2 CHAPTER

Linear Measurements

Q.1 Which of the following instrument is generally used for base line measurements?
(a) Chain (b) Metallic tape
(c) Steel tape (d) Invar tape

Q.2 Which of the following methods of offsets involves less measurement on the ground?
(a) Method of perpendicular offsets
(b) Method of oblique offsets
(c) Method of ties
(d) All involves equal measurement on the ground

Q.3 The permissible error in chaining for measurement with chain on rough or hilly ground is
(a) 1 in 100 (b) 1 in 250
(c) 1 in 500 (d) 1 in 1000

Q.4 The correction for sag is
(a) always additive
(b) always subtractive
(c) always zero
(d) sometimes additive and sometimes subtractive

Q.5 The correction to be applied to each 30 metre chain length along θ° slope, is
(a) 30 (secθ – 1) m (b) 30 (1 – sinθ) m
(c) 30 (1 – cosθ) m (d) 30 (tanθ –1) m

Q.6 Correct distance obtained by an erroneous chain is
(a) $\frac{\text{Erroneous chain length}}{\text{Correct chain length}} \times$ Observed distance
(b) $\frac{\text{Correct chain length}}{\text{Erroneous chain length}} \times$ Observed distance
(c) $\frac{\text{Correct chain length}}{\text{Observed distance}} \times$ Erroneous chain length
(d) None of these

Q.7 The correction applied to the measured base of length L is
(a) tension $= \frac{(P-P_s)L}{AE}$, sag $= \frac{L^3w^2}{24P^2}$ where w is the weight of tape/m
(b) slope $= \frac{h^2}{2L} + \frac{h^4}{8L^3}$ where h is height difference of end supports
(c) reduction to mean sea level $= \frac{Lh}{R}$
(d) All of the above

Q.8 Match List-I with List-II and select the correct answer using the codes given below the lists

List I
A. Boning rod
B. Travelling rod
C. Sight rails
D. Batter boards

List II
1. It is a flat, square, wooden board which is forced on the top of a pin anchored in ground. It is also known as slope rail
2. The horizontal member of the cross head nailed to the posts
3. It is generally used in layout of trenches for sewers, pipe lines etc.
4. The horizontal piece can be moved along a graduated vertical staff

Codes:

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

Q.9 Match List-I with List-II and select the correct answer using the codes given below the lists

List-I

A. Fathometer
B. Passometer
C. Tellurometer
D. Altimeter

List-II

1. Microwave instrument
2. Sounding instrument
3. Distance measuring instrument
4. Height measuring instrument
5. Pressure measuring instrument

Codes:

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

Q.10 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

A. Correction for sag
B. Least count 30'
C. Overlap
D. Additive constant

List-II

1. Tacheometer
2. Aerial photograph
3. Base line
4. Prismatic compass

Codes:

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

Q.11 Match List-I with List-II and select the correct answer using the codes given below the lists:

List-I

A. Sextant
B. Sounding
C. Fatho-meter
D. Range

List-II

1. Measurement of depth below the water surface
2. The line on which soundings are taken
3. The lines which are usually used for depths above about 6 m
4. Instrument used for measuring angles from boat
5. Instrument used for measuring depth in ocean

Codes:

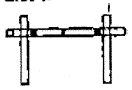
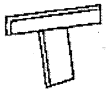
	A	B	C	D
(a)	5	1	4	2
(b)	4	2	5	3
(c)	5	3	4	1
(d)	4	1	5	2

Q.12 Match List-I (Names) with List-II (figures) and select the correct answer using the codes given below the lists:

List-I

A. Boning rod
B. Travelling rod
C. Sight rails
D. Batter boards

List-II

1. 
2. 
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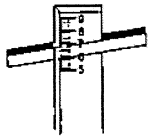
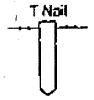
4. 
5. 

Codes:

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

Q.13 A 30 m metric chain is found to be 0.1 m too short throughout the measurement. If the distance measured is recorded as 300 m, then the actual distance will be

(a) 300.1 m (b) 301.0 m
(c) 299.0 m (d) 310.0 m

Q.14 The true length of a line is known to be 200 m. When this was measured with a 20 m tape, the length came out to be 200.80 m. The correct length of the 20 m tape is

(a) 19.92 m (b) 19.98 m
(c) 20.04 m (d) 20.08 m

Q.15 A plot of land 60 m × 20 m is measured by a steel tape. If the standard error of length and width measurements is taken as ±1 cm, then the standard error of the area of the plot would be

(a) $\pm 0.1414\ m^2$ (b) $\pm 0.566\ m^2$
(c) $\pm 0.632\ m^2$ (d) $\pm 0.8484\ m^2$

Q.16 The distance between two points measured along a slope is 428 m. If the angle of slope between the points is 8° then the horizontal distance between them is

(a) 59.56 m (b) 60.15 m
(c) 400 m (d) 423.83 m

Q.17 A line of true length 500 m when measured by a 20 m tape is reported to be 502 m long. The correct length of the tape is

(a) 19.92 m (b) 20.08 m
(c) 20.80 m (d) 21 m

Q.18 A 20 m chain was found to be 10 cm too long after chaining a distance of 2000 m. It was found to be 18 cm too long at the end of the day's work after chaining a total distance of 4000 m. What is the true distance if the chain was correct before the commencement of the day's work?

(a) 3962 m (b) 4019 m
(c) 3981 m (d) 4038 m

Q.19 A surveyor measured the distance between two points on the plan drawn to a scale of 1 cm = 40 m and the result was 468 m. Later he discovered that he used a scale of 1 cm = 20 m. What is the true distance between the two points?

(a) 936 m (b) 234 m
(c) 117 m (d) 702 m

Q.20 The length of a line measured with a 20 metre chain was found to be 250 metres. What is the true length of the line if the chain was 10 cm too long?

(a) 251.25 m (b) 248.75 m
(c) 250.1 m (d) 249.9 m

Q.21 During the measurement of a line by chain or tape in slopes, if the length of line is 'l' and level difference between the ends of the line is 'h', then the correction to the measured length is more than $h^2/2l$ by

(a) Zero (b) $+\frac{h^4}{8l^2}$
(c) $+\frac{h^3}{4l^2}$ (d) $-\frac{h^3}{2l^2}$

Q.22 A 100 m tape is suspended between the two ends under a pull of 200 N. The weight of the tape is 30 N. The correction for sag and correct distance between the tape ends are respectively

(a) 0.056 m; 99.944 m
(b) 0.094 m; 99.906 m
(c) 0.094 m; 100.094 m
(d) 0.056 m; 100.056 m

Q.23 Distance between two stations A and B can be precisely measured with one complete Gunter's chain and one complete Engineer's chain. The distance between A and B is

(a) 166 ft. (b) 266 ft.
(c) 133 ft. (d) 233 ft.

Q.24 Normal tension is that pull which

(a) is used at the time of standardizing the tape
(b) neutralizes the effect due to pull and sag
(c) makes the correction due to sag equal to zero
(d) makes the correction due to pull equal to zero

Q.25 The length of a base line measured on ground at an elevation of 300 metres above mean sea level is 2250 metres. The required correction to reduce

to sea level length (given Radius of earth = 6370 km) will be

(a) 106 mm (b) 206 mm
(c) 306 mm (d) 212 mm

Q.26 An angle measuring instrument reading upto one-sixth of a degree on the main scale is equipped with a vernier having 19 main scale divisions divided into 20 parts. The correct least count of the instrument is:

(a) 60 seconds (b) 30 seconds
(c) 20 seconds (d) 10 seconds

Q.27 If 'h' is the difference in level between end points separated by 'L', then the slope correction is $\frac{h^2}{2L}+\frac{h^4}{8L^3}$. The second term may be neglected if the value of h in a 20 m distance is less than:

(a) 1/2 m (b) 3 m
(c) 2 m (d) None of these

Q.28 The slope correction for a length of 30 m along a gradient of 1 in 20 is

(a) 3.75 cm (b) 37.5 cm
(c) 0.375 cm (d) None of these

Q.29 A tape of length 'L' and weight 'W kg/m is suspended at its ends with a pull of 'P' kg, the sag correction is

(a) $\frac{L^3W^2}{24P^2}$ (b) $\frac{L^2W^2}{24P^3}$

(c) $\frac{L^2W^2}{24P^2}$ (d) None of these

Q.30 Metric chains are generally available in

(a) 10 m and 20 m length
(b) 15 m and 20 m length
(c) 20 m and 30 m length
(d) None of these

Q.31 Which of following expression represents the normal tension applied to tape suspended in the air?

(a) $\frac{0.204W\sqrt{AE}}{\sqrt{P-P_0}}$ (b) $\frac{0.314P_0\sqrt{AE}}{\sqrt{P-P_0}}$

(c) $\frac{0.324WP_0\sqrt{AE}}{\sqrt{P-P_0}}$ (d) $\frac{0.402WP_0\sqrt{AE}}{\sqrt{P-P_0}}$

where P_0 = standard pull,
P = pull applied during measurement
W = total weight of tape
E = modulus of elasticity of tape

Q.32 A 20 m chain was found to be 10 cm too long after chaining a distance of 2000 m. It was found to be 18 cm too long at the end of the day's work after chaining a total distance of 4000 m. If the chain was correct before the commencement of the day's work, the true distance in:

(a) 3981 m (b) 4019 m
(c) 4038 m (d) 3962 m

Q.33 Planimeter measures the area of the plan of old survey map plotted to scale of 15 to 1 cm measures 80.2 cm^2. The plan is found to have shrunk so that line originally 10 cm long measures 9.8 cm only. The true area of survey map is

(a) 14.70 m^2 (b) 38.15 m^2
(c) 83.51 m^2 (d) 41.07 m^2

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Answers Linear Measurements

1. (d)	2. (a)	3. (b)	4. (b)	5. (c)	6. (a)	7. (d)	8. (a)	9. (a)	10. (b)
11. (d)	12. (c)	13. (c)	14. (a)	15. (c)	16. (d)	17. (a)	18. (b)	19. (a)	20. (a)
21. (b)	22. (b)	23. (a)	24. (b)	25. (a)	26. (b)	27. (b)	28. (a)	29. (a)	30. (c)
31. (c)	32. (b)	33. (c)							

Explanations Linear Measurements

1. (d)
Invar tapes are used for linear measurement of very high degree precision such as base line measurements, cloth or lines tap for rough and subsidiary measurements such as offset.

4. (b)
Always negative

$$C_{S_1}=\frac{l_1(wl_1)^2}{24p^2}$$

(Assuming parabola curve)
l_1 = length suspended (m)
p = pull applied (kg or N)
w = weight of tape per meter length
wl_1 = weight of tape suspended between supports

13. (c)
True length of chain = 30 – 0.1 = 29.9 m

Actual distance = $l'\left(\frac{L'}{L}\right)$

$= 300\times\left(\frac{29.9}{30}\right) = 299.0$ m

14. (a)

True length of the line = $l'\left(\frac{L'}{L}\right)$

$\Rightarrow \quad 200 = 200.8\times\left(\frac{L'}{20}\right)$

$\Rightarrow \quad L' = \frac{200\times20}{200.8} = 19.92$ m

15. (c)
Standard error of area is

$$\rho_A=\sqrt{\left(\rho_l\frac{dA}{dl}\right)^2+\left(\rho_b\frac{dA}{db}\right)^2}$$

$\because \quad A = l\times b$

$\therefore \quad \frac{dA}{dl} = b = 20$

and $\frac{dA}{dl} = l = 60$

Now, $\rho_l = \rho_b = \pm 1$ cm $= 0.01$ m
$\therefore \quad \rho_A = \pm 0.632$ m^2

16. (d)
Horizontal distance
$= l\cos\theta$
$= 428\cos8°$
$= 423.83$ m

17. (a)
Correct length of tape
$= \frac{500}{502}\times20 = 19.92$ m

18. (b)
For the first 2000 m, average error is
$e = \frac{0+10}{2} = 5$ cm $= 0.05$ m
$\therefore$ Incorrect length of chain,
$L' = 20 + 0.05 = 20.05$ m
Measured length, $l' = 2000$ m
$\therefore$ True length of first 2000 m is

$$l_1=\left(\frac{L'}{L}\right)\times l'$$

$$= \left(\frac{20.05}{20}\right) \times 2000 = 2005 \text{ m}$$

For the next 2000 m, average error is

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

$\therefore$ $L' = 20 + 0.14 = 20.14$ m

$l' = 2000$ m

$\therefore$ True length for next 2000 m is

$$l_2 = \left(\frac{L'}{L}\right) \times l'$$

$$= \left(\frac{20.14}{20}\right) \times 2000 = 2014 \text{ m}$$

Hence, true distance,

$l = l_1 + l_2$

$= 2005 + 2014$

$= 4019$ m

19. (a)

Distance between two points measured with a scale of 1 cm to 20 cm

$$= \frac{468}{20} = 23.4 \text{ cm}$$

Actual scale of the plan is 1 cm = 40 m

$\therefore$True distance between points

$= 23.4 \times 40 = 936$ m

20. (a)

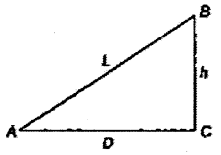
The true length of line is given by

$$l = l'\left(\frac{L'}{L}\right)$$

$$= 250 \times \left(\frac{20.1}{20}\right)$$

$= 251.25$ m

21. (b)



The distance measured along the slope is always greater than the horizontal distance between the points. Therefore, if the distance is measured on the slope, it must be immediately reduced to its corresponding horizontal distance.

$$D = \sqrt{L^2 h^2}$$

$$C_{SL} = L - D = L - (L^2 - h^2)^{1/2}$$

$$\Rightarrow \quad L - L\left(1 - \frac{h^2}{L^2}\right)^{1/2}$$

$$\Rightarrow \quad L - L\left[1 - \frac{h^2}{(2L)^2} - \frac{h^4}{8L^4} + \ldots\right]$$

$$\Rightarrow \quad L - L + \frac{h^2}{2L} + \frac{h^4}{8L^3}$$

$$\Rightarrow \quad \frac{h^2}{2L} + \frac{h^4}{8L^3}$$

where h = difference in elevation of A and B.

L = measured length of the line (in m).

(slope correction, C_{SL} is always substractive)

22. (b)

$$\text{Correction for sag} = \frac{W^2 L}{24P^2}$$

$$= \frac{30^2 \times 100}{24 \times 200^2} = 0.094 \text{ m}$$

$$\text{Correct distance} = 100 - 0.094$$

$$= 99.906 \text{ m}$$

23. (a)

Gunter's chain is 66 ft. long & Engineer's chain is 100 ft. long.

Distance between A & B

$= 100 + 66 = 166$ ft

25. (a)

$$\text{Correction to MSL} = \frac{Lh}{R} = \frac{300 \times 2.25}{6370}$$

$$= 0.106 \text{ m} = 106 \text{ mm}$$

26. (b)

$$S = \frac{1°}{6} = 0.166° \text{ or } 600''$$

$n = 20$

$$\therefore \quad \text{Least count} = \frac{S}{n} = \frac{600}{20}$$

$$LC = 30''$$

Hence option (b) is correct.

27. (b)

$$\frac{h^2}{2L} = 1$$

$$\Rightarrow \quad h^2 = 2 \times 20$$

$$\Rightarrow \quad h = 3 \text{ m}$$

28. (a)

Slope correction

$$= \frac{h^2}{2L} = \frac{\left(\frac{30}{20}\right)^2}{2 \times 30} \times 10^2 = 3.75 \text{ cm}$$

29. (a)

Check by putting units.

31. (c)

Normal tension is pull which equalises correction due to pull and sag.

$$\Rightarrow \quad C_P = C_{sag}$$

$$\frac{(P - P_0)l}{AE} = \frac{W^2 l}{24P^2}$$

$$\Rightarrow \quad P = \frac{0.204 W\sqrt{AE}}{\sqrt{P - P_0}}$$

32. (b)

Mean equation

$$= \frac{0+18}{2} = 09 \text{ cm} = 0.09 \text{ m}$$

First 2000 m;

True length measured

$$= \frac{20+0.10}{20} \times 2000 = 2010 \text{ m}$$

Next 2000 m;

True length measured

$$= \frac{20.09}{20} \times 2000 = 2009 \text{ m}$$

$\therefore$ True length

$= 2010 + 2009 = 4019$ m

33. (c)

Shrinkage factor

$$= \frac{\text{Shrunk length}}{\text{Original length}} = \frac{9.8}{10} = 0.98$$

Shrunk scale

$=$ SF $\times$ original scale

$= 0.98 \times 15 = 14.70$ m

Correct area

$$= \frac{\text{Measured area}}{(\text{SF})^2}$$

$$= \frac{80.2}{(\text{SF})^2} = 83.51 \text{ m}^2$$

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