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SURVEYING

CIVIL ENGINEERING

Date of Test : 14/04/2025

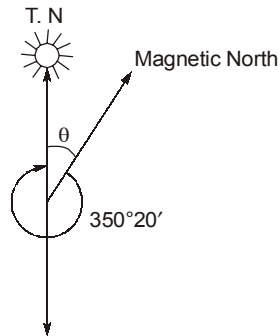
ANSWER KEY ➤

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

Detailed Explanations

1. (a)

At noon true bearing of sun = 180° or 0°



$\therefore$ Magnetic declination, $\theta = 360^\circ - 350^\circ 20' = 9^\circ 40'$

2. (b)

Given, elevation of tower from the bottom is 1250 m.

$$\therefore d = \frac{hr}{H}$$

Here,

$$h = 50 \text{ m}$$

$$H = 2500 - 1250 = 1250 \text{ m}$$

$$\therefore d = \frac{50 \times 6.35}{1250} = 0.25 \text{ cm}$$

3. (c)

Let the multiplying and additive constants of the tacheometer be K and C respectively.

$$\text{For 20 m distance, } 20 = K(0.195) + C \quad \dots(i)$$

$$\text{For 100 m distance, } 100 = K(0.995) + C \quad \dots(ii)$$

From equations (i) and (ii),

$$K = 100 \text{ and } C = 0.5 \text{ m}$$

$$\frac{K}{C} = 200$$

4. (d)

RL of the under side of T-beam = RL of the floor + Staff reading + Staff reading held upside down

$$\Rightarrow 107.82 = 101.56 + 2.48 + \text{Staff reading held upside down}$$

$$\therefore \text{Staff reading held upside down} = 3.78 \text{ m}$$

5. (a)

Correction to latitude of any side

$$= \text{Total error in latitude} \times \frac{\text{Length of that side}}{\text{Perimeter of traverse}}$$

$$= 0.75 \times \frac{3}{15} \times 100 \text{ cm} = 15 \text{ cm}$$

6. (c)

$$\frac{\text{Length of long chord}}{\text{Tangent length}} = \frac{2R \sin \Delta/2}{R \tan \Delta/2} = \frac{2 \times 60 \sin 60^\circ}{60 \tan 60^\circ} = 1.0$$

7. (b)

$$\text{RL of } B = \text{RL of } A + \Sigma BS - \Sigma FS = 770.815 + 32.665 - 30.445 = 773.035 \text{ m}$$

$$\text{Given RL of } B = 772.935 \text{ m}$$

$$\therefore \text{Closing error} = 773.035 - 772.935 = 0.100 \text{ m}$$

8. (c)

If R is the radius of the circular curve, then

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} = 2R$$

$$\Rightarrow \frac{300}{\sin 60^\circ} = 2R$$

$$\Rightarrow R = \frac{346.41}{2} = 173.20 \text{ m}$$

10. (a)

$$\text{Correction per chain} = -(l - l') = l' - l = +0.1 \text{ m}$$

$$\text{Correction per metre} = \frac{(l - l')}{l} = \frac{+0.1}{20}$$

$$\text{Total correction, } C_a = \frac{0.1}{20} \times 841.5 = +4.2 \text{ m}$$

$$\text{Correct distance, } L = 841.5 + 4.2 = 845.7 \text{ m}$$

11. (d)

We know,

$$\frac{f}{(H - h)} = \frac{x}{X}$$

here,

$$x = 10.16 \text{ cm}$$

$$X = 2.54 \text{ cm} \times 50000 = 2.54 \times 500 \text{ m} = 1270 \text{ m}$$

$$f = 16 \text{ cm}$$

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

$$\therefore \frac{16}{(H - 200)} = \frac{10.16}{1270}$$

$$\Rightarrow H - 200 = 2000 \text{ m}$$

$$\Rightarrow H = 2200 \text{ m}$$

12. (b)

Since total number of observations are even so we apply Simpson's rule on first 7 observations

$$A_1 = \frac{30}{3} [(0 + 6.5) + 4(6.8 + 5.4 + 7) + 2(7.8 + 4.8)] = 1085 \text{ m}^2$$

$$A_2 = \text{Applying trapezoidal rule between offsets 6.5 and 0}$$

$$= \frac{30}{2} [6.5 + 0] = 97.5 \text{ m}^2$$

$$A = A_1 + A_2 = 1085 + 97.5 = 1182.5 \text{ m}^2$$

13. (d)

The difference in elevation between the vane and instrument axis

$$D \tan \alpha = 3000 \times \tan 5^\circ 36' = 294.153 \text{ m}$$

Combined correction due to curvature and refraction

$$h = 0.0673 D^2, \quad (D \text{ is in km})$$

$$= 0.0673 \times 3^2 = 0.606 \text{ m}$$

(here correction will be subtractive)

So, difference in elevation between the vane and instrument axis

$$\therefore h = 294.153 - 0.606 = 293.547 \text{ m}$$

$$\text{RL of instrument axis} = 436.050 + 2.865 = 438.915 \text{ m}$$

$$\therefore \text{RL of vane} = \text{RL of instrument axis} - h = 438.915 - 293.547 = 145.368 \text{ m}$$

$$\therefore \text{RL of staff station } Q = 145.368 - 2 = 143.368 \text{ m}$$

14. (c)

Sensitivity of bubble tube is given by,

$$\alpha' = \frac{S}{nD} \times \left(\frac{360^\circ}{2\pi} \times 60 \times 60 \right) = 20 \text{ Seconds}$$

$$S = ? \text{ (staff intercept)}$$

$$n = 2 \text{ divisions (deflection) and } D = \text{distance of the staff from level} = 100 \text{ m}$$

$$\therefore 20 = \frac{S}{2 \times 100} \left(\frac{360}{2\pi} \times 60 \times 60 \right) = \frac{S}{2 \times 100} (206265)$$

$$\Rightarrow S = \frac{20 \times 2 \times 100}{206265} \simeq 19.40 \times 10^{-3} \text{ m}$$

15. (a)

I is correct.

For example, an angle A with a weight of 4, will have the weight of 4A as $\frac{1}{4}$.

If a quantity is multiplied by a factor, the weight of the result is then equal to the weight of that quantity divided by the square of the factor.

In case II, Weight of 0.5α is 2

$$\Rightarrow \text{Weightage of } (0.33 \alpha) \text{ should be } \frac{2}{(0.33 / 0.5)^2}$$

$$\therefore \text{Weightage of } (0.33 \alpha) \text{ is } 4.5.$$

16. (b)

20 m chain,

$$\text{True length of 20 m chain, } L' = 20 + 0.1 = 20.1 \text{ m}$$

$$\text{Actual length of survey line, } l = 1200 \times \frac{20.1}{20} = 1206 \text{ m}$$

25 m length,

Actual length of survey line,

$$l = \text{Measured length} \times \frac{\text{True length of 25 m}}{\text{Considered length of 25 m}}$$

$$\Rightarrow 1206 = 1212 \times \frac{L'}{25}$$

$$\Rightarrow L' = 24.88 \text{ m}$$

$$[\therefore (25 - 24.88) \times 100 = 12 \text{ cm}]$$

$\therefore$ The 25 m chain was 12 cm too short.

17. (d)

$$\tan \angle PAB = \frac{150}{200} = \frac{3}{4}$$

$\Rightarrow$

$$\angle PAB = 36.87^\circ$$

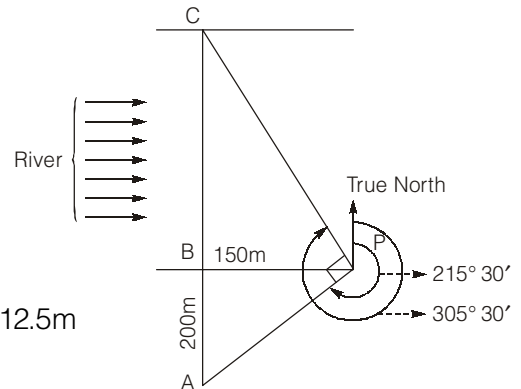
$$\angle APC = 305^\circ 30' - 215^\circ 30' = 90^\circ$$

$\therefore$

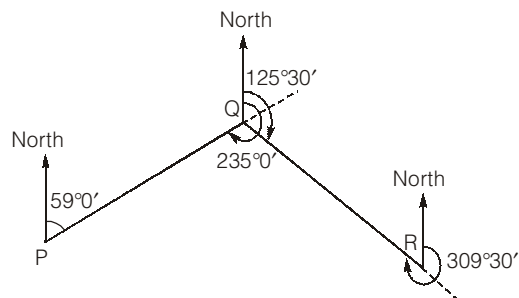
$$\begin{aligned} \angle ACP &= 180^\circ - \angle PAB - \angle APC \\ &= 53.13^\circ = \angle BCP \end{aligned}$$

$\therefore$

$$BC = \frac{PB}{\tan \angle BCP} = \frac{15^\circ}{\tan 53.13^\circ} = 112.5 \text{ m}$$



18. (b)



$$\begin{aligned} \text{Interior angle } PQR &= \text{BB of } PQ - \text{FB of } QR \\ &= 235^\circ 0' - 125^\circ 30' = 109^\circ 30' \end{aligned}$$

19. (a)

$$\text{Measured length} = 468 \text{ m}$$

$$\text{Scale of plan} = \frac{1}{4000}$$

$$\text{Scale used for measurement} = \frac{1}{2000}$$

$$\text{Correct length} = \frac{\text{drawn length on plan}}{\text{scale of plan}} = \frac{\left(468 \times \frac{1}{2000}\right)}{\frac{1}{4000}} = 936 \text{ m}$$

20. (b)

For the first 2000 m, average error is

$$e = \frac{0 + 10}{2} = 5 \text{ cm} = 0.05 \text{ m}$$

$\therefore$ Incorrect length of chain,

$$L' = 20 + 0.05 = 20.05 \text{ m}$$

$$\text{Measured length, } l' = 2000 \text{ m}$$

$$\therefore \text{ True length, } l_1 = \left(\frac{L'}{L}\right) \times l' = \left(\frac{20.05}{20}\right) \times 2000 = 2005 \text{ m}$$

For the next 2000 m, average error is

$$e = \frac{10 + 18}{2} = 14 \text{ cm} = 0.14 \text{ m}$$

$$\therefore L' = 20 + 0.14 = 20.14 \text{ m}$$

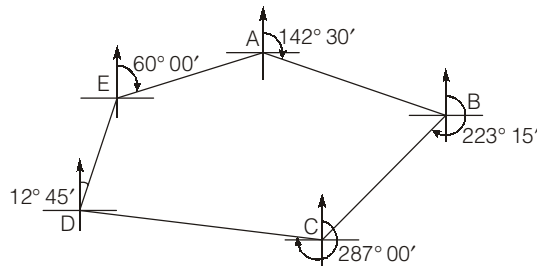
$$l' = 2000 \text{ m}$$

$$\therefore \text{ True length, } l_2 = \left(\frac{L'}{L} \right) \times l' = \left(\frac{20.14}{20} \right) \times 2000 = 2014 \text{ m}$$

$$\text{Hence, true distance, } l = l_1 + l_2 = 2005 + 2014 = 4019 \text{ m}$$

21. (b)

Refer to the figure shown below and convert the quadrantal bearings to whole circle bearings.



As the traversing is done in the clockwise direction, the included angles will be exterior angles.

Included angle = F.B. of next line – B.B. of previous line.

$$\begin{aligned} \angle A &= \text{F.B. of AB} - \text{B.B. of EA} = 142^\circ 30' - 239^\circ 00' \\ &= -96^\circ 30' = -96^\circ 30' + 360^\circ = 263^\circ 30' \end{aligned}$$

$$\begin{aligned} \angle B &= \text{F.B. of BC} - \text{B.B. of AB} = 223^\circ 15' - 322^\circ 30' = -99^\circ 15' \\ &= -99^\circ 15' + 360^\circ = 260^\circ 45' \end{aligned}$$

$$\angle C = \text{F.B. of CD} - \text{B.B. of BC} = 287^\circ 00' - 44^\circ 15' = 242^\circ 45'$$

$$\begin{aligned} \angle D &= \text{F.B. of DE} - \text{B.B. of CD} = 12^\circ 45' - 107^\circ 45' \\ &= -95^\circ 00' = -95^\circ + 360^\circ = 265^\circ 00' \end{aligned}$$

$$\begin{aligned} \angle E &= \text{F.B. of EA} - \text{B.B. of DE} = 60^\circ 00' - 193^\circ 15' \\ &= -133^\circ 15' = -133^\circ 15' + 360^\circ = 226^\circ 45' \end{aligned}$$

$$\begin{aligned} \text{Sum of angles} &= \angle A + \angle B + \angle C + \angle D + \angle E \\ &= 263^\circ 30' + 260^\circ 45' + 242^\circ 45' + 265^\circ 00' + 226^\circ 45' = 1258^\circ 45' \end{aligned}$$

$$\text{Theoretical sum of external angles} = (2n + 4)90^\circ = (2 \times 5 + 4) \times 90 = 1260^\circ$$

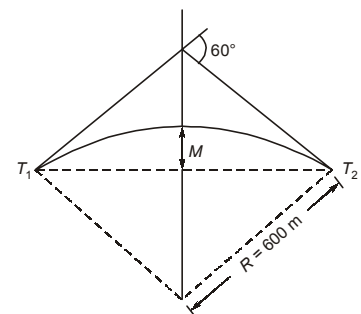
$$\therefore \text{ Error} = 1260^\circ - 1258^\circ 45' = 1^\circ 15' = 75'$$

$$\text{Correction for each angle} = 75'/5 = + 15'$$

22. (b)

$$\begin{aligned} \text{Length of long chord, } T_1T_2 &= 2R \sin(\Delta/2) \\ &= 2 \times 600 \times \sin(60/2) \\ &= 600 \text{ m} \quad (\because \Delta = 60^\circ) \end{aligned}$$

$$\begin{aligned} \text{Length of mid-ordinate, } M &= R[1 - \cos(\Delta/2)] \\ &= 600[1 - \cos(60/2)] \\ &= 600 \times 0.134 = 80.4 \text{ m} \end{aligned}$$



23. (b)

$$\begin{aligned} \text{Total volume} &= d \left[\frac{A_1 + A_n}{2} + A_2 + A_3 + \dots + A_{n-1} \right] \\ &= 7 \left[\frac{3 + 29}{2} + 25 + 22 + 15 + 12 + 8 + 6 \right] \\ &= 7[16 + 25 + 22 + 15 + 12 + 8 + 6] = 728 \times 10^4 \text{ m}^3 \end{aligned}$$

$$60\% \text{ full volume} = 728 \times 10^4 \times 0.6 = 436.8 \times 10^4 \text{ m}^3$$

$$\text{Volume of water upto depth of 14 m} = 7 \left[\frac{22+3}{2} + 15 + 12 + 8 + 6 \right] = 374.5 \times 10^4 \text{ m}^3$$

$$\text{Volume of water upto depth of 7 m} = 7 \left[\frac{25+3}{2} + 22 + 15 + 12 + 8 + 6 \right] = 539 \times 10^4 \text{ m}^3$$

Depth of water, when the reservoir is 60% full

$$= 14 + \frac{7-14}{539 \times 10^4 - 374.5 \times 10^4} (436.8 \times 10^4 - 374.5 \times 10^4)$$

$$= 14 - \frac{7}{164.5} \times 62.3 = 11.3489 \text{ m} \simeq 11.4 \text{ m}$$

24. (a)

$$\text{Additive constant, } C = (f + d) = 0.20 + 0.10 = 0.30 \text{ m}$$

$$D = ks \cos^2 \theta + C \cos \theta$$

$$\Rightarrow 50 = k \times 0.500 \cos^2 3^\circ 48' + 0.30 \cos 3^\circ 48'$$

$$\Rightarrow \text{Multiplying constant, } k = 99.84$$

25. (b)

If 'h' is the difference in level, then

$$D^2 = l^2 - h^2$$

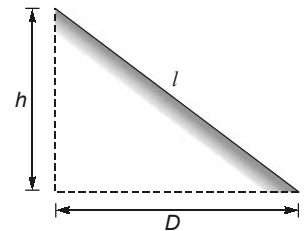
Here

$$l = 20 \text{ m, } h = 80 \text{ cm} = 0.8 \text{ m}$$

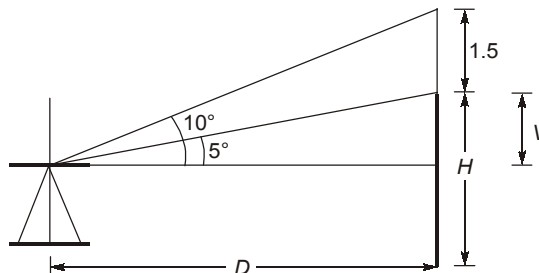
$$\Rightarrow D^2 = (20)^2 - (0.8)^2$$

$$\Rightarrow D = \sqrt{399.36}$$

$$\therefore D = 19.984 \text{ m}$$



27. (d)



$$\tan 5^\circ = \frac{V}{D}, \tan 10^\circ = \frac{V+1.5}{D}$$

$$\Rightarrow D = \frac{1.5}{\tan 10^\circ - \tan 5^\circ} = 16.88 \text{ m}$$

$$V = D \tan 5^\circ = 1.477 \text{ m}$$

$$\text{R.L. of top of flag post} = \text{R.L. of building at the base} + H + 1.5$$

H is not known and cannot be computed.

28. (d)

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

$$\Rightarrow 16.26 - \Sigma FS = 23.50 - 23.47$$

$$\Rightarrow \Sigma FS = 16.23 \text{ m}$$

29. (b)

The horizontal distance is given by $D = \frac{f}{i}s + C$

$$\text{Error in distance, } \delta D = -s \frac{f}{i^2} \cdot \delta i \quad (\text{Where, } \delta i \text{ is error in the stadia interval}) \quad \dots(i)$$

$$\text{Now,} \quad \frac{f}{i} = 100$$

$$\Rightarrow \quad i = \frac{f}{100} = \frac{25}{100} = 0.25 \text{ cm}$$

Substituting the values of $\frac{f}{i}$, i and δi in equation (i),

$$\Rightarrow \quad \delta D = -s \times \frac{f}{i} \cdot \frac{1}{i} \cdot \delta i = -s(100) \left(\frac{1}{0.25} \right) (0.0025) = -s.$$

30. (d)

Let the vertical angle is θ

$$\text{True horizontal distance, } D = ks \cos^2 \theta$$

$$\text{Sloping distance, } L = ks$$

$$\Rightarrow \quad \frac{\text{Sloping distance}}{\text{Horizontal distance}} = \frac{ks}{ks \cos^2 \theta} = \sec^2 \theta$$

Permissible error is 2 in 500

$$\Rightarrow \quad \frac{L}{D} = \frac{500 + 2}{500} = \frac{502}{500}$$

$$\Rightarrow \quad \sec^2 \theta = \frac{502}{500}$$

$$\therefore \quad \theta = 3.62^\circ$$

