7

CHAPTER

Levelling and Contouring

Q.1 Which of the following is not the function of levelling head?
- (a) To support the main part of the instrument
- (b) To attach the theodolite to the tripod
- (c) To attach the theodolite to the tripod
- (d) None of the above

Q.2 A 'level line' is a
- (a) horizontal line
- (b) line parallel to the mean spheroidal surface of earth
- (c) line passing through the centre of cross hairs and the centre of eye piece
- (d) line passing through the objective lens and the eyepiece of a dumpy or tilting level

Q.3 The difference between a level line and a horizontal line is that
- (a) level line is a curved line while horizontal line is a straight line
- (b) level line is normal to plumb line while horizontal line may not be normal to plumb line at the tangent point to level line
- (c) horizontal line is normal to plumb line while level line may not be normal to the plumb line
- (d) both are one and the same thing

Q.4 With the rise of temperature, the sensitivity of a bubble tube
- (a) decreases
- (b) increases
- (c) remains unaffected
- (d) None of the above

Q.5 As applied to staff readings, the corrections for curvature and refraction are respectively
- (a) + and –
- (b) – and +
- (c) + and +
- (d) – and –

Q.6 Which of the following arithmetic checks can be applied in rise and fall method?
- (a) $\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall$ only
- (b) $\Sigma BS - \Sigma FS = \Sigma Last\ RL - First\ RL$ only
- (c) $\Sigma Rise - \Sigma Fall = \Sigma Last\ RL - First\ RL$ only
- (d) $\Sigma BS - \Sigma FS = \Sigma Rise - \Sigma Fall = Last\ RL - First\ RL$

Q.7 The correction for refraction as applied to staff reading is
- (a) $+\frac{1}{7}\left(\frac{d^2}{2R}\right)$
- (b) $-\frac{1}{7}\left(\frac{d^2}{2R}\right)$
- (c) $+\frac{1}{7}\left(\frac{d^2}{R}\right)$
- (d) $-\frac{1}{4}\left(\frac{d^2}{R}\right)$

where R is the radius of earth

Q.8 While doing levelling in undulating terrain, it is preferable to set the level on
- (a) the top of summit
- (b) the bottom of a valley
- (c) only side of the slope
- (d) anywhere

Q.9 Which of the following statement is incorrect?
- (a) Error due to refraction may not be completely eliminated by reciprocal levelling.
- (b) Tilting levels are commonly used for precision work.
- (c) The last reading of levelling is always a backsight
- (d) All of the above statements are incorrect.

Q.10 A series of closely spaced contour lines represents a
- (a) steep slope
- (b) gentle slope
- (c) uniform slope
- (d) plane surface

Q.11 In the cross-section method of indirect contouring, the spacing of cross-sections depends on

1. contour interval
2. scale of plan
3. characteristics of ground

The correct answer is
(a) only 1
(b) 1 and 2
(c) 2 and 3
(d) 1, 2 and 3

Q.12 Closed contours, with higher value inwards, represent a
(a) depression
(b) hillock
(c) plain surface
(d) non of the above

Q.13 Benchmark is established by
(a) hypsometry
(b) barometric levelling
(c) spirit levelling
(d) trigonometrical levelling

Q.14 Consider the following statement.
Besides contours, relief on topographic map is represented in general, by
1. hachures
2. point heights
3. hypsometric tints
4. hill shading

Of these statements
(a) 2 and 4 are correct
(b) 1 and 2 are correct
(c) 2, 3 and 4 are correct
(d) 1, 3 and 4 are correct

Q.15 During levelling if back sight is more than foresight then
(a) the forward staff is at lower point
(b) the back staff is at lower point
(c) the difference in level cannot be ascertained
(d) None of these

Q.16 In reciprocal levelling, the error which is not completely eliminated, is due to
(a) earth's curvature
(b) non-adjustment of line of collimation
(c) refraction
(d) non-adjustment of the bubble tube

Q.17 Accuracy of elevation of various points obtained from contour map is limited to

(a) $\frac{1}{2}$nd of the contour interval

(b) $\frac{1}{4}$th of the contour interval

(c) $\frac{1}{3}$rd of the contour interval

(d) $\frac{1}{5}$th of the contour interval

Q.18 If θ is the vertical angle of an inclined sight, δ is the angle of tilt of the staff, then the error 'E is

(a) $E = 1 - \dfrac{\cos(\theta \pm \delta)}{\cos\theta}$

(b) $E = 1 - \dfrac{\sin(\theta \pm \delta)}{\sin\theta}$

(c) $E = 1 - \dfrac{\tan(\theta \pm \delta)}{\tan\theta}$

(d) None of those

Q.19 Match List-I (Contour) with List-II (Explanation) and select the correct answer using the codes given below the lists:

List-I
A. Contour gradient
B. Steepest gradient
C. Saddle line
D. Line of drainage basin

List-II
1. The line which passes through ridges and saddles setting up a domain
2. The line which passes through ridges and saddles setting up a domain
3. Ridge or valley line
4. The line lying on the surface of the ground keeping a constant inclination to the horizontal
5. The gradient of the line joining the highest and the lowest point on the contour map

Codes:
	A	B	C	D
(a)	4	3	1	2
(b)	4	5	3	2
(c)	3	5	1	2
(d)	2	4	1	3

Q.20 Match List-II with List-II and select the correct answer using the codes given below the lists:

List-I
A. Reciprocal levelling
B. Balancing foresight and back sight
C. Inverted staff reading
D. Tilting level

List-II
1. Points above the line of collimation
2. Eliminates the collimation error
3. The vertical axis is not perpendicular to the line of collimation
4. Eliminates error due to inclined line of collimation also

Codes:
	A	B	C	D
(a)	1	2	4	3
(b)	4	2	1	3
(c)	4	3	1	2
(d)	1	3	4	2

Q.21 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I
A. Equally spaced contour lines
B. Contours are always perpendicular to
C. Contours increase in elevation from inside to outside

List-II
1. Steepest slope
2. A hill
3. A saddle
4. A depression
5. Uniform slope

Codes:
	A	B	C
(a)	1	2	3
(b)	1	3	4
(c)	5	3	2
(d)	5	1	4

Directions: The following items consists of two statements; one labelled as 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below:

Codes:
(a) both A and R are true and R is the correct explanation of A
(b) both A and R are true but R is not a correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

Q.22 Assertion A : Rise and fall method is preferred for reduction of levels in important works.
Reason R : It provides a complete check on reduction of levels of all points.

Q.23 Assertion A : Combined correction due to the curvature and refraction to the staff reading on a distant object is negative.
Reason R : Due to curvature effect, the actual reading should be smaller than what is observed. However, due to horizontal line of sight, the observed reading will be higher.

Q.24 Assertion A : In rise and fall method of booking observations and reducing elevations of points, a complete check on the reduction of R.Ls of intermediate stations is available.
Reason R : Intermediate sights are included for the calculation of rise and fall.

Q.25 Assertion A : Except in case of an overhanging cliff, two contour lines cannot merge or intersect at a point on the map.
Reason R : Intersection of two contour lines means one point on the surface of the earth will have two different elevations. This is not possible.

Q.26 To find the R.L. of a roof slab of a building, staff readings were taken from a particular set-up of the levelling instrument. The readings were 1.050 m with staff on the benchmark and 2.300 m with staff below the roof slab and held inverted. Taking the R.L. of the B.M. as 135.150 m. the R.L. of the roof slab will be
(a) 129.800
(b) 131.900
(c) 134.400
(d) 138.500

Q.27 An observer standing on the deck of a ship just sees the top of a lighthouse which is 30 m above

the sea level. If the height of the observer's eye is 10 m above the sea level, then the distance of the observer from the lighthouse will be nearly
(a) 22.5 km
(b) 24.3 km
(c) 33.3 km
(d) 59.7 km

Q.28 A lighthouse is visible just above the horizontal at a certain station at the sea level. The distance between the station and the lighthouse is 40 km. The height of the lighthouse is approximately
(a) 187 m
(b) 137.7 m
(c) 107.65 m
(d) 87.3 m

Q.29 If the staff intercept on a staff located at 100 m from the level for five division deviation of the bubble is 0.050 m and if the length of one division of the bubble is 2 mm, then the radius of curvature of the bubble tube is
(a) 2.02 m
(b) 2.20 m
(c) 20.00 m
(d) 20.20 m

Q.30 Which one of the following gives the correct distance between the lighthouse and a ship, when the lighthouse whose height is 100 m is visible just above the horizontal from the ship?
(a) 30.68 km
(b) 36.50 km
(c) 38.55 km
(d) 40.54 km

Q.31 A sewer is laid from a manhole A to a manhole B, 250 m apart along a downward gradient of 1 in 125. If the reduced level of the invert at A is 205.75 m and the height of the boning rod is 3 m then, reduced level of the sight rail at B, is
(a) 202.75 m
(b) 206.75 m
(c) 208.75 m
(d) 211.75

Q.32 A dumpy level is set up with its eyepiece vertically over a peg A. The height from the top of peg A to the centre of the eyepiece is 1.540 m and the reading on peg B is 0.705 m. The level is then set up over peg B. The height of the eyepiece above peg B is 1.490 m and the reading on A is 2.195 m. The difference in level between A and B is
(a) 2.900 m
(b) 3.030 m
(c) 0.770 m
(d) 0.785 m

Q.33 If the R.L. of a B.M. is 100.00 m, the backsight is 1.215 m and the foresight is 1.870 m, the R.L. of the forward station is
(a) 99.345 m
(b) 100.345 m
(c) 100.655 m
(d) 101.870 m

Q.34

Station	BS	IS	FS	Rise	Fall	RL	Remarks
A	2.1	2.3		1.5		100.00	CP
B	1.0		X		101.10		
C			1.3	0.3		100.80	

Above table shows a part of a level field book. What is value of X?
(a) 0.5
(b) 1.0
(c) 1.1
(d) 2.1

Q.35 The RL of a point A which is on the floor is 100 m and back sight reading on A is 2.455 m. If the foresight reading on the point B which is on the ceiling is 2.745 m, then the RL of point B will be
(a) 94.80 m
(b) 99.71 m
(c) 100.29 m
(d) 105.20 m

Q.36 What is the arithmetic error in the following table?

Station	BS	IS	FS	HI	RL	Remarks
A	2.00			102.00	101.00	B.M
B	1.00				102.00	
C			0.50		102.00	

(a) The RL of BM should be 100.00
(b) The height of instrument (HI) should be 103.00
(c) The back sight should be 1.00
(d) There is no error in the table

Q.37 The following consecutive readings were taken with a dumpy level:
0.635, 1.525, 2.395, 0.605, 0.805, 0.125
The instrument was shifted after the third and fifth readings. The readings 2.395 and 0.635 respectively represents
(a) F.S. and B.S.
(b) F.S. and I.S.
(c) B.S. and F.S.
(d) I.S. and B.S.

Q.38 In the above question, the number of stations is
(a) 2
(b) 5
(c) 6
(d) 7

Q.39 In Question no. 39 above, the R.L. of last point
(a) is greater than R.L. of first point
(b) is same as R.L. of first point
(c) is smaller than R.L. of first point
(d) cannot be determined from the given data

Q.40 The following consecutive readings were taken with a dumpy level and a 3 m staff on a continuously sloping ground.
0.425, 1.035, 1.950, 2.360, 2.950, 0.750, 1.505, 2.450, 0.320, 1.025, 2.165, 2.955
Which of the following readings are back-sights.
(a) 0.245, 2.950, 0.750, 0.320
(b) 0.425, 0.750, 0.320, 2.955
(c) 0.425, 0.750, 0.320
(d) 0.425, 2.360, 0.750, 0.320

Q.41 A level was set up at a point A and distance to the staff station B was 100 m. The net combined correction due to curvature and refraction as applied to the staff reading is
(a) 0.00673 m
(b) 0.000673 m
(c) -0.000673 m
(d) -0.00673 m

Q.42 Contour interval is
(a) inversely proportional to the scale of the map.
(b) directly proportional to the flatness of ground
(c) large for accurate works.
(d) None of these

Q.43 The contours lines of different elevations can intersect in the case/cases of
1. Vertical diff
2. Cave
3. Over hanging diff
(a) Only 3
(b) 2 and 3 only
(c) 1, 2 and 3
(d) 1 and 3 only

Q.44 Which of the following methods of contouring is most suitable for a hilly terrain?
(a) Direct method
(b) Square method
(c) Cross-sections method
(d) Tacheometric method

Q.45 Two points A and B are 1530 m apart across a river. The reciprocal levels measured are

Level at	Readings on (in m)	
	A	B
A	2.165	3.810
B	0.910	2.355

The true difference in levels between A and B would be
(a) 1.255 m
(b) 1.355 m
(c) 1.545 m
(d) 1.645 m

Q.46 If the observed staff reading at a station is 800.925 m then the correction due to refraction is 0.115 m and correction due to curvature is 0.805. Then the correct staff reading will be
(a) 801.615 m
(b) 800.235 m
(c) 800.005 m
(d) 800.120 m

Q.47 Which of the following sights will be applicable for a change point?
(a) Back sight
(b) Intermediate sight and fore sight
(c) Fore sight
(d) Back sight and fore sight

Q.48 Curvature correction to the staff reading in a differential levelling survey is
(a) always subtractive
(b) always zero
(c) always additive
(d) dependent on latitude

Q.49 Which one of the following statement is not correct?
(a) Change point is a point denoting shifting of level.
(b) For levelling work both centering and levelling of a dumpy level are prerequisite.
(c) Bench mark is a point whose RL is always known.
(d) None of the above

Q.50 The bubble tube parallel to the telescope of a theodolite should be more sensitive, since it controls the,
(a) vertical axis
(b) horizontal axis
(c) axis of bubble tube
(d) None of these

Q.51 A line of levels was run from Bench Mark A (770.815) to a Bench Mark B (772.940). The sum of back sights was 32.665 m and sum of fore sights was 30.44 m. The closing error is (in m)
(a) 0.105
(b) 0.100
(c) 0.205
(d) 0.200

Q.52 The RL of a classroom floor is 30.00 m and the staff reading on the floor is 1.40 m. The staff reading when, held inverted with the bottom touching the Tee beam of the roof is 3.67 m. The height of the beam above the floor is
(a) 35.07 m
(b) 2.27 m
(c) 5.07 m
(d) 27.73 m

Q.53 The distance of visible horizon from a height of 36 m above mean sea level is given by
(a) $\sqrt{\dfrac{36}{0.6728}}$ km
(b) $36\sqrt{\dfrac{1}{0.06728}}$ km
(c) $\sqrt{\dfrac{36}{0.06728}}$ km
(d) $36\sqrt{0.06728}$ km

Q.54 If sensitivity of the bubble tube is 30" per 2 mm division then what would be the error in staff reading on a vertically held staff at a distance of 200 m when its bubble is out of centre by 2.5 divisions?
(a) 0.73 m
(b) 0.073 m
(c) 0.0073 m
(d) 7.3 m

Q.55 Change points in levelling are
(a) the instrument station that are changed from one position to another.
(b) the staff station that are changed from point to point to obtain the reduced levels of the points.
(c) the staff stations of known elevations.
(d) the staff stations where back sight and fore sight readings are taken.

Q.56 The height of instrument method of reducing levels is preferred when
(a) there are large numbers of intermediate sights.
(b) there are no intermediate sights.
(c) there are large number of fore sights.
(d) there are no fore sights.

Q.57 Reciprocal leveling is employed to determine the accurate difference in level of two points which
(a) are quite far apart and where it is possible to set up the instrument midway between the points.
(b) are quite close and where it is not possible to set up the instrument midway between the points.
(c) have very large difference in level and two instrument settings are required to determine the difference in level.
(d) are at almost same elevation.

Q.58 The angular value of one division of the bubble tube of a level is 20 seconds. The reading on a staff held 100 metres away for a disturbance of the bubble 3 divisions from centre towards the observer the reading with bubble in the centre being 2.540 m will be
(a) 2.511 m
(b) 2.569 m
(c) 2.290 m
(d) 2.731 m

Q.59 The check available in levelling is as follows:
(a) Σ Rise – Σ Fall = Last R.L – First R.L
(b) Σ B.S – Σ F.S = Σ Rise – Σ Fall
(c) Σ B.S – Σ I.S = Last R.L – I.R.L
(d) Both (a) and (b) are correct

Q.60 The R.L., of the point A which is on the floor is 100 m and backsight reading on A is 2.455 m. If the foresight reading on the point B which is on the ceiling is 2.745 m, the R.L. of point B will be
(a) 94.80 m
(b) 99.71 m
(c) 100.29 m
(d) 105.20 m

Q.61 The least count of an ordinary levelling staff is :
(a) 0.05 m
(b) 0.001 m
(c) 0.005 cm
(d) 0.005 m

Q.62 The curvature correction in levelling is always:
(a) Negative
(b) Positive
(c) Zero
(d) Neglected

Q.63 In levelling work, if Σfall = zero, then the ground is:
(a) continuously rising
(b) continuously falling
(c) undulating
(d) All the above

Q.64 Two points C and D are on opposite banks of a river. The following reciprocal levels are taken with one level.

Level at	Staff reading on	
	C	D
C	2.156 m	3.568 m
D	1.958 m	3.262 m

Find the true statement:
(a) D is 1.535 m higher than C
(b) C is 1.353 m higher than D
(c) C is 1.412 m higher than D
(d) C is 1.294 m higher than D

Q.65 Area enclosed in a contour may be determined by means of
(a) Periscope
(b) Planimeter
(c) Pantograph
(d) Ghat Tracer

Q.66 The slope between any two points on a contour map depends upon
(a) Contour interval only
(b) Horizontal equivalent only
(c) Contour interval and horizontal equivalent both
(d) None of these

Q.67 Select the correct statement:
(a) Contour interval on any map is not kept constant
(b) Direct method of contouring is cheaper than indirect method
(c) Intervisibility of points on a contour map can be ascertained
(d) Slope of a hill cannot be determined with the help of contours

Q.68 An imaginary line lying on the ground and maintaining a constant slope is known as
(a) Contour line
(b) Horizontal equivalent
(c) Contour interval
(d) Grade contour

Q.69 Intersection method of detailed plotting is most suitable for

(a) Forests
(b) Urban area
(c) Hilly areas
(d) Plains

Q.70 A dumpy level was set up at the mid-point between two pegs A and B, 50 m apart and the staff readings at A and B were 1.22 m and 1.06 m with the level set up at A, the readings at A and B were 1.55 m and 1.37 m. The collimation error per 100 m length of sight is
(a) 0.02 m inclined upwards
(b) 0.04 m inclined downwards
(c) 0.04 m inclined upward
(d) None of these

Q.71 Keeping the instrument height as $1\dfrac{1}{2}$ m, length of staff 4 m, the up gradient of the ground 1 in 10, the sight on the up slope must be less than
(a) 25 cm
(b) 20 cm
(c) 45 m
(d) 10 m

Q.72 Two stations A and B 60 km apart, have elevations 15 m and 270 m above mean sea level respectively. The minimum height of the signal required at B to see from A will be
(a) 15.00 m
(b) 14.00 m
(c) 15.50 m
(d) 15.25 m

Q.73 The correction due to curvature in metres for a distance 'D' is given by:
(a) 0.0112 D^2
(b) 0.0673 D^2
(c) 0.0785 D^2
(d) 0.0587 D^2

Q.74 Which of the following errors are eliminated in reciprocal levelling?
(i) Curvature
(ii) Refraction
(iii) Instrument adjustment error
(iv) Variations in average refraction
(a) (i), (ii), (iii) only
(b) (i) and (ii) only
(c) (i), (ii) and (iv) only
(d) All of the above

Q.75 A sailor standing on deck of ship just sees the top of light house. The top of light house is 30 m above sea level and height of sailor's eye is 5 m above sea level. The distance of sailor from the light house is:

(a) 21.16 m   (b) 8.64 m
(c) 29.80 m   (d) 12.52 m

Q.76 The sensitivity of bubble tube of level is 30" per 2 mm division. If the staff is vertically held at distance of 150 m, the error in staff reading caused by a bubble 2 divisions out of the centre is:
(a) 0.0216 m   (b) 0.0346 m
(c) 0.0436 m   (d) 0.0128 m

Q.77 The reduced levels of peg A and B are 283.665 m and 284.295 m respectively. A level is set up 25 m from peg A and 50 m from peg B reads 2.847 m on staff held on A and 3.462 m on staff held on B keeping bubble at its centre while reading. The collimation error per 100 m is
(a) 0.120 m   (b) 0.060 m
(c) 0.045 m   (d) 0.090 m

Q.78 Sensitivity of a bubble increase with
(i) Smoothness of finish of internal surface of the tube.
(ii) Increase in radius of curvature of tube.
(a) Only (i) is correct
(b) Only (ii) is correct
(c) Both (i) and (ii) are correct
(d) None is correct

Q.79 The reduced level of floor is 90.855 m and staff reading on floor is 3.065 m. The reading on staff held upside down against the underside of the beam is 3.56 m. The height of Tee-beam above the floor level is
(a) 5.825 m   (b) 6.625 m
(c) 7.285 m   (d) 5.265 m

■■■■

Answers   Levelling and Contouring

1. (d) 2. (b) 3. (a) 4. (a) 5. (b) 6. (d) 7. (a) 8. (c) 9. (d) 10. (a)
11. (d) 12. (b) 13. (c) 14. (d) 15. (b) 16. (c) 17. (a) 18. (a) 19. (b) 20. (b)
21. (d) 22. (a) 23. (b) 24. (a) 25. (a) 26. (d) 27. (c) 28. (c) 29. (c) 30. (c)
31. (b) 32. (c) 33. (a) 34. (c) 35. (d) 36. (b) 37. (a) 38. (b) 39. (c) 40. (c)
41. (c) 42. (a) 43. (b) 44. (d) 45. (c) 46. (b) 47. (d) 48. (a) 49. (d) 50. (b)
51. (b) 52. (c) 53. (c) 54. (b) 55. (d) 56. (a) 57. (a) 58. (b) 59. (d) 60. (d)
61. (d) 62. (a) 63. (a) 64. (b) 65. (b) 66. (b) 67. (c) 68. (d) 69. (c) 70. (b)
71. (c) 72. (d) 73. (c) 74. (d) 75. (c) 76. (c) 77. (b) 78. (c) 79. (b)


Explanations   Levelling and Contouring

4. (a)
With a rise in temperature the liquid expands. Hence the bubble shortens and consequently its sensitivity decreases.

10. (a)
Closed contours ⇒ Steep slope
apart contour lines ⇒ Gentle slope
Equally spaced contours ⇒ Uniform slope

Straight parallel and equally spaced contours ⇒ plane surface

26. (d)
Since the staff at roof slab is held vertically inverted,
∴ RL of roof slab
= RL of BM + BS on BM + FS on roof slab
= 135.15 + 1.050 + 2.30
= 138.5 m

27. (c)
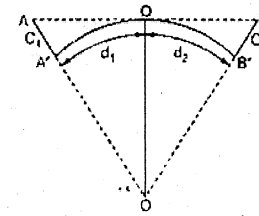
Let A be the position of top of light house and B be the position of observer's-eye. Let AB be tangential to water surface at O.
The diameter d_1 and d_2 are given by

$$d_1 = 3.8553\sqrt{C_1}\ \text{km}$$
$$= 3.8553\sqrt{30}\ \text{km}$$
$$= 21.12\ \text{km}$$

and
$$d_2 = 3.8553\sqrt{C_2}\ \text{km}$$
$$= 3.8553\sqrt{10}\ \text{km}$$
$$= 12.19\ \text{km}$$

∴ Distance between A and B
$$= d_1 + d_2$$
$$= 21.12 + 12.19$$
$$= 33.31\ \text{km}$$

28. (c)
The height of the light house is given by
$$C = 0.06728\ d^2\ \text{metres}$$
$$= 0.06728 \times 40^2\ \text{metres}$$
$$= 107.65\ \text{metres}$$

29. (c)
The radius of curvature of bubble is given by
$$\frac{\ln D}{s} = \frac{2/1000 \times 5 \times 100}{0.05} = 20.0\ \text{m}$$

31. (b)
Reduced level of the invert at
$$B = \frac{205.75 - 250}{125} = 203.75\ \text{m}$$
Hence the reduced level of the sight rail at B
$$= 203.75 + 3.0 = 206.75\ \text{m}$$

32. (c)
Level difference
$$= \frac{1}{2}\left[(1540 - 0705) + (2195 - 1490)\right] = 0.770\ \text{m}$$

33. (a)
As we know
Height of instrument = RL of BM + BS
∴   HI = 100 + 1.215 = 101.215 M
and RL of forward station
$$= HI - FS$$
$$= 101.215 - 1.870$$
$$= 99.345\ \text{m}$$

34. (c)
$$X = 2.1 - 1.0 = 1.1$$

35. (d)
Since the staff at the elevated point B on the ceiling is held vertically inverted.
RL of B = RL of A + B.S. on A + FS on B
$$= 100 + 2.455 + 2.745$$
$$= 105.20\ \text{m}$$

37. (a)
Since the instrument was shifted after the third and fifth readings, these reading i.e., 2.395 and 0.805 represents the Fore Sight (FS). Also the first reading i.e., 0.635 represents Back Sight (BS).

38. (b)
The given staff readings can be shown in a table as shown below:

Station	B.S.	I.S.	F.S.
A	0.635		
B		1.525	
C	0.605		2.395
D		0.805	
E			0.125

Therefore, the total number of station is 5.

39. (c)
RL of last point - RL of first point = ΣBS - ΣFS
Since ΣBS < ΣFS, hence (RL of last point) < (RL of first point).

40. (c)
Since the readings were taken on a continuously sloping ground, reading can be 3 metres only, and therefore, fifth reading, will be a fore sight taken on a turning point and sixth reading will be a back sight. Similarly ninth reading i.e., 0.320 will be a back sight. Also the first reading i.e., 0.425 will be a back sight.

41. (c)
Net combined correction
$= -0.0673 \, d^2$ metres where d is in kms
$= -0.0673 \, d^2 \left(\dfrac{1}{10}\right)^2 = -0.000673 \text{ m}$

45. (c)
True difference in levels,
$h = \dfrac{(3.810-2.165)+(2.355-0.910)}{2}$
$= 1.545 \text{ m}$
Error in collimation adjustment,
$e = \dfrac{(3.810-2.165)-(2.355-0.910)}{2}$
$= 0.1 \text{ m}$
When the level is at A, the reading on the staff at A is correct, while reading on the staff at B is incorrect. When the level is at B, the reading on the staff at B is correct while reading on the staff at A is incorrect.
Correct readings are:

Level at	Readings on (in m)	
	A	B
A	2.165	3.710
B	0.810	2.355

47. (d)
A change point is the point selected on the route before shifting the instrument. The change point is also called a turning point. The staff is kept on the turning point and a foresight is taken before shifting the instrument. The staff should not be moved when the instrument is being shifted. After the instrument has been shifted and set up at the new location, a back sight is taken on the staff still held at the change point.

51. (b)
$RL_0 = RL_A + \Sigma BS - \Sigma FS$
$RL_B = 770.815 + 32.665 - 30.44 = 773.035$
$\therefore$ Closing error $= 773.035 - 772.940 = 0.10$

52. (c)
Height $=$ staff reading on floor $+$ inverted staff reading
$= 1.40 + 3.67 = 5.07 \text{ m}$

54. (b)
The sensitivity of a bubble tube is given by
$\alpha' = 206265 \dfrac{S}{nD} \text{ sec.}$
$\therefore \quad S = \dfrac{nD\alpha'}{206265} = \dfrac{2.5 \times 200 \times 30}{206265}$
$= 0.073 \text{ m}$
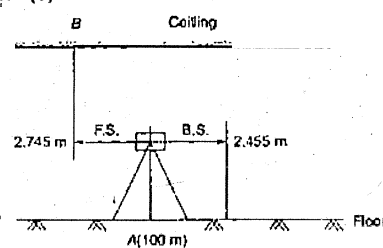
58. (b)
$20 = \dfrac{S}{3 \times 100} \times 206265$
$\therefore \quad S = 0.029 \text{ m}$
Reading $= 2.54 + 0.029 = 2.569 \text{ m}$

59. (d)
Check available for levelling are:
(i) $\Sigma B.S - \Sigma F.S =$ Last R.L – First RL
(ii) $\Sigma Rise - \Sigma fall =$ Last RL – First RL
(iii) $\Sigma B.S - \Sigma FS = \Sigma Rise - \Sigma fall$
Hence option (d) is correct.

60. (d)

R.L of B = R.L of A + B.S + F.S
$= 100 + 2.455 + 2.745$
$= 105.20 \text{ m}$
Hence option (d) is correct.

61. (d)
Least count of an ordinary levelling staff is 5 mm.
Hence option (d) is correct.

62. (a)
Since due to effect of curvature more staff reading is taken.
So error is positive.
Hence corresponding correction is negative.
$\therefore \quad C_c = -0.0785 \, d^2 \text{(m)}$
where d is in km
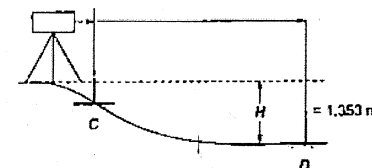Hence option (a) is correct.

64. (b)

Level at	Staff reading on	
	C	D
C	$h_c = 2.156$ m	$h_D = 3.568$ m
D	$h_c' = 1.968$ m	$h_D' = 3.262$ m

$h_D - h_c = 3.568 - 2.156 = 1.412$ m $\}$ Not same
$h_D' - h_c' = 3.262 - 1.968 = 1.294$ m $\}$
Hence instrument is faulty.
Exact difference of level,
$H = \dfrac{\left(h_D - h_c\right) + \left(h_D' - h_c'\right)}{2}$
$H = \dfrac{1.412 + 1.294}{2}$
$H = 1.353 \text{ m}$

Hence C is 1.353 m higher than D.

65. (b)
A planimeter is an instrument which measures the area of plan of any shape very accurately.

66. (b)
The vertical distance between any two consecutive contour is called contour interval. The contour interval is kept constant for a contour map.
The horizontal distance between two points on two consecutive contours is known as the horizontal equivalent and it depends upon the slope of the ground.

67. (c)
Contour interval is kept constant for a contour map. The direct method is slow, tedious and expensive as compare to indirect method. It is used for small areas and where great accuracy is required.
If a contour map is given, the slope of hill can be determined.
Contour maps are used to determine the intervisiblity between two points.
Hence option (c) is correct.

68. (d)
Contour gradient is a line lying throughout on the surface of the ground and preserving a constant inclination to the horizontal.
Contour line is an imaginary line on the ground joining the points of equal elevation.
The horizontal distance between two points on two consecutive contour is known as the horizontal equivalent.
The vertical distance between any two consecutive contour is called contour interval.
Hence option (d) is correct.

69. (b)
Intersection method is useful where it is not possible to measure the distance on ground as in case of a mountainous region. Hence, this method is employed for locating in accessible points, the broken boundaries, rivers, fixing survey stations.
Hence option (c) is correct.

70. (b)

Distance between a and $b = 50$ m
When instrument at is centre
$$= 0.22 - 1.06 = 0.16 \text{ m}$$
When instrument is near to A
$$= 1.55 - 1.37 = 0.18 \text{ m}$$
Difference $= 0.16 - 0.18 = -0.020$ m
(– indicates downwards)
Collimation error for 100 m length
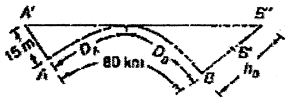$$= \frac{0.020}{50} \times 100 = 0.04 \text{ m}$$
(inclined downwards)

71. (c)

upslope wight $= \dfrac{h^2}{2L}$

where, $h = 1.5 + \dfrac{4}{10} = 1.9$ m

$$= \frac{1.9^2}{2L} = 45 \text{ m}$$

72. (d)

Given $\quad h_A = 15$ m
$\qquad h_B = 270$ m
$\qquad D = 80$ km

$\qquad D_A = 3.853\sqrt{h_A}$

$\qquad\quad = 3.853\sqrt{15} = 14.92$ km

$\qquad D_B = 80 - 14.92 = 65.08$ km

Therefore, $\quad h'_B = 0.06735 \, D_B^2$
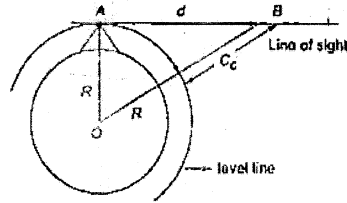
$\qquad\qquad = 0.06735 \times (65.08)^2$

$\qquad\qquad = 285.25$ m

Since the elevation of B is 270 m, the height of signal required at B is

$\qquad\qquad = 285.25 - 270 = 15.25$ m

Hence option (d) is correct

73. (c)

In $\triangle OAB$,

$$R^2 + d^2 = (R + C_c)^2$$
$$R^2 + d^2 = R^2 + C_c^2 + 2R_{C_c}$$
$$d^2 = C_c(2R + C_c)$$
$$C_c = \frac{d^2}{2R} \qquad \therefore (2R + C_c \simeq 2R)$$

Radius of earth is approximately 6370 km

$\therefore \qquad\qquad C_c = \dfrac{d^2 \times 1000}{2 \times 6370}(m)$

$\qquad\qquad\quad = -0.0785 \, d^2 \, (m)$

Hence option (c) is correct.

74. (d)

Reciprocal levelling eliminates all of above errors.
In reciprocal levelling reading from both sides are taken.

75. (c)

$\qquad\qquad h = 0.067 \, d^2$ m
$\qquad\qquad h$ is in metres, d is in km
$\qquad\qquad h_1 = 30 = 0.067 \, D_1^2$
$\Rightarrow \qquad D_1 = 21.16$ m

Similarly, $\quad D_2 = \sqrt{\dfrac{5}{0.067}} = 8.64$ km

Hence, total distance
$\qquad\qquad = 21.16 + 8.64 = 29.80$ km

76. (c)

Sensitivity of bubble tube,

$\qquad\qquad \alpha' = \dfrac{S}{nD} \times 206265$

or, $\quad S = \dfrac{\alpha DN}{206265} = \dfrac{30 \times 2 \times 150}{206265}$

$\Rightarrow \qquad S = 0.0436$ m

77. (b)

Let collimation error per 100 m is e.
True staff reading at A
$$= 2.847 + 0.25 \, e$$
True staff reading at B

$$= 3.462 + \frac{50}{100} e$$

$$= 3.462 + 0.50 \, e$$

Difference in elevation

$$= 3.462 + 0.5 \, e - (2.847 + 0.25 \, e)$$
$$= 0.615 + 0.25 \, e$$

From RL of A and B difference in elevation

$$= 284.295 - 283.665 \text{ m} = 0.630 \text{ m}$$
$$= 0.615 + 0.25 \, e = 0.630$$
$\Rightarrow \qquad e = 0.060$ m /100 m

78. (c)

Larger the diameter and length of tube, greater the sensitivity.
Lesser the viscosity, more is the sensitivity.
Greater the smoothness, more is the sensitivity.

79. (b)

RL of plane of collimation
$$= 90.855 + 3.065 = HI$$
$HI \Rightarrow 93.92$ m
RL of underside of beam
$$= 93.92 + 3.56 = 97.48 \text{ m}$$
Hence, height of Tee-beam above floor level
$$= 97.43 - 90.855 = 6.625 \text{ m}$$

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