 18 \text{ minutes} \end{aligned}$$

23. (b)

For staff at P,

$$S_1 = 1.365 \text{ m, } S_2 = 1.920 \text{ and } S_3 = 2.475 \text{ m}$$

$$\therefore (S_2 - S_1) = 0.555 \text{ m}$$

$$(S_3 - S_2) = 0.555 \text{ m}$$

$\therefore$ Staff is perpendicular to LOS.

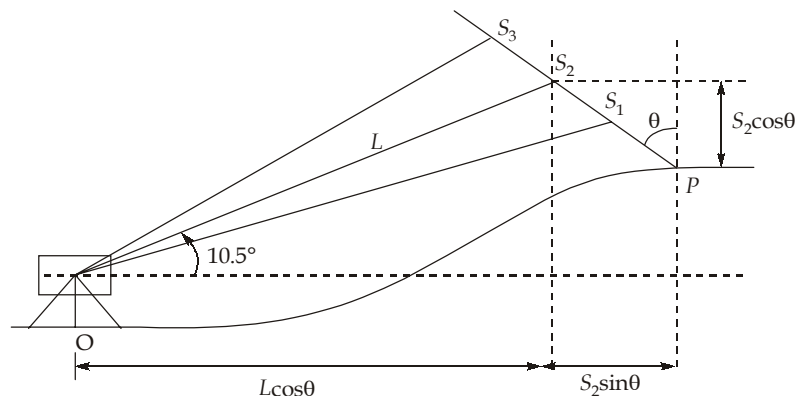
For staff at Q,

$$S_1 = 1.06 \text{ m, } S_2 = 1.88 \text{ m, } S_3 = 2.705 \text{ m}$$

$$\therefore (S_2 - S_1) = 0.82 \text{ m}$$

$$(S_3 - S_2) = 0.825 \text{ m}$$

$\therefore$ Staff is kept vertical.



Now,

$$L = kS + C$$

 $\Rightarrow$

$$L = 100(2.475 - 1.365) + 0 = 111 \text{ m}$$

$$D_{OP} = L \cos \theta + S_2 \sin \theta$$

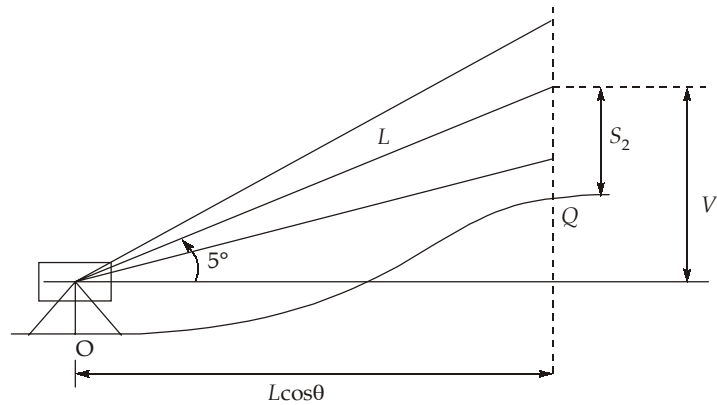
$$= 111 \cos 10.5^\circ + 1.920 \sin 10.5^\circ$$

$$= 109.491 \text{ m}$$

$$V = L \sin \theta = 111 \sin 10.5^\circ = 20.228 \text{ m}$$

$$\text{RL of P} = \text{H.I.} + V - S_2 \cos \theta = \text{H.I.} + 20.228 - 1.920 \cos 10.5^\circ$$

$$= \text{H.I.} + 18.34$$



$$L = kS \cos \theta + C = 100(1.645) \cos 5^\circ + 0$$

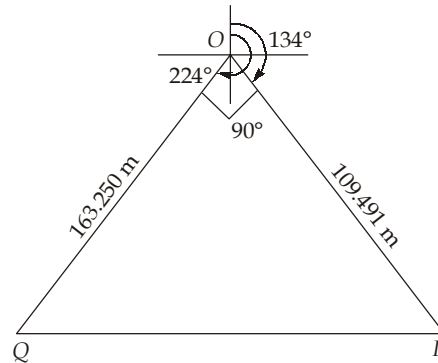
$$= 163.874 \text{ m}$$

$$D_{OQ} = L \cos \theta = 163.874 \cos 5^\circ = 163.250 \text{ m}$$

$$V = L \sin \theta = 163.874 \sin 5^\circ = 14.283 \text{ m}$$

$$\text{RL of } Q = \text{H.I.} + V - S_2 = \text{H.I.} + 14.283 - 1.88$$

$$= \text{H.I.} + 12.403$$



$$D_{QP} = \sqrt{163.25^2 + 109.491^2} = 196.568 \text{ m}$$

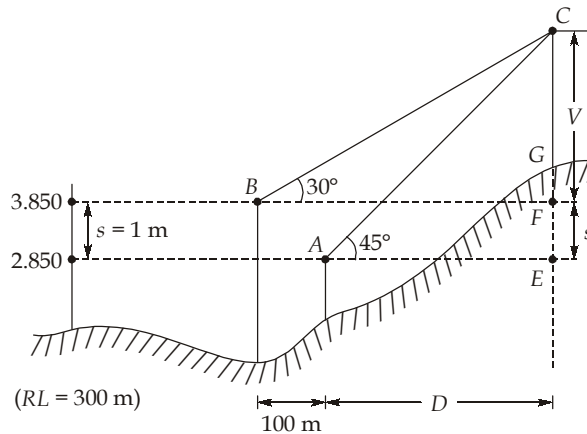
$$\text{Gradient} = \frac{y}{x}$$

$$y = |RL_P - RL_Q|$$

$$= |H.I + 18.37 - (H.I + 12.403)| = 5.967 \text{ m}$$

$$\text{Gradient} = \frac{5.967}{196.568} = \frac{1}{32.94} \simeq \frac{1}{33}$$

24. (d)

In $\triangle CAE$,

$$\tan 45^\circ = \frac{V + s}{D}$$

$$\Rightarrow \tan 45^\circ = \frac{V + 1}{D} \quad \dots(i)$$

$$\Rightarrow D = V + 1$$

In $\triangle CBF$,

$$\tan 30^\circ = \frac{V}{100 + D}$$

$$\Rightarrow V = (100 + D) \tan 30^\circ \quad \dots(ii)$$

From (i) and (ii), we get

$$D = (100 + D) \tan 30^\circ + 1$$

$$\Rightarrow D[1 - \tan 30^\circ] = 100 \cdot \tan 30^\circ + 1$$

$$\Rightarrow D = 138.969 \text{ m}$$

$$V = (100 + 138.969) \tan 30^\circ = 137.969 \text{ m}$$

Now, RL of foot of signal is given as

$$(RL)_G = 300 + 3.850 + 137.969 - 5 = 436.819 \text{ m}$$

25. (c)

$$\text{Weight of } (A - B) = \frac{1}{\frac{1}{2} + \frac{1}{3}} = \frac{6}{5}$$

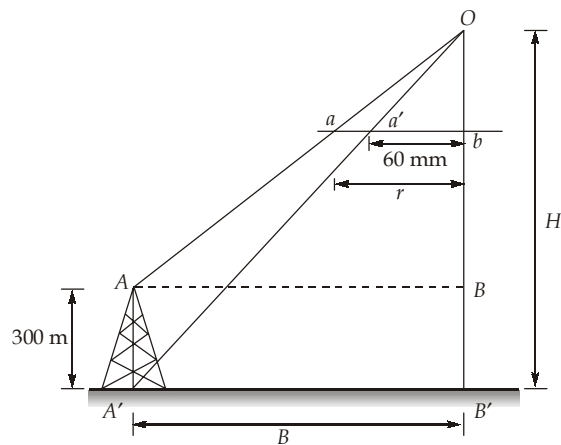
$$\text{Weight of } \left(\frac{A - B}{5} \right) = \frac{\text{weight of } (A - B)}{\frac{1}{5^2}} = \frac{6 \times 5^2}{5} = 30$$

$$\text{Weight of } \left[5.5 + \frac{(A - B)}{5} \right] = \text{Weight of } \left(\frac{A - B}{5} \right) = 30$$

26. (c)

$$\text{Given, } h_a = 300 \text{ m, } S = \frac{1}{12000}$$

$$r_2 = 60 \text{ mm, } f = 200 \text{ mm} = 0.2 \text{ m}$$



$$S = \frac{f}{H}$$

$$\Rightarrow \frac{1}{12000} = \frac{0.2}{H}$$

$$\Rightarrow H = 2400 \text{ m}$$

From $\triangle Oa'b$ and $\triangle OA'B'$, $\frac{ob}{a'b} = \frac{OB'}{A'B'}$

$$\Rightarrow \frac{200}{60} = \frac{2400}{B}$$

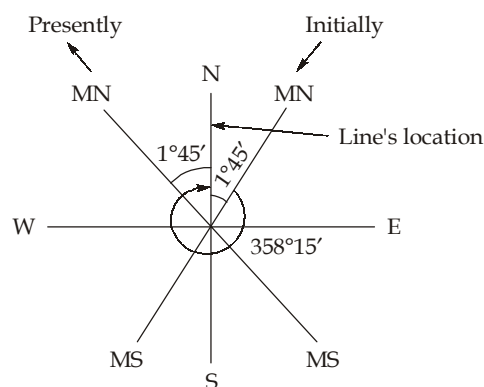
$$\Rightarrow B = 720 \text{ m}$$

From $\triangle Oab$ and $\triangle OAB$, $\frac{Ob}{ab} = \frac{OB}{AB}$

$$\Rightarrow \frac{200}{r_1} = \frac{2400 - 300}{720}$$

$$\Rightarrow r_1 = 68.57 \text{ mm}$$

27. (b)



$$\text{True bearing of line} = 1^\circ 45' + 358^\circ 15' = 360^\circ$$

Now the magnetic meridian has moved $3^\circ 30'$ towards west,

So, inclination of magnetic meridian = $3^\circ 30' - 1^\circ 45' \text{ W} = 1^\circ 45' \text{ W}$

So, Current magnetic bearing = $1^\circ 45'$

28. (b)

The adjustments in transit theodolite are of two types:

1. Permanent adjustment
2. Temporary adjustment

The permanent adjustments are made to establish the fixed relationships between the fundamental line of the instrument and once made, they last for a long time. These include

1. Adjustment of the horizontal plate levels.
2. Collimation adjustment.
3. Horizontal axis adjustment.
4. Adjustment of the telescope level
5. Vertical circle index adjustment

The temporary adjustments are made at each setup of the instrument before taking readings. These includes

1. Setting up of theodolite over the station
2. Levelling up the theodolite
3. Elimination of parallax
4. Focusing

29. (b)

Total number of divisions through which the bubble has moved

$$n = \frac{(20 - 10) + (20 - 10)}{2} = 10$$

$$\text{Change in staff reading, } S = 1.68 - 1.602 = 0.078 \text{ m}$$

$$\therefore \frac{S}{D} = \frac{nl}{R}$$

$$\Rightarrow R = \frac{n l D}{S} = \frac{10 \times 2 \times 10^{-3} \times 100}{0.078} \text{ m} = 25.64 \text{ m} \simeq 25.6 \text{ m}$$

30. (b)

Sum of latitudes

$$\begin{aligned} \Sigma L &= \Sigma \text{Northing} - \Sigma \text{Southing} \\ &= (101 + 419) - (437 + 83) = 0 \end{aligned}$$

Sum of departures

$$\begin{aligned} \Sigma D &= \Sigma \text{Easting} - \Sigma \text{Westing} \\ &= (199.25 + 299.75) - (300.5 + 200.5) = -2 \text{ m} \end{aligned}$$

Magnitude of closing error

$$e = \sqrt{0^2 + (-2)^2} = 2 \text{ m}$$

Direction of closing error

$$\theta = \tan^{-1} \left(\frac{\Sigma D}{\Sigma L} \right) = \tan^{-1} \left(\frac{-2}{0} \right) = 270^\circ$$

