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SURVEYING

CIVIL ENGINEERING

Date of Test : 16/06/2025

ANSWER KEY ➤

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

Detailed Explanations

1. (b)

Chain surveying is used for securing data for exact description and marking of the boundaries of a piece of land or for preparing the maps of the area to show various details. It is generally used for plans of estates, fields, etc. on a large scale when the area is small in extent and the ground is fairly level and open.

The cross-staff survey is a special type of chain survey conducted to locate the boundaries of a field for the purpose of determining the area of the field.

2. (d)

Photomaps are the aerial photographs which are used as a suitable for maps. The photomap may consist of one photograph, but usually photomaps are obtained by assembling two or more photographs to form a large map.

The large photomaps from two or more photographs are called mosaics. To varying degree of accuracy, a mosaic is a map substitute.

The mosaic has an overall average scale comparable to the scale of a planimetric map.

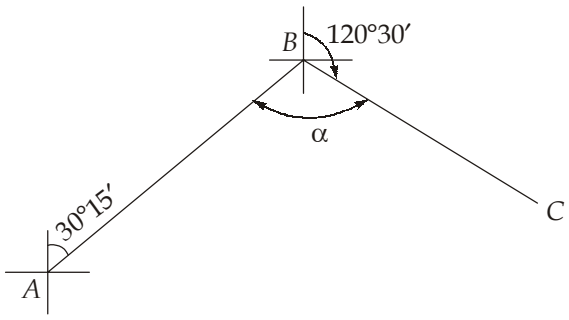
3. (d)

Sensitivity of a bubble tube, $S = \frac{nl}{R}$

Now, $n = 1$

$\therefore \quad S = \frac{1\times10^{-3}}{0.9} = \frac{1}{900}$

4. (b)



The included angle, α = BB of AB – FB of BC

= (30°15′ + 180°) – 120°30′

= 89°45′

5. (a)

The magnetic needle is attached to a graduated aluminium ring. The ring is graduated from 0° to 360°. Degrees are subdivided into half degrees.

6. (b)

Reciprocal levelling is method of levelling in which the difference in elevation between two points which are at considerable distance is to be determined accurately and when it is not possible to setup the level midway between the two points. Reciprocal levelling eliminates the errors due to:

(i) Refraction

(ii) Inclination of line of collimation

(iii) Curvature

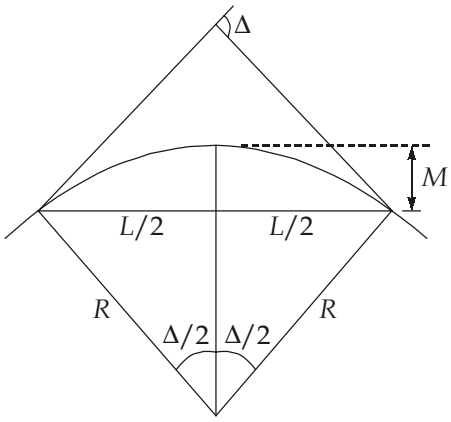
7. (c)

$$D = kS + C$$

$$S = 2.634 - 1.530 = 1.104 \text{ m}$$

$$D = 100 \times 1.104 + 0.5 = 110.9 \text{ m}$$

8. (a)



Mid ordinate, $M = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$

$$= 30 - \sqrt{30^2 - 25^2}$$

$$= 13.42 \text{ m}$$

9. (c)

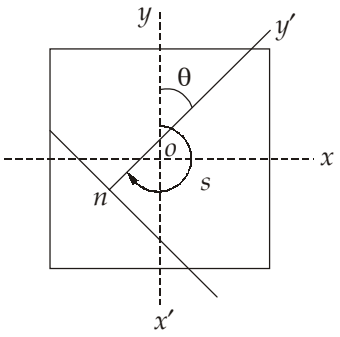
Height of lighthouse $= 0.0673 \times D^2$

$$= 0.0673 \times (40)^2$$

$$= 107.68 \text{ m}$$

10. (c)

The seeing angle (s) is the clockwise angle measured in the plane of photograph from the positive y-axis the photographic nadir point (n)

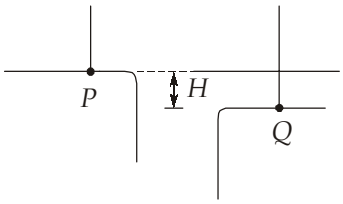


Thus, the rotation angle, $\theta = s - 180°$

$= 230° - 180°$

$= 50°$

11. (a)



Using reciprocal levelling, $H = \dfrac{(Q_1 - P_1) + (Q_2 - P_2)}{2}$

$= \dfrac{(2.205 - 1.475) + (2.060 - 1.44)}{2}$

$= 0.675$ m

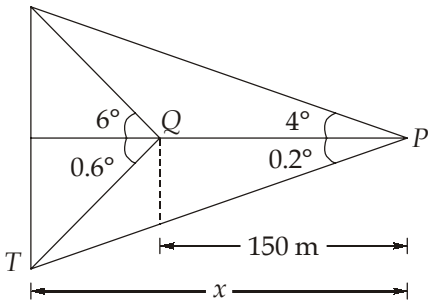
If instrument is at P then true reading at Q will be

$Q_1^T = P_1 + H = 1.475 + 0.675 = 2.15$ m

So, Collimation error = Measured value – True value

$= 2.205 - 2.15 = 0.055$

12. (b)



$$x(\tan 4° + \tan 0.2°) = (x - 150)(\tan 6° + \tan 0.6°)$$

$$\Rightarrow \quad 0.0734\,x = (x - 150)(0.11558)$$

$$\Rightarrow \quad 0.04218\,x = 17.337$$

$$\Rightarrow \quad x = 411.024 \text{ m}$$

$$\therefore \quad \text{Height of tower} = 411.024(\tan 4° + \tan 0.2°)$$

$$= 30.176 \text{ m}$$

13. (c)

Line	Length (m)	Bearing	Latitude (m)	Departure (m)
AB	30	60.5°	14.77	26.11
BC	120	300°	60	$-60\sqrt{3}$
CD	l	270°	0	$-l$
DA	300	θ	$300\cos\theta$	$300\sin\theta$

$\because \quad \Sigma L = 0$

And $\quad \Sigma D = 0$

$\therefore \quad \Sigma L = 0$

$$300\cos\theta = -74.77 \qquad \text{...(i)}$$

Similarly, $\quad \Sigma D = 0$

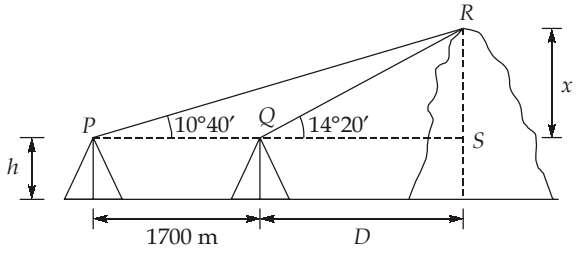
$$\Rightarrow \quad 300\sin\theta = 77.813 + l \qquad \text{...(ii)}$$

Squaring and adding eq. (i) and (ii)

$$(300)^2 = (-74.77)^2 + (77.813 + l)^2$$

$$\Rightarrow \quad l = 212.72 \text{ m}$$

14. (c)



In ΔPRS,

$$\tan 10°40' = \frac{x}{1700 + D}$$

$\Rightarrow$ $x - 0.188D = 320.194$ ...(1)

In ΔQRS, $\tan 14°20' = \frac{x}{D}$

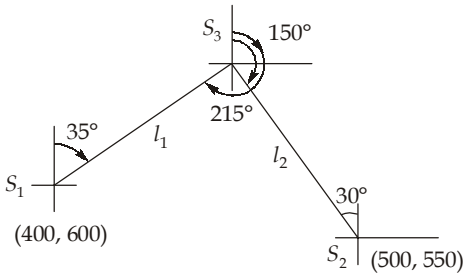
$\Rightarrow$ $x - 0.256\,D = 0$ ...(2)

From (1) and (2) $x = 1205.44$ m and $D = 4708.74$ m

$\therefore$ Elevation of top of hill $= x + h$

$= 1205.44 + 436.50 = 1641.94$ m

15. (b)



Let $S_1S_3 = l_1$ and $S_2S_3 = l_2$

Northing of S_3:

$600 + l_1 \cos 35° = 550 + l_2 \cos 30°$

$l_1 \cos 35° - l_2 \cos 30° = -50$ ...(1)

Easting of S_3:

$400 + l_1 \sin 35° = 500 - l_2 \sin 30°$

$\Rightarrow$ $l_1 \sin 35° + l_2 \sin 30° = 100$ ...(2)

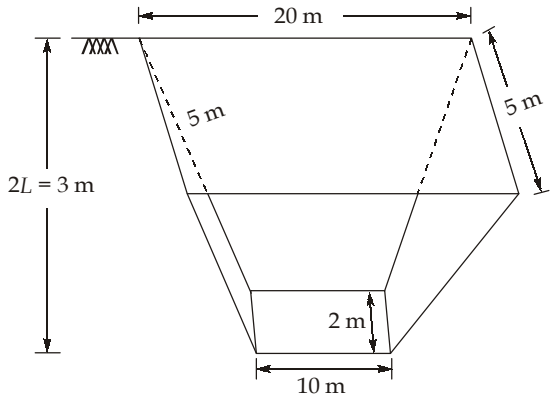
Solving (1) and (2)

$l_1 = 67.97$ m

$l_2 = 122.03$ m

$\therefore$ Easting of $S_3 = 400 + 67.97 \sin 35° = 438.986$ m $\simeq 439$ m

16. (a)



Mean area $(A_m) = \left(\frac{20+10}{2}\right) \times \left(\frac{5+2}{2}\right) = 15 \times 3.5 = 52.5$ m^2

Top area (A_1) = $20 \times 5 = 100\ m^2$

Bottom area (A_2) = $10 \times 2 = 20\ m^2$

$\therefore$ Using prismoidal formula,

$$\text{Volume, } V = \frac{L}{3}(A_1 + 4A_m + A_2)$$

$$V = \frac{1.5}{3}(100 + 4 \times 52.5 + 20)$$

$$= 165\ m^3$$

17. (b)

$$\text{Shrinkage factor} = \frac{18}{20} = 0.9$$

$$\text{Reduced plan area} = (\text{Shrinkage factor})^2 \times \text{Actual plan area}$$

$$324 = (0.9)^2 \times \text{Actual plane area}$$

$\therefore$ Area plan area = $400\ cm^2$

$\therefore$ Actual area of survey (in ha) = $400 \times \frac{(20)^2}{10^4}$

= 16 hectares

18. (a)

h = 1500 m

Scale = 1 : 8500

f = 20 cm

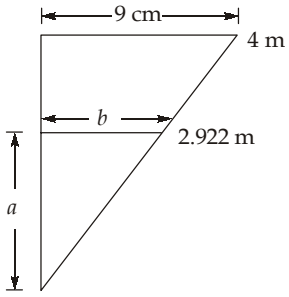
$$\text{Scale} = \frac{f}{H - h}$$

$\Rightarrow$ $$\frac{1}{8500} = \frac{20 \times 10^{-2}}{H - 1500}$$

$\Rightarrow$ H = 3200 m

$\Rightarrow$ H = 3.2 km

19. (b)



$$\frac{b}{9} = \frac{2.922}{4}$$

$\Rightarrow$ b = 6.5745 cm

$\therefore$ Correct reading (a) = $\sqrt{2.922^2 - (0.065745)^2}$

= 2.92126 m $\simeq$ 2.9213 m

20. (b)

BS	IS	FS	Rise	Fall	RL	Comment
1.135	–	–	–	–	90.000	–
1.08	–	0.368	0.767	–	90.767	–
1.155	–	1.844	–	0.764	90.003	–
–	2.632	–	–	1.477	88.526	–
–	1.196	–	1.436	–	89.962	–
–	–	0.976	0.22	–	90.182	–

(All values in m)

So, the value of Y = 89.962 m.

21. (b)

$$\text{Scale} = \frac{1}{5000}, \quad S = 5000,$$

Area, $A = 100 \text{ km}^2$

Length recorded by 1 photo $= ls\,(1 - p_s)$
$= 150 \times 5000 \times (1 - 0.7) \times 10^{-6}$
$= 0.225$ km

Width recorded by 1 photo $= bs\,(1 - p_s)$
$= 150 \times 5000 \times (1 - 0.4) \times 10^{-6}$
$= 0.45$ km

Area recorded by 1 photo $= (0.225 \times 0.45) = 0.10125 \text{ km}^2$

No. of photos required,

$$N = \frac{A}{a'} = \frac{100}{0.10125} = 987.654 \text{ photos} \simeq 988 \text{ photos}$$

22. (a)

$$A = \frac{d}{3}\,[(\text{First ordinate} + \text{Last ordinate}) + 4\,(\text{Sum of even ordinates}) + 2(\text{Sum of odd ordinates})]$$

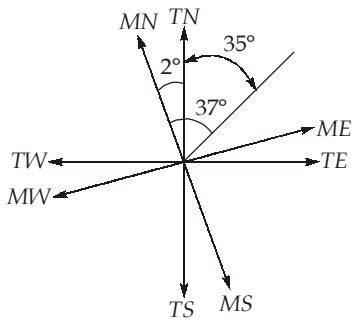
$$\Rightarrow \quad A = \frac{d}{3}\left[(O_1 + O_9) + 4(O_2 + O_4 + O_6 + O_8) + 2(O_3 + O_5 + O_7)\right]$$

$$\Rightarrow \quad A = \frac{30}{3}\left[(0 + 0) + 4(6.5 + 5.8 + 7.6 + 5.8) + 2(7.0 + 4.5 + 6.0)\right]$$

$$\Rightarrow \quad A = 1378 \text{ m}^2$$

23. (b)

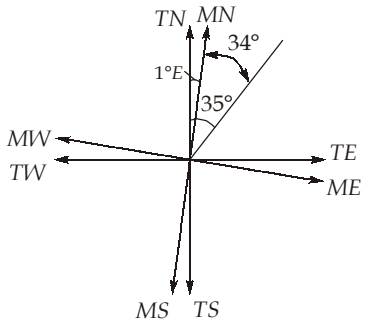
In December 1985



Now rate of annual magnetic declination is 5′E, so in 36 years i.e. 1985 to 2021 magnetic meridian got shifted by 5 × 36 i.e. 180′ means 3° in east ward side. So net declination in 2021 is 1°E.

$\therefore$ $TB = MB - \delta_W$

$= 37° - 2° = 35°$

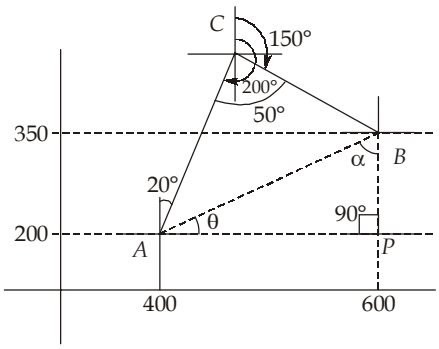


$TB = MB - \delta_E$

$\Rightarrow$ $35° = MB + 1°$

$\Rightarrow$ $MB = 34°$

24. (b)



$\angle C = 200° - 150° = 50°$

BP = 350 – 200 = 150 m

AP = 600 – 400 = 200 m

$\therefore$ AB $= \sqrt{BP^2 + AP^2} = \sqrt{150^2 + 200^2} = 250$ m ...(i)

Now, $\tan\theta = \frac{BP}{AP} = \frac{150}{200}$

$\therefore \quad \theta = 36.87°$

$\therefore \quad \alpha = 180° - (90° + 36.87) = 53.13°$

$\therefore \quad$ FB of BA $= 180 + \alpha = 180° + 53.13° = 233.13°$

FB of CB $= 150°$ (Given)

FB of AC $= 200° - 180° = 20°$ (Alternate angle)

For a closed transverse,

$\because \quad \Sigma L = 0$

$\Rightarrow \quad L_{AC}\cos 20° + L_{CB}\cos 150° + L_{BA}\cos 233.13° = 0$

$\Rightarrow \quad 0.94\,L_{AC} - 0.86\,L_{CB} + 250\,(-0.60) = 0$

$\Rightarrow \quad 0.94\,L_{AC} - 0.86L_{CB} = 150$ ... (ii)

$\because \quad \Sigma D = 0$

$\Rightarrow \quad L_{AC}\sin 20° + L_{CB}\sin 150° + L_{BA}\sin 233.13° = 0$

$\Rightarrow \quad 0.34\,L_{AC} + 0.5\,L_{CB} - 0.8(250) = 0$

$\Rightarrow \quad 0.3\,L_{AC} + 0.5L_{CB} = 200$ ... (iii)

By solving equations (ii) and (iii)

$L_{AC} = 339.286$ m

$L_{CB} = 196.428$ m

and $L_{AB} = 250$ m [From eq. (i)]

$\therefore$ Perimeter of transverse $= 339.286 + 196.428 + 250 = 785.714$ m

25. (a)

For a simple circular curve,

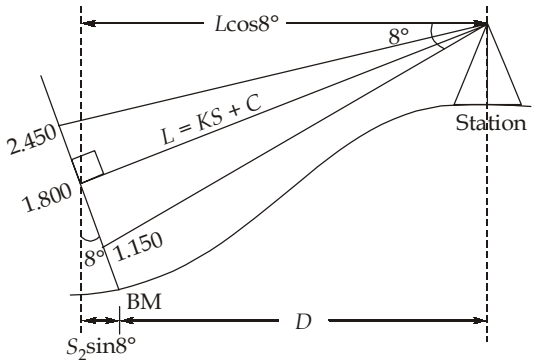
$$\text{Length of curve} = \frac{\pi R\Delta}{180} = \frac{\pi \times 300 \times 60}{180} = 314.16\text{ m}$$

$$\text{Length of long chord} = 2R\sin\frac{\Delta}{2} = 2(300)\sin\left(\frac{60°}{2}\right) = 300\text{ m}$$

$$\text{Apex distance} = R\left(\sec\frac{\Delta}{2} - 1\right) = 300\left[\frac{1}{\cos 30°} - 1\right] = 46.41\text{ m}$$

$$\text{Mid ordinate} = R\left(1 - \cos\frac{\Delta}{2}\right) = 300[1 - \cos 30°] = 40.19\text{ m}$$

26. (d)



$\because \quad D = L\cos 8° - S_2\sin 8°$

$\Rightarrow \quad D = (KS + C)\cos 8° - S_2\sin 8°$

$\Rightarrow$ $D = [100(2.450 - 1.150) + 0]\cos 8° - 1.800\sin 8°$

$\Rightarrow$ $D = 128.484 \text{ m} \simeq 128.48 \text{ m}$

27. (b)

Value	Mean	$x - \bar{x}$	$(x - \bar{x})^2$
160° 20′ 00″	160° 20′ 43.75″	– 43.75″	31′ 54.06″
160° 20′ 30″		– 13.75″	3′ 9.06″
160° 21′ 05″		+ 21.25″	7′ 31.56″
160° 21′ 20″		+ 36.25″	21′ 54.06″

$\Sigma = 1° 4' 28.74''$

$$E_s = \pm 0.6745 \times \sqrt{\frac{\Sigma (x - \bar{x})^2}{n - 1}}$$

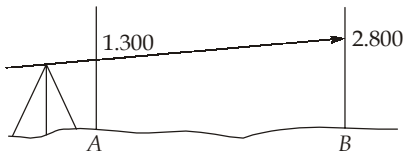
$$= \pm 0.6745 \times \sqrt{\frac{1°4'28.74''}{(4 - 1)}} \pm 24.22''$$

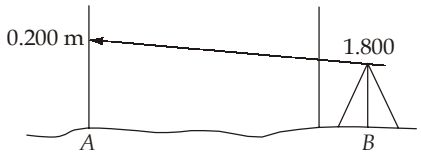
$$\text{Probables error of mean} = \frac{E_s}{\sqrt{n}} = \frac{24.22''}{\sqrt{4}} = 12.11''$$

28. (c)

$a_1 = 1.300$ m $\quad b_1 = 2.800$ m

$a_2 = 0.200$ m $\quad b_2 = 1.800$ m





$$\Delta h = \frac{(a_1 - b_1) + (a_2 - b_2)}{2}$$

$\Rightarrow$ $$\Delta h = \frac{(1.3 - 2.8) + (0.2 - 1.8)}{2}$$

$\Rightarrow$ $\Delta h = -1.55$ m (fall)

$\therefore$ True reading at B when instrument was at $A = 1.300 + 1.550 = 2.850$ m

$\therefore$ Total error $= 2.800 - 2.850 = -0.05$ m

Error includes, error due to curvature, refraction and collimation

$$-0.05 = E_c + \frac{6}{7}\left(\frac{D^2}{2R}\right)$$

$\Rightarrow$ $$E_c = -0.05 - \frac{6}{7}\left(\frac{800^2}{2 \times 6370 \times 1000}\right) \text{ m} = -93.06 \text{ mm}$$

29. (d)

$\therefore$ Accuracy of linear measurement is $\frac{1}{15}$.

$\therefore$ For 15 m length, accuracy of linear measurement is $\frac{15}{15}$

Now, displacement due to angular error on ground = $l\sin\alpha$ = 20 $\sin\alpha$

$$\therefore \quad \frac{\sqrt{(l\sin\alpha)^2 + x^2}}{S} = 0.025$$

$$\Rightarrow \quad \frac{\sqrt{(15\sin\alpha)^2 + \left(\frac{15}{15}\right)^2}}{50} = 0.025$$

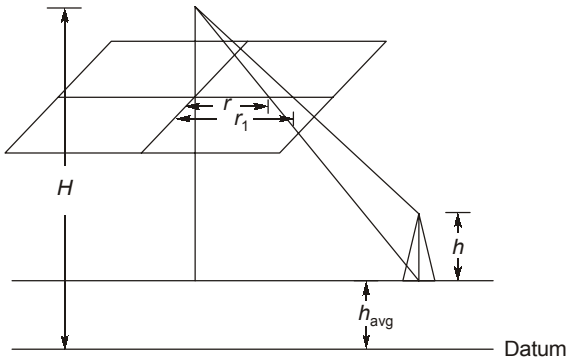
$$\Rightarrow \quad (15\sin\alpha)^2 + \left(\frac{15}{15}\right)^2 = 1.5625$$

$$\Rightarrow \quad \sin\alpha = 0.05$$

$$\therefore \quad \alpha = \sin^{-1}(0.05) = 2.87°$$

$$\therefore \quad \alpha = 2.87°$$

30. (b)



Given: H = 700 m, h_{avg} = 250 m

Relief displacement, $d = r_1 - r$

$= 112.5 - 82.40 = 30.1$ mm

$\because \quad d = \frac{hr_1}{H - h_{avg}}$

[where h is height of tower]

$$\Rightarrow \quad 30.1 = \frac{h \times 112.5}{700 - 250}$$

$$\therefore \quad h = 120.4 \text{ m}$$

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