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Reg.No.....

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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/
MANAGEMENT/COMMERCIAL PRACTICE, APRIL-2020

SURVEYING-I

[Maximum marks: 75] (Time: 2.15 Hours)

PART – A

(Answer any ***three*** questions in one or two sentences. Each question carries 2 marks)

I. (1). Differentiate between a tie line and a check line.

(2). Write the methods of orientation in plane table survey.

(3). What is agonic lines.

(4). What is Benchmark.

(5). The vertical distance between any two consecutive contours is known as. (3 x 2 = 6)

PART – B

(Answer any ***four*** of the following questions. Each question carries 6 marks)

II. (1). Explain the procedure for indirect ranging and write the condition at which it is to be done.

(2). What are the instruments used for Plane table survey and briefly explain each.

(3). Find the true bearing of the lines from the following magnetic bearing and declination.

Line	Magnetic bearing	Declination
PQ	$56^{o}21'$	$3^{o}10'E$
RS	$S12^{o}10'W$	$2^{o}04'W$

(4). The following consecutive readings were taken with a dumpy level and a 4m levelling staff on a continuously sloping ground.

0.780,1.545,1.585,2.330,2.585,3.835,1.055,1.765,2.625,3.550,0.735,0.895,1.350,2.350.RL of 1^{st} point was 50.000m. Rule out the page of level book and enter the readings and find the reduced levels of other stations by line of collimation method. Apply the usual checks.

(5). What are the temporary adjustments of a dumpy level.

(6). Differentiate between Countour and Countour Interval.

(7). Define reciprocal levelling and explain the procedure for reciprocal levelling. (4 x 6= 24)

PART – C

(Answer ***any of the three units*** from the following. Each question carries 15 marks)

UNIT –I

III. (a). How will you conduct chaining on sloping ground. (7)

(b). What are the advantages and disadvantages of plane tabling. (8)

OR

IV. The following are bearings taken on a closed compass traverse.

Line	F.B	B.B
AB	80°10’	295°0’
BC	120°20’	301°50’
CD	170°50’	350°50’
DE	230°10’	49°30’
EA	310°20’	130°15’

Compute the interior angles and correct them for observational errors. Assume the observed bearing of line CD to be correct adjust the bearing of remaining sides. (15)

UNIT-II

V. Below are the bearings observed in traversing with a compass.

Line	FB	BB
AB	80°30’	260°30’
BC	351°15’	173°00’
CD	32°15’	208°
DE	106°15’	287°45’
EF	99°00’	280°00’
FG	209°30’	29°30’

At what stations do you suspect local attraction. Find the corrected bearings of the lines. (15)

OR

VI. (a). Explain Fore bearing and Back bearing of a line. (7)

(b). Explain how orientation is done in plane table surveying (briefly explain the two methods). (8)

UNIT-III

VII. The following staff readings were observed successively with a level. The instrument having been shifted after third, sixth and eighth readings:2.228,1.606, 0.988, 2.090, 2.864, 1.262, 0.602, 1.982, 1.044, 2.684 meters. Enter the readings in a level field book and calculate the RL of points if the first readings was taken with a staff held on a bench mark of 432.384m in Rise and fall method. (15)

OR

VIII. (a).Explain the term Differential levelling. (7)

(b). Explain about curvature and refraction in levelling and explain its effects in levelling. (8)

UNIT-IV

IX. . (a). The following observations were made in a reciprocal levelling.

Inst at	Staff readings on		Remarks
	P	Q	Distance between P and Q=1010m
P	1.824	2.748	RL of P = 126.386
Q	0.928	1.606	

Find (a) the RL of Q

(b). The Combined correction for curvature and refraction. (15)

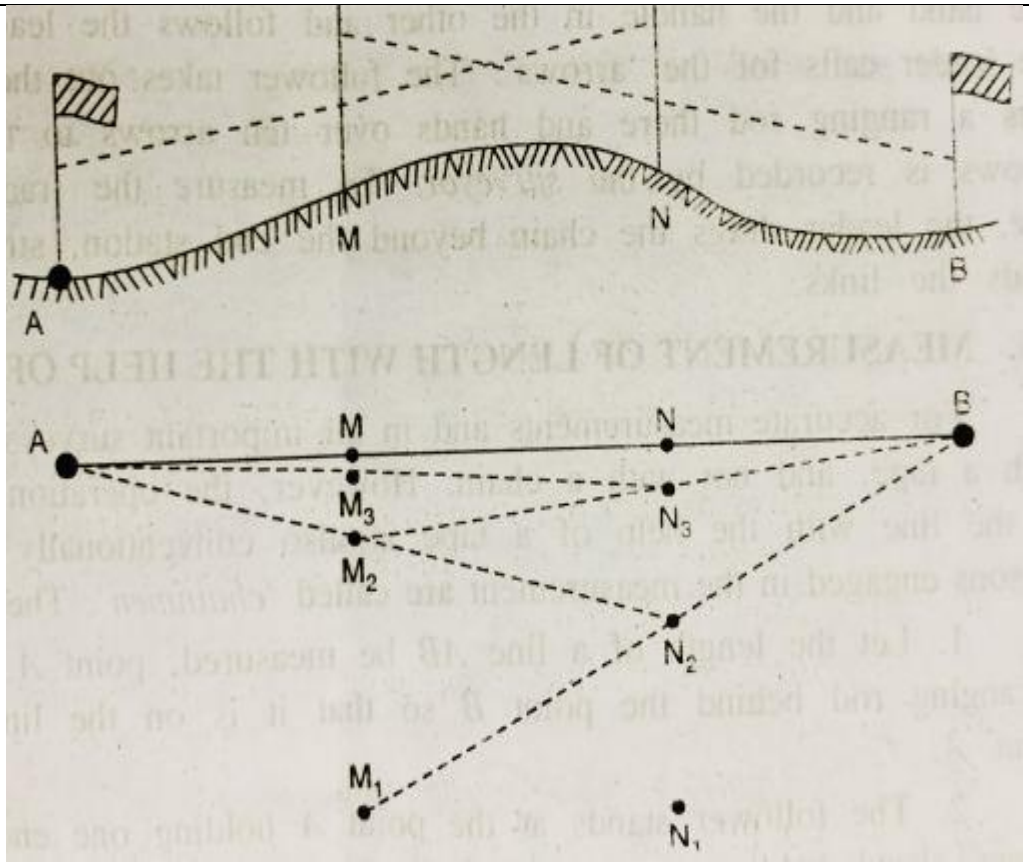
OR

X. (a). Differentiate between Contour interval and Horizontal Equivalent. (7)

(b). What are the use of contour-Explain. (8)

QUES. NO	QUESTION / ANSWER		MARKS
	PART A		
1	**Check line** joins the apex of main triangle with any fixed point on other two sides of triangles. ... **Tie line** joins two fixed points on main survey lines and it checks the accuracy of surveyinf as well as it helps in showing the details of the surveyed field		**2**
2	Orientation may be done by magnetic needle and back-sighting. Orientation by magnetic needle: This method is suitable when the local attraction is not suspected in the area		**2**
3	When the two poles align, declination is zero, and the line of zero declination is termed the agonic line.		**2**
4	Benchmark is a permanent and temporary reference point in surveying. The term is usually applied to any item used to mark a point as an elevation reference.		**2**
5	This vertical distance between any two contour lines in a map is called the contour interval (C.I.) of the map.		**2**
	PART B		
1	**Indirect Ranging** Indirect ranging is employed when the two points are not intervisible or the two points are at a long distance. This may be due to some kind of intervention between the two points. In this case, the following procedure is followed. As shown in figure-3, two intermediate points are located M1 and N1 very near to chain line by judgment such that from M1, both N1 and B are visible& from N1 both M1 and A are visible. At M1 and N1 two surveyors stay with ranging rods. The person standing at M1 directs the person at N1 to move to a new position N2 as shown in the figure. N2 must be inline with M1B. Next, a person at N2 directs the person at M1 to move to a position M2 such that it is inline with N2A. Hence, the two persons are in points are M2 and N2.	**3**	**6**

Remarks:

		**3**	
2	1) The Drawing Board: The board is made of well-seasoned wood such as teak or pine and varies in size from 16" X 12" to 18" X 24" rectangular. It is mounted on a tripod in such a manner that it can be leveled, and revolved about a vertical axis and clamped in any position. 2) The Alidade : The alidade consists of a metal ruler about 18" long. It has rectangular holes with a fine wire held vertically in the opening. While using the alidade, the user sights an object and lines it up with the wires in each vane. 3) A compass is for marking the north direction on the paper . 4) A plumbing fork with a plumb bob for centering the table. 5) Tripod : A tripod is a three-legged stand for a drawing board , used to stabilize the drawing board. 6) Other items: Paper, Pins, Pencil , Rubber , Scale etc.	**6**	**6**

Remarks:

3	True bearing = magnetic bearing + declination if declination east True bearing = magnetic bearing - declination if declination west For line PQ , true bearing = magnetic bearing + declination since declination east $= 56^{o}21' + 3^{o}10' = 59^{o}31'$ For line RS , whole circle bearing = $102^{o}10'$ True bearing = $102^{o}10' - 2^{o}04' = 100^{o}8'$	**3** **3**	**6**

4		**5** **1**	**6**

STATION	BS	IS	FS	HI	RL	REMARKS
A	0.780			50.780	50	BM
B		10545		50.780	49.235	
C		1.585		50.780	49.195	
D		2.330		50.780	48.45	
E		2.585		50.780	48.195	
F		3.835		50.780	46.945	
G		1.055		50.780	49.755	
H		1.765		50.780	49.015	
I		2.625		50.780	48.155	
J		3.550		50.780	47.23	
K		.735		50.780	50.045	
L		.895		50.780	49.885	
M		1.350		50.780	49.43	
N			2.350		48.28	

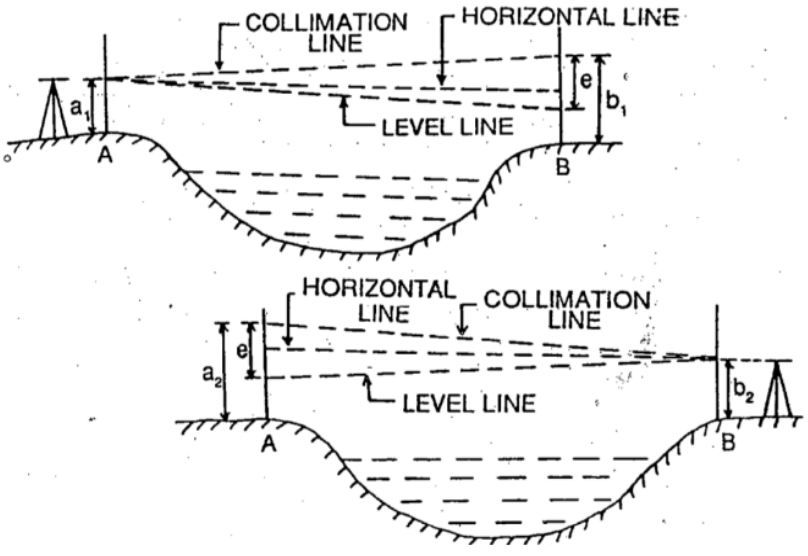
CHECK

$\sum$BS- $\sum$FS= LAST RL- FIRST RL

Remarks:

5	The temporary adjustment of a dumpy level consists of (1)Setting , (2)Leveling and (3) Focusing . During **Setting**, the tripod stand is set up at a convenient height having its head horizontal (through eye estimation). The instrument is then fixed on the head by rotating the lower part of the instrument with right hand and holding firmly the upper part with left hand. Before fixing, the leveling screws are required to be brought in between the tribrach and trivet. The bull's eye bubble (circular bubble), if present, is then brought to the centre by adjusting the tripod legs. Next, **Leveling** of the instrument is done to make the vertical axis of the instrument truly vertical. It is achieved by carrying out the following steps: **Step 1:** The level tube is brought parallel to any two of the foot screws, by rotating the upper part of the instrument. **Step 2:** The bubble is brought to the centre of the level tube by rotating both the foot screws either inward or outward. (The bubble moves in the same direction as the left thumb.) **Step 3:** The level tube is then brought over the third foot screw again by rotating the upper part of the instrument. **Step 4:** The bubble is then again brought to the centre of the level tube by rotating the third foot screw either inward or outward. **Step 5:** Repeat Step 1 by rotating the upper part of the instrument in the same quadrant of the circle and then Step 2. **Step 6:** Repeat Step 3 by rotating the upper part of the instrument in the same quadrant of the circle and then Step 4. **Step 7:** Repeat Steps 5 and 6, till the bubble remains central in both the positions. **Step 8:** By rotating the upper part of the instrument through 180 o , the level tube is brought parallel to first two foot screws in reverse order. The bubble will remain in the centre if the instrument is in permanent adjustment.	**2** **2** **2**	**6**

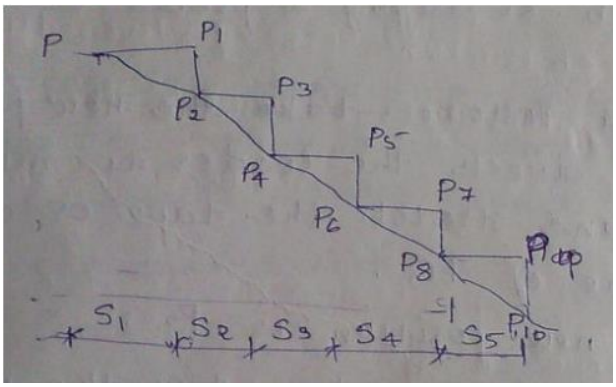
Remarks:

6	A contour line is a line drawn on a topographic map to indicate ground elevation or depression. A contour interval is the vertical distance or difference in elevation between contour lines. Index contours are bold or thicker lines that appear at every fifth contour line. If the numbers associated with specific contour lines are increasing, the elevation of the terrain is also increasing. If the numbers associated with the contour lines are decreasing, there is a decrease in elevation. As a contour approaches a stream, canyon, or drainage area, the contour lines turn upstream. They then cross the stream and turn back along the opposite bank of the stream forming a "v". A rounded contour indicates a flatter or wider drainage or spur. Contour lines tend to enclose the smallest areas on ridge tops, which are often narrow or very limited in spatial extent. Sharp contour points indicate pointed ridges.	**6**	**6**
7	in the case of a river or valley, it is not possible to set up the level midway between two points on the opposite bank. In such a case, the method of reciprocal levelling is adopted. In reciprocal levelling, the level is set up on both bank of the river or valley and two sets of staff reading is taken by holding the staff on both banks in this case it is found that error is completely eliminated and true difference of level is equal to the mean of the two apparent difference of level. **Procedure:** **1.** Suppose A and B are two points on an opposite bank of a river. The level is set up very near A and after proper temporary adjustment staff reading are taken at A and B. suppose reading a1 and b1 **2.** level is shifted and set up very near B and after proper adjustment, staff reading is taken as A and B. Suppose the reading are a2 and b2  	**3** **3**	**6**

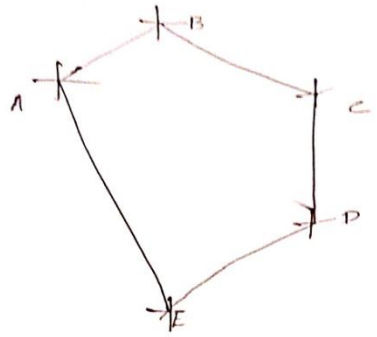
Remarks:

	PART C		
III.a	***Chaining on Sloping Ground | Surveying and Levelling*** There are two methods for determining horizontal distance on sloping ground. 1. Direct Method 2. Indirect Method ***Direct Method*** This method is also known as **"Stepping Method"**. The horizontal distances are directly measured by the process of stepping. ***Procedure*** A path of chain or tape is stretched out from 'P'. The path length of chain or tape depends on the steepness of the ground. The follower holds the zero end of the chain at 'P' and directs the leader at P1 to be in the line of PQ and stretch the chain or tape above the ground in horizontal line. The leader then transfers the point 'P1' to P2 on the ground by means of plumb bob or dropping a pebble or an arrow, Now the followers take the new position 'P2' and directs the leader to move forward and stretch the tape or chain in a line of PQ. Now the followers take the new position 'P2' and directs the leader to move forward and stretch the tape or chain in a line of PQ and the new position is P3. Again the leader transfers the point P3 to P4 on the ground as done earlier. This process is repeated till the point Q is reached.		

Remarks:

	 Horizontal distance PQ = S1 + S2 + S3 + S4 + S5 Indirect Method of Chain Surveying In this method, the sloping side is measured on the ground and later it is converted into the horizontal equivalent using geometrical condition. The following methods are adopted for calculating horizontal distance indirectly: • By measuring angle of inclination • By measuring difference of levels • By hypotenusal allowance	**7**	**15**
III.b	Advantages of Plane Table Surveying: (i) It is one of the most rapid method of surveying. (ii) Field-notes are not required, and thus the possibility of mistakes in booking is eliminated. (iii) Measuring of lines and angles is mostly dispensed with since they are obtained graphically. (iv) Since the map is plotted in the field, there is no chance of omitting necessary measurement. (v) The surveyor is fully confident about the true representation of the area since he can always compare his work with the actual features on the ground and cannot, therefore, over-look any essential detail. (vi)The surveyor can check the accuracy of his work more frequently and from any position he may desire, thus eliminating all error at the spot.	**8**	

Remarks:

	Disadvantages of Plane Table Surveying (i) It is unsuitable for work in a wet climate, and is difficult in high wind. (ii) It is not useful for large scale surveys and accurate work. (iii) It is not suitable for surveying a densely wooded area. (iv) The instrument is heavy and cumbersome and the various accessories, being loose, are likely to be lost. (v) The absence of field-notes is sometimes inconvenient if the survey has to be replotted to a different scale. (vi) Only day time can be availed of for the field and plotting work whereas in other methods of surveying, day time can be used for field- work and night or even hot and rainy days can be utilised for plotting.		
IV	Stations C and D are free from local attraction  Included Angles $\angle A = 50^\circ 51'$ $\angle B = 174^\circ 10' 0''$ $\angle C = 131^\circ 0' 0''$ $\angle D = 120^\circ 40' 0''$ $\angle E = 99^\circ 10' 0''$ Sum of Included angles $= 575^\circ 35'$ Error $= 575^\circ 35' - 540^\circ$ $= 35^\circ 35' 0''$ Correction on each angle $= \frac{-35^\circ 35'}{5} = -7^\circ 7'$	**4**	

Remarks:

Corrected Included angles

$\angle A = 42^\circ 58' 0''$

$\angle B = 167^\circ 33' 0''$

$\angle C = 123^\circ 53' 0''$

$\angle D = 113^\circ 33' 0''$

$\angle E = 92^\circ 3' 0''$

$\Rightarrow$ FB of DE = Back bearing of CD − $\angle D$

$= 226^\circ 57' 0''$

BB of DE = $46^\circ 57' 0''$

$\Rightarrow$ FB of line EA = B'ack bearing of DE − ext $\angle E$

$= 46^\circ 57' 0'' + \text{ext}(\angle E)$

$= 267^\circ 57' 0''$

BB of EA = $87^\circ 57' 0''$

$\Rightarrow$ FB of AB = BB of EA − $\angle A$

$= 44^\circ 59' 0''$

BB of AB = $224^\circ 59' 0''$

$\Rightarrow$ FB of line BC = BB of line AB − $\angle B$

$= 57^\circ 26' 0''$

BB of BC = $237^\circ 26' 0''$

Corrected Angles

AB	$44^\circ 59'$	$224^\circ 59'$
Bc	$57^\circ 26' 0''$	$237^\circ 26' 0''$
CD	$170^\circ 5' 0''$	$350^\circ 50' 0''$
DE	$226^\circ 57' 0''$	$46^\circ 57'$
EA	$267^\circ 57'$	$87^\circ 57'$

4

4

3

15

Remarks:

VI.a

Fore bearing and Back bearing

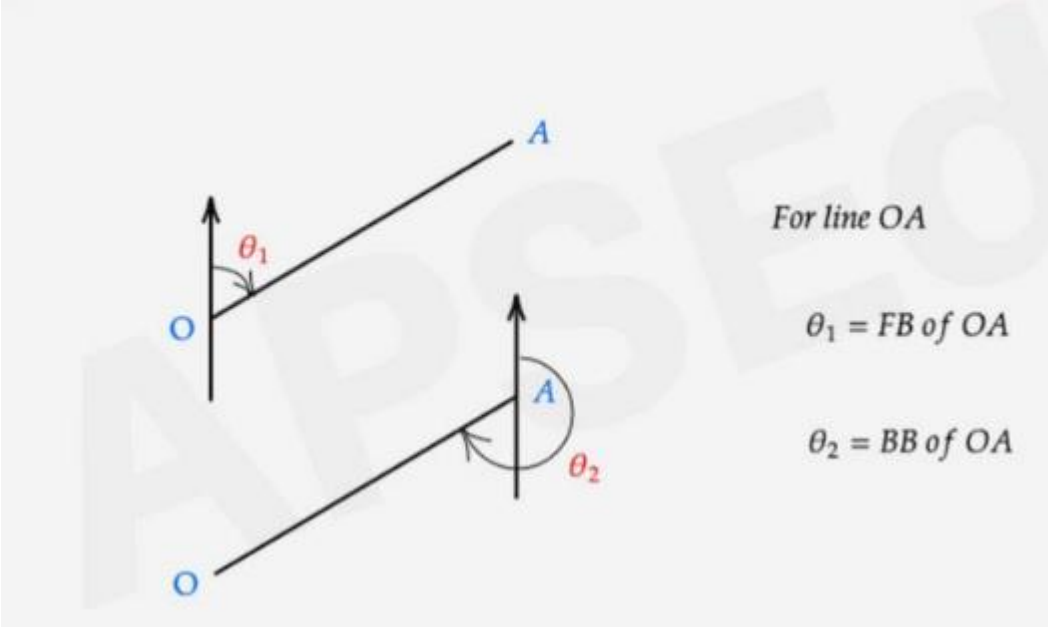
The bearing of a line measured in the forward direction of the survey lines is called the 'fore bearing'(F.B.) of that line.

The bearing of a line measured in direction backward to the direction of the progress of survey is called the 'back bearing'(B.B.) of the line.

The bearing of a line is the direction with respect to a given meridian; Meridian is a fixed reference line. While setting out a survey line, the bearing readings are necessary.

Simply,

- Fore Bearing - Bearing measured in the direction of progress of the survey
- Back Bearing - Bearing measured opposite to the direction of survey

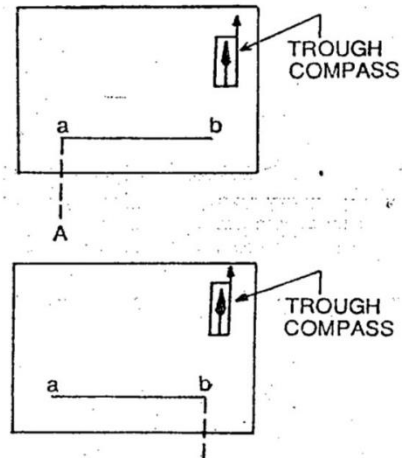


Remarks:

	Relation Between Fore Bearing and Back Bearing **Case 1(Fore Bearing is less than 180 degrees)** **Let OA be the survey line.** According to the definition of fore and back bearing, in the figure: **θ1** is the fore bearing of OA **ϕ1** is the back bearing of OA Using fundamental geometry, we can write- $\phi 1 = \theta 1 + 180$ degrees So, Back bearing = Fore bearing + 180 degrees **Case 2(Fore Bearing is more than 180 degrees)** Let OB be the survey line. According to the definition of fore and back bearing, in the figure: **θ1** is the fore bearing of OB **ϕ1** is the back bearing of OB Using fundamental geometry, we can write- $\theta 1 = \phi 1 + 180$ degrees So, Fore bearing = Back bearing + 180 degrees This is all about the concept of fore and back bearing. The next thing we are going to see, how we can convert an angle to bearing and vice versa.	**7**	
VI.b	**Orientation** The method of setting up the plane table at each of the successive station parallel to the position it occupied at the starting station is known as orientation. Orientation may be done by magnetic needle and Backsight. **Orientation by magnetic needle-** This method is suitable when a local attraction is not suspected in an area.		

Remarks:

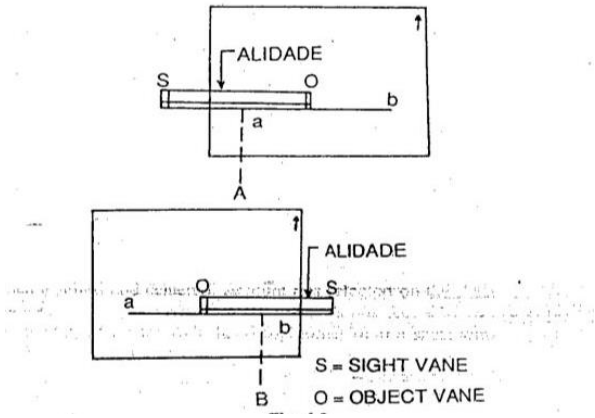
		8	



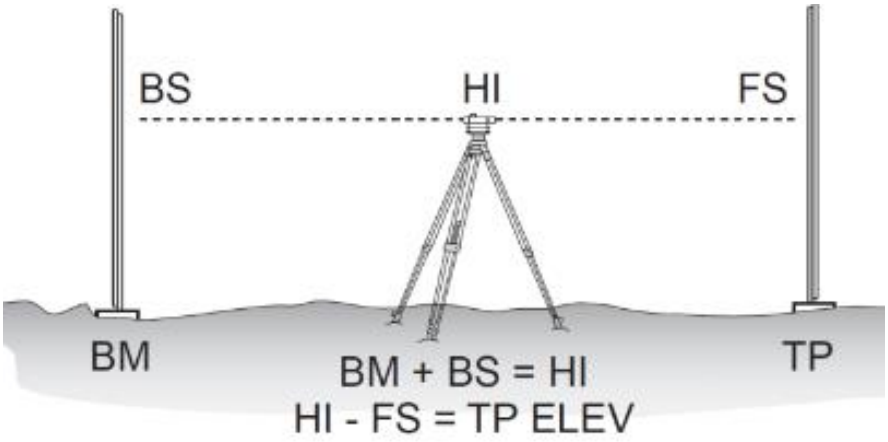
- suppose Aand B are two stations. The plane table is set up a station A and levelled by spirit level. The centre is done by U fork and plumb bob so that point a is just over A. Then the through compass or circular box compass is placed on the right-hand top corner of the sheet in such a way that the needle consists with O-O mark. After this, a line represents the north line is drawn through the edge of the compass box the table is them clamped.
- With the alidade touch point, a ranging rod at A is bisected and ray is drawn. The distance AB is measured and plotted on any suitable scale.
- The table is sifted and centre over B, so that point b is just over B. the table is levelled now through compass, is exactly along the north line draw previously. The table is then turned clockwise or anticlockwise until the needle coincides exactly with the o-o mark of the compass. While turning the table care should be taken not to disturb the centring. In case it should be adjusted immediately.
- When the centring and levelling are perfect and the needle exactly at o-o the orientation should be perfect.

15

Orientation by Backsight- **This method is always accurate and it is always preferred.**



Remarks:

	• Suppose A and B are the two station. The plane table is set up over A. the table is levelled by spirit level and centre by U fork so that point a is just over a station A. the north line mark on the right-hand top corner of the sheet by through compass. • With the alidade touching a the ranging rod B is bisected and ray is drawn. The distance AB is measured and plotted on any suitable scale.so the point b represent station B. • The table is shifted and set up over B . it is levelled and centre so that b is just over B. now the alidade is placed along the line ba and the ranging rod A is bisected by turning the table clockwise or anticlockwise. At this time centring may be disturbed and it should be adjusted immediately if required. When the centring, levelling and bisecting of ranging rod A is perfect then the orientation is said to be perfect.		
VIII.a	Differential leveling is a very simple process based on the measurement of vertical distances from a horizontal line. Elevations are transferred from one point to another through the process of using a leveling instrument to read a rod held vertically on, first, a point of known elevation and, then, on the point of unknown elevation. Simple addition and subtraction are used to calculate the unknown elevations.  A single-level setup is illustrated in Figure 1. A backsight reading is taken on a rod held on a point of known elevation. That elevation is transferred vertically to the line of sight by reading the rod and then adding the known elevation and the backsight reading. The elevation of the line of sight is the height of instrument (*HI)*. By definition, the line of sight is horizontal; therefore, the line of sight elevation can then be transferred down to the unknown elevation point by turning the telescope to the foresight and reading the rod. The elevation of the foresight station is found by subtracting the rod reading from the height of instrument. Note that the difference in elevation from the backsight station to the foresight station is determined by subtracting the foresight rod reading from the backsight rod reading.	**7**	**15**

Remarks:

VIII.b

Curvature:

Earth has a curved face which is assumed to be a level surface but the line of sight as furnished by the levelling instrument is horizontal and not the level line. Therefore, all points on the line of sight are not equidistant from the surface of the earth and consequently the points read on the staff are not strictly at the same level as horizontal hair of the diagram.

A' is the instrument station and P the point where the staff is held. On looking through the telescope, we sight along AB, the horizontal line of sight, and take the staff reading PB. The point B is consider to be at the same level as A, but actually the points C and A are at the same level. The true reading is, therefore, PC.

The difference BC between the observed and true staff readings denotes the error due to curvature of the earth, which may be determined as follows:

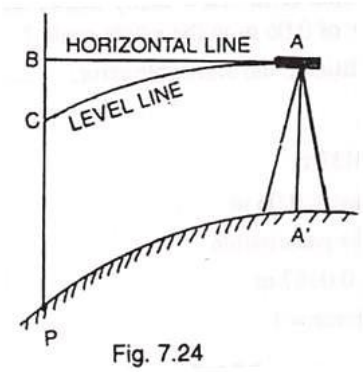


Fig. 7.24

By Geometry, BC x BE =BA^2

Or BC (BC= CE) = BC^2

Or BC^2 +BC x CE=BA^2

since BC is usually very small as compared with the diameter of the earth and its square will still be much smaller and may therefore be neglected in calculation:

$$BC \times CE = BA^2$$

$$\text{or} \quad BC = \frac{BA^2}{CE} = \frac{D^2}{2R}$$

taxing diameter of the earth as 12,742 kilometers ,we get:

8

Remarks:

$$BC = \frac{D^2}{12,742} \text{ Km}$$

$$= \frac{D^2 \times 1000}{12,742} \text{ metres}$$

$$= 0.0785\ D^2 \text{ metres} \quad \ldots \quad \ldots \quad \ldots$$

Hence the error in staff reading due to curvature of the earth = $0.0785\ D^2$ metres, where D is the distance from the level to the staff in kilometres. The effect of curvature is to increase the staff reading i.e., this error is positive and so the correction is negative.

Refraction:

It is a well-established law of physics that rays of light passing through layers of different densities do not remain straight but are refracted or bent down towards the denser medium. Consequently, the ray of light from the staff to the instrument is not straight as AB in fig. 7.26 but it follows a curved path AD concave towards the earth as the near the surface of the earth is denser than the upper layers of air.

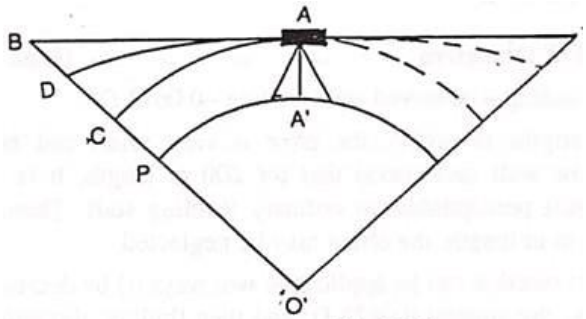


Fig. 7.26

Under normal atmospheric conditions, arc AD may be taken as circular and of radius seven times that of the earth. The effect of refraction is therefore 1/7th7 the of that of the curvature, but is of opposite nature. Hence the correction for refraction is additive to the staff reading.

The error due to refraction:

$$BD = \frac{1}{7} BC$$

$$= \frac{1}{7}\ 0.0785\ D^2$$

$$= 0.0112\ D^2 \text{ metres} \quad \ldots \quad \ldots \quad \ldots \text{(Eqn 7.2)}$$

Remarks:

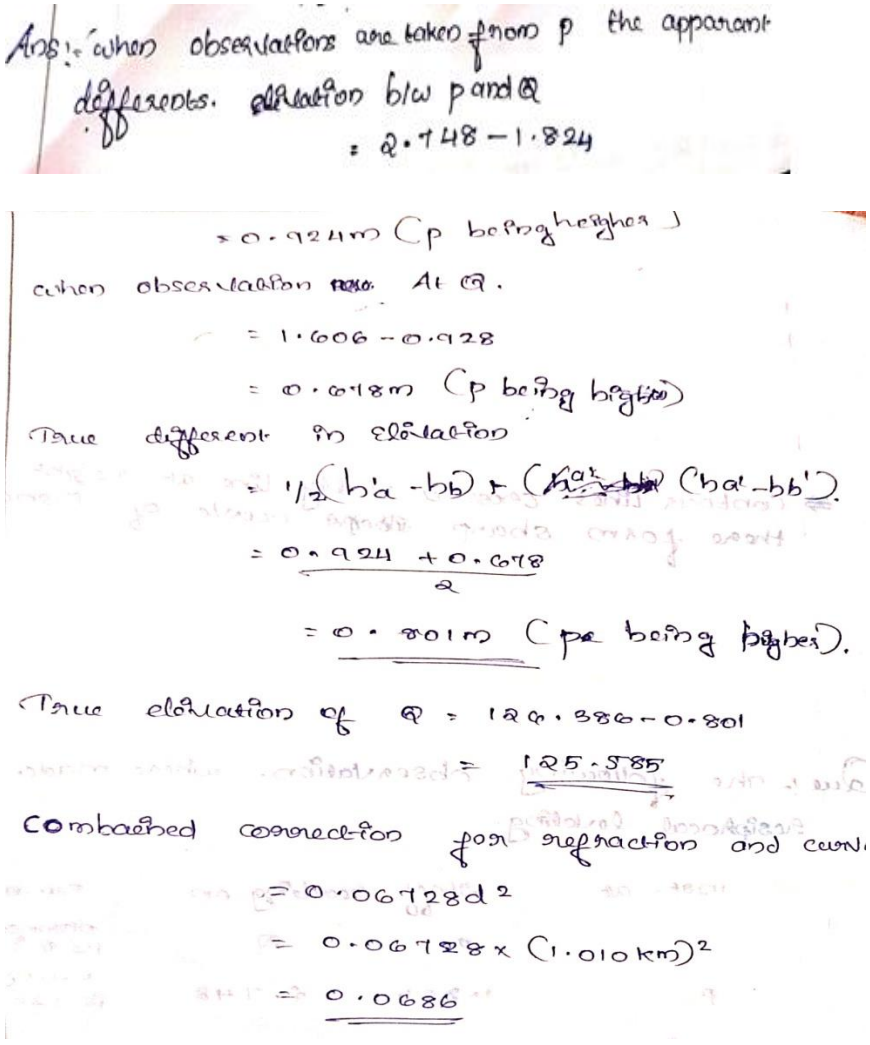
VII								**15**	**15**

STATION	BS	IS	FS	RISE	FALL	RL	REMARKS
A	2.228					432.384	BM
B		1.606		0.622		433.006	
C	2.090		.988	0.618		433.624	CP1
D		2.864			0.774	432.85	
E	0.602		1.262	1.602		434.85	CP2
F	1.044		1.982		1.38	433.072	CP3
G			2.684		1.64	431.432	

CHECK

∑BS- ∑FS = ∑ RISE - ∑ FALL = LAST RL – FIRST RL
-0.952= -0.952 = -0.952

IX a



7

Remarks:

IX.b

The combined error due to curvature and refraction: — **2**

$$CD = BC - BD$$

$$= BC - \frac{1}{7} BC = \frac{6}{7} BC$$

$$= \frac{6}{7} \ 0.0785 \ D^2$$

$$= 0.0673 \ D^2 \text{ metres} \quad \ldots \quad \ldots \quad \ldots \quad \text{(Eqn. 7.3)}$$

And true staff reading = observed staff reading -0.0673 D^2

For ordinary lengths of sights, the error is very small and hence negligible. It may be well understood that for 200 m length, it is only 0.003 m and it is just perceptible on ordinary levelling staff. Therefore sights less than 200 m in length, the effect may be neglected. — **6**

The combined correction can be application two ways:

(i) By decreasing each staff reading by the amount 0.0673 D^2 and then finding, the reduced levels and

(ii) By first finding the reduced levels of the points in the usual way and then increasing them by the amount 0.0673 D^2.

The error due to curvature and refraction can be eliminated by equalising back sight and fore sight distances and also by the method of reciprocal levelling

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X.a

S.No	Contour Interval	Horizontal Equivalent
1	It is based on vertical levels	Represents horizontal distance
2	No measurement or scaling is required since the contour levels are indicated on the contour lines	The distance must be measured on the map and converted to actual distance by multiplying with the scale of the map
3	In a given map the contour interval is a constant	The horizontal equivalent varies with slope. Closer distance indicates steep slope and wider distance gentle slop

7

7

Remarks:

X.b	**Uses of contours maps** Contours provide valuable information about the nature of terrain. This is very important for selection of sites, determination of catchment area of a drainage basin, to find intervisibility between stations etc. Some of the salient uses of contours are described below **Nature of Ground** To visualize the nature of ground along a cross section of interest, **To Locate Route** Contour map provides useful information for locating a route at a given gradient such as highway, canal, sewer line etc. **Intervisibility between Stations** When the intervisibility between two points can not be ascertained by inspection of the area, it can be determined using contour map. **To Determine Catchment Area or Drainage Area** The catchment area of a river is determined by using contour map. The watershed line which indicates the drainage basin of a river passes through the ridges and saddles of the terrain around the river. Thus, it is always perpendicular to the contour lines. The catchment area contained between the watershed line and the river outlet is then measured with a planimeter **Storage capacity of a Reservoir** The storage capacity of a reservoir is determined from contour map. The contour line indicating the full reservoir level (F.R.L) is drawn on the contour map. The area enclosed between successive contours are measured by planimeter .The volume of water between F.R.L and the river bed is finally estimated by using either Trapezoidal formula or Prismoidal formula.	**2** **2** **2** **2**	**8**

Remarks: