MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION

(Autonomous)

(ISO/IEC-270001 – 2005 certified)

WINTER-13 EXAMINATION

Subject code: **17310**   **Model Answer**   Page No:1/ 24

Important Instructions to examiners:

1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

3) The language error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding.

Q1)a)Attempt any SIX of the following	12
i)State the principles of survey	
Following are the principles of surveying	
01. To work from the whole to the part.	1
02. To fix the position of new station by at least two independent processes (i.e the processes may be both linear, both angular, one linear & one angular)	1
ii)Define ranging	
The operation of establishing intermediate points on a straight line between the terminal points (end points) is known as ranging.	2

iii)State the principle of optical square-	
If there are two plane mirrors whose reflecting surfaces makes a given angle with each other and if a ray of light in a plane perpendicular to planes of the both mirrors if reflected successively from both, it undergoes a deviation of twice the angle between the reflecting surfaces. **OR** The angle between the first incident ray and last reflected ray is twice the angle between the two mirrors.	2
iv) Define long offset and short offset.	
Long offset- Offset having length more than 15 meter is known as long offset Short offset- Offset having length less than 15 meter is known as short offset	1 1
v)State the principle of plane table survey	
1) The rays drawn from different point should pass thought a single point that represents the position plane table. 2) Parallelism is the principle of plane table survey. 3) The rays drawn from the station to objects on the paper are parallel to the lines from the station to the objects on the ground *(Any two 1 mark each)*.	*
vi)Define line of collimation	
The line joining the intersection of cross hairs on diaphragm to the optical center of object glass and its continuation is known as line of collimation.	2
vii) Enlist the components of prismatic compass.	
Following are the component parts of prismatic compass. 1)Compass box.2) Pivot3)Magnetic needle 4) Agate cap 5)Compass ring 6)Glass cover 7)Prism 8)Prism cap 9)Eye vane 10)Hinged sunglasses 11)Focusing stud for prism 12)Hinged strap 13)Object vane 14)Horse hair 15)Adjustable mirror 16)Break pin or knob 17)Spring break 18)Lifting pin 19)Lifting liver *(Any four ½ mark each)*	*
viii) What is true Meridian?	
The line in which the plane passing through the given point and the true north and true south poles intersect the surface of earth is known as true meridian.	2

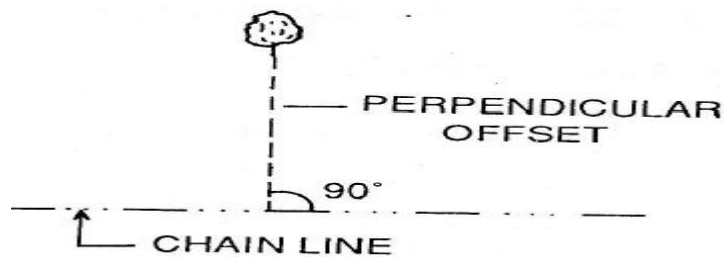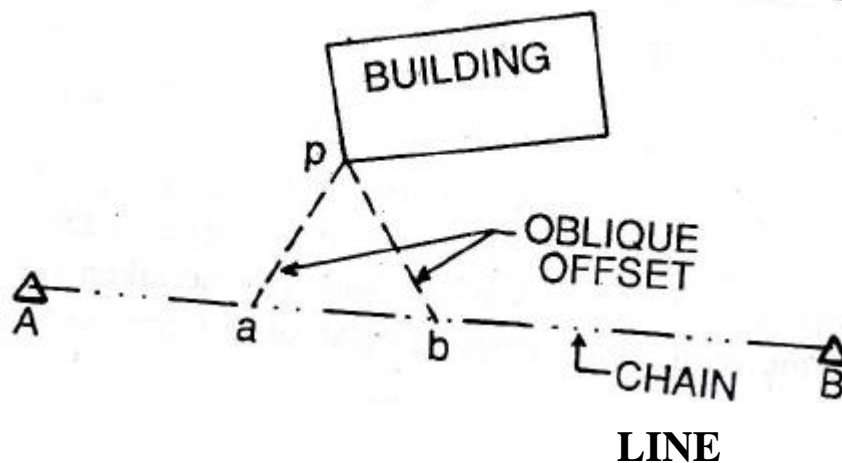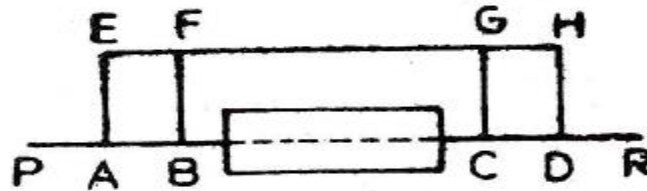|	
b)Attempt any two of the following	8
i)What is perpendicular and oblique offset ?	
Perpendicular Offset-The measurement which are made at right angle to the survey line are known as perpendicular offset. **OR** Perpendicular Offset-When the lateral measurement are taken perpendicular to the chain line, they are known as perpendicular Offset **Fig. Perpendicular Offset** Oblique offset – The measurement which are not made at right angle to the survey line are known as oblique offsets. **OR** Oblique offset –Any offsets not perpendicular to the chain line said to the oblique. **LINE**	01 01 01 01
ii)Explain the method to overcome an obstacle in chaining, where vision and chaining both are abstracted .	
Suppose PR is the chain line (As shown below inn fig.).Two point A and B are selected on it at one side of the building .Equal perpendicular AE and BF are erected .The line E F is extended until the building is crossed. On the extended line two point G and H are selected .Then perpendicular G C and H D are so erected that	02

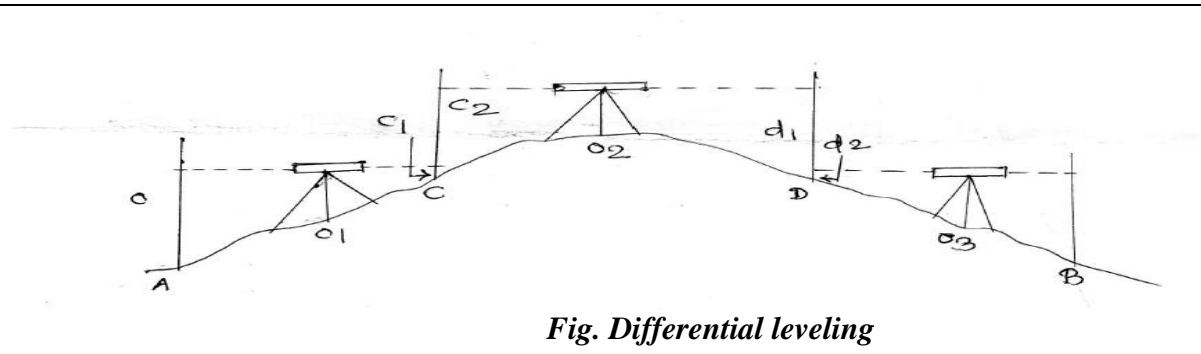|	
G C=H D=E A=F B	
Thus the point C, D, A and B will lie on the same straight line PR.	
Hence,　　　　　　　　　　　BC=F G	
The distance FG is measured , and is equal to the required distance BC	01
	01
iii) Explain with near sketch differential leveling.	

Fig. Differential leveling

Differential leveling is used to find out the difference in elevation between two point under following condition	*

1)If they are too far apart or 2)If the difference in elevation between them is too great or 3)If there are obstacles intervening.

  It is also used to establish bench marks

Procedure-Suppose it is required to know the difference between station A and B. The level is set up at points O1,O2,O3 etc. After temporary adjustment staff readings are taken at every setup . The points C,D are known as change point. Calculate RLs of all points and find difference between A and B.

(Note-sketch 2 marks, Explanation and procedure 2 marks)

Q.2 Attempt any four of the following -	16
a)What is plane and geodetic survey	
Plane survey-1) In plane survey curvature of earth is not taken into account.	*

4

2) It extends over small areas.

3) The earth surface is considered as plane.

4) The line connecting any two points are assumed as straight and angles of polygon as plane angles.

5) The surveys up to 250 km^2 areas are considered under.

(Any two Points 02 Marks)

Geodetic survey-

1) These survey are done by Survey of India Dept.

2) Curvature of earth is taken in to account.

3) It extends over large distances and areas.

4) The fig. formed by the line joining three points on the mean surfaces of the earth is a spherical triangle.

5) The lines forming its side's arcs of great circles and the angles are spherical.

(Any two Points 02 Marks)

Note:- Consider if point are explained with sketch

**b)**Explain with neat sketch the procedure of indirect ranging

Step wise procedure indirect ranging i.e. reciprocal ranging-

Let A and B be the two station with rising ground or a hill intervening between them even i)Select any two intermediate station say M1 and N1 , between A and B with ranging rods such that from M1 points N1 and B are visible and from N1 , points M1 and A are visible   (as shown in fig.)

ii) Chainman at M1 direct the chainman at N1 to in line with M1 B point ie position at N2 then chainman at N2 directs the chainman at M1 two in line with N2 to A ie position at M2 .iii)In the next step Chainman at M2 direct the chainman at N2 to move in line with M2 B ie position at N3.

iv) Thus by successively directing each other into line there position will be changed until finally they are both on the line A B exactly.

02

Elevation

02
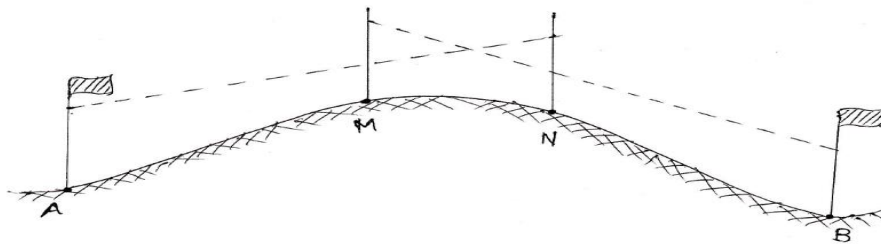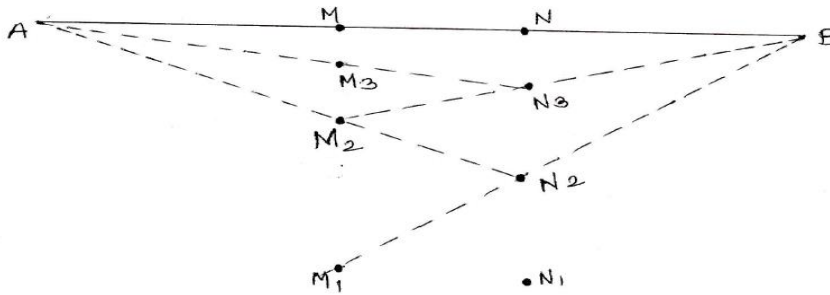
Plan

Fig. Indirect Ranging

c) State the procedure of setting offset with optical square

Setting out offset with optical square

i)Two set out a perpendicular to a line AB at a given point D on it , the observed stand on the line holding the instrument over the point D and observed the ranging rod at B through the unsealed portion of the horizon glass

02

ii) Observer at D direct the chainman to move is ranging rod C two right or left as required until its image is seen by reflection .
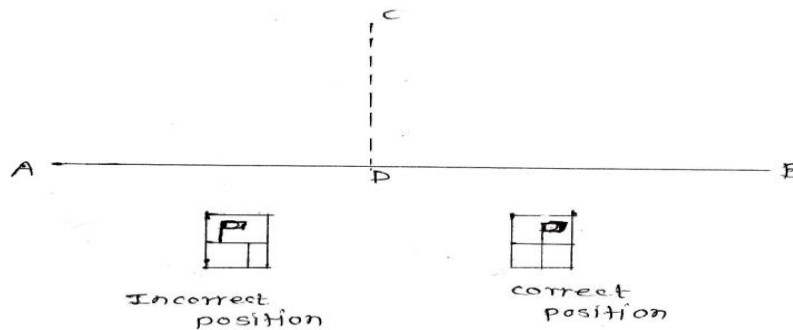

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Fig- Setting out offset with optical square

d) Compare whole circle bearing with quadrantal bearing system

Whole circle bearing System	Quadrantal bearing system	
Bearing are measured are clock wise direction only.	Bearing are measured are clock wise and anticlockwise direction	*
Space around the station is considered as circular	Space around the station is divided into quadrant.	
Magnitude of bearing are varies from 0 to 360 degree	Magnitude of bearing are varies from 0 to 90 degree	
Bearing are measured from north meridian only.	Bearing are measured from north and south meridian.	
Prismatic compass is used to measured whole circle bearing	Surveyor compass is used to measure qunadrantal bearings.	

(Any four Points each 01 Mark)

e) Explain temporary adjustment of plane table.

Following are the temporary adjustment of plane table.

i)Fixing – Fix the plane table over the tripod stand as per the adjustment provided by the manufacturer like by ball and socket arrangement or screw arraignment etc.at a convenient height   01

ii)Setting the plane table - It includes

1) Leveling – It can be done by using a level tubes kept both at perpendicular directions along the edges of table .

2) Centering –It can be done by using plumbing fork or U fork with plumb bob   01

3)Orientation- It is necessary when the instrument is to be set up at more than one station   01

Orientation can be done by two method – i)Magnetic meridian ii)By back sighting .

In magnetic meridian method trough compass is used for orientation where as in back sighting method back sight is taken on earlier stations.

4)Sighting the points or focusing – The points to be located are sighted through the alidade.

The alidade are of two types –Plain alidade and Telescopic alidade .The alidade kept   01

pivoted about the plotted locations of the instrument station. If telescopic alidade is used then by using focusing screw the focusing is done for locating the point or object.

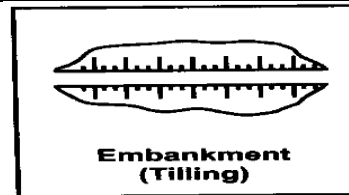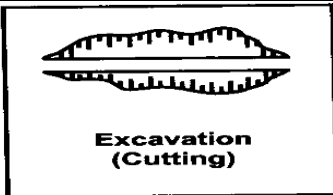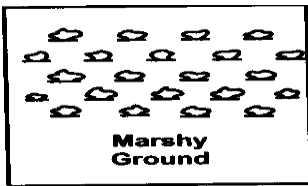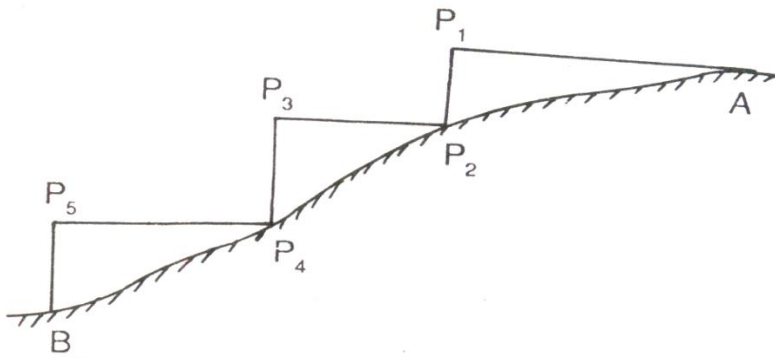|	
f) State the fundamental lines of dumpy levels and give their relationship	
Following are the fundamental lines of the dumpy level i)The axis of bubble tube (or the bubble axis) ii)The line of collimation (or the line of sight) iii)The vertical axis iv)The axis of telescope . The following are the fundamental relationships that must exists in dumpy level- a)The line of collimation should be parallel to the bubble tube axis b)The bubble tube axis should be perpendicular to the vertical axis	02 02
Q.3 Attempt any four of the following	16
a)Draw conventional symbols for i)Cutting ii)Embankment iii)Marshy land iv)Forest	
i) Cutting ii) Embankment iii) Marshy Land iv) Forest *(*Each 01 Mark*)	*
b) Explain the procedure of changing on sloping ground.	

The following are the methods which is used to measure the horizontal distance on sloping ground
    i)   Direct Method :- By Stepping
    ii)   Indirect Method :-
            By Measuring the slope with a clinometers
            By knowing the difference of level between two points.
            By applying hypotenusal allowance
  Direct Method :- By Stepping :-
	01

Suppose the horizontal distance between points A and B as shown in fig. is to be measured. The line AB is first ranged properly. Then the follower holds the zero end of the tape at A. The Leader selects a suitable length AP1 so that P1 is at chest height and AP1 is just horizontal. The horizontally is maintained by eye estimation, by tri-square or by wooden set square. The point P2 is marked on the ground by plumb bob so that P1 is just over P2. The horizontal length AP1 is noted. Then the follower moves to the position P2 and hold the zero end of the tape at that point. Again the leader selects a suitable length P2P3 in such way that P2P3 is horizontal and P3P4 is Vertical. Then the horizontal lengths P2P3 and P4P5 are Measured.

So the total Horizontal Length AB= AP1 + P2P3 + P4P5

c)Explain with neat sketch the construction of optical square

Construction of Optical Square is as follows -

It consist of a small circular metal box of diameter 5 cm and depth 1.25 cm it has a metal cover which slides round the box to cover the slits. The following are the internal arrangements of the optical square

1) A horizon glass H is fixed at the bottom of the metal box. The lower half of the glass is unsilvered and the upper half is silvered.
2) An index glass I is also fixed at bottom of the box which is completely silvered.
3) The angle between the index glass and hrizon glass is maintained at 45^0.
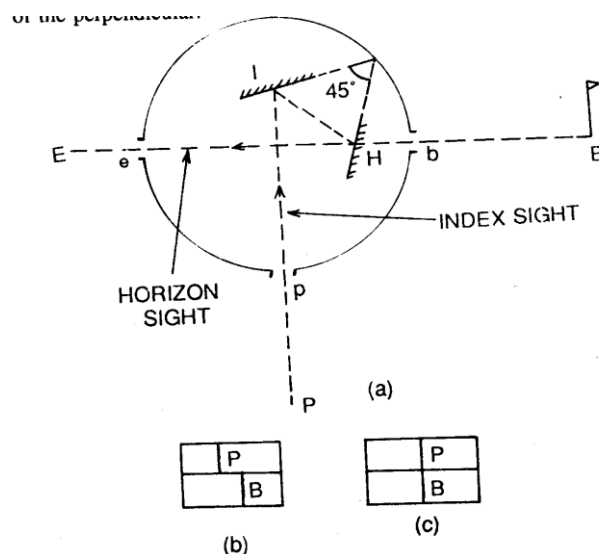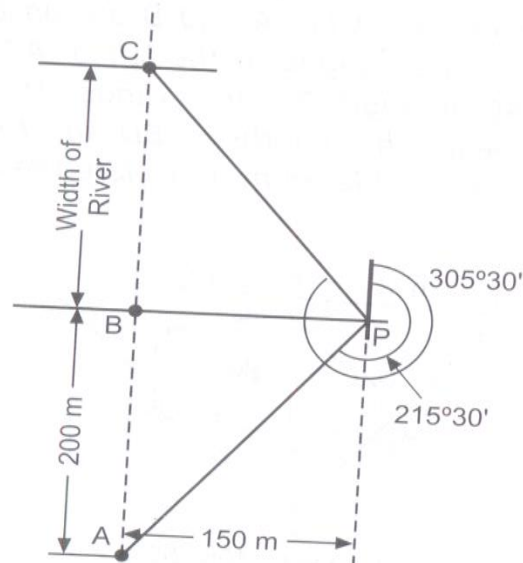
4) The opening 'e' is a pinhole for eye E, 'b' is small rectangular hole for ranging rod B, 'P' is large rectangular hole for the object P. 5) The line EB is known as horizon sight and IP as index sight. 6) The horizon glass is placed at an angle of 120^0 with the horizon sight. The index glass is placed at angle of 105^0 with index sight. The ray of light from P is first reflected from I, then it is further reflected from H, after which it ultimately reaches the eye E as shown in fig. *(For sketch 02 Mark and explanation 02 mark)*	
d)B and C are two point on the opposite bank are river along a chain line ABC which crosses the river at right angles to the bank .From a point P which is 150 m from B along the bank,the bearing of C is 305^0 30' and the bearing of A is 215^0 30'.If the length AB is 200 m,find width of river .	

In Δ ABP,   l(AB) = 200 m
             l(BP) = 150 m
       tan(<APB) = AB/BP
       tan < APB = 200/150 = 1.33
       <APB = 53^0 7^0 48"

From Fig.
     <APC = 305^0 30' - 215^0 30' = 90^0
     Now < BPC = 90^0 - 53^0 7^0 48" = 36^0 53'
Now Δ BPC
TAN< BPC = BC/BP =
     BC = BP tan <BPC
     BC = 150 tan 36^0 53'
     BC = 112.555 m
Width of River is 112.555 m

01

01

01

01

e)Calculate back bearing for following bearing : i)135^0 30',ii)230^0 iii)S 40^0 30' W ,iv)N 50^0 W	
Back Bearing = Fore Bearing $\pm 180^0$ i)Back Bearing = 135^0 30' + 180^0 = 315^0 30' ii) Back Bearing = 230^0 - 180^0 = 50^0 iii) Back Bearing = N $40^0$30 'E iv) Back Bearing = S $50^0$00 'E	01 01 01 01
f) Convert following bearing from R.B to W.C.B. i)N 30^0 30' E, ii)S 60^0 E ,iii)S 70^0 30' W ,iv)N 65^0 W	
i) W.C.B. = R.B. = 30^0 30' ii) W.C.B. = 180^0 - 60^0 = 120^0 iii) W.C.B. = 180^0 + 70^0 30' = 250^0 30' iv) W.C.B. = 360^0 - 65^0 = 295^0	01 01 01 01
Q.4 Attempt any FOUR of the following :	
a) State the code of singles for ranging.	

The following code of signals may be may be used in directing the assistant into line
   1) Rapid Sweeps with right hand –   Move considerably to the right.
   2) Rapid Sweeps with left hand –   Move considerably to the left.
   3) Slow Sweeps with right hand –   Move slowly to the right.
   4) Slow Sweeps with left hand –   Move slowly to the left.
   5) Right arm extended –   Continue to move to the right.
   6) Left arm extended –   Continue to move to the left.
   7) Right arm up and moved to the right –   Plumb the rod the right.
   8) left arm up and moved to the left –   Plumb the rod the left.
   9) Both hands above head and
      then brought down –   Correct.
  10) Both arms extended forward horizontally
     and the hands depressed briskly –   Fix.
                *(Any four 1 mark each)
	*

b) A 30 m chain was tested before commencement of chaining work .Line P Q was changed by it and observed length PQ was 1230 m. The chain was tested at the end of days' work and was found to be 12 cm too short .Find the correct distance PQ.	

Correct distance = L1/L x Measured distance
   L1 = Incorrect length of Chain
   L= Correct length of Chain
     Error before commencement = 0.0 m
 	
     Error at the end = - 0.12 m
 	
     Average error = (0+12)/2 = -0.06 m
	01

L1 = 30 – 0.06 = 29.94 m; L = 30 m

01

Measured distance = 1230 m

Correct length = L1/L x Measured distance

= 29.94/30 x 1230

= 1227.54 m

02

OR

Correct distance = L1/L x Measured distance
L1 = Incorrect length of Chain
L= Correct length of Chain

01

Error before commencement = 0.12 m

Error at the end = - 0.12 m

Average error = (0.12+0.12)/2 = 0.12 m

L1 = 30 – 0.12 = 29.88 m; L = 30 m

01

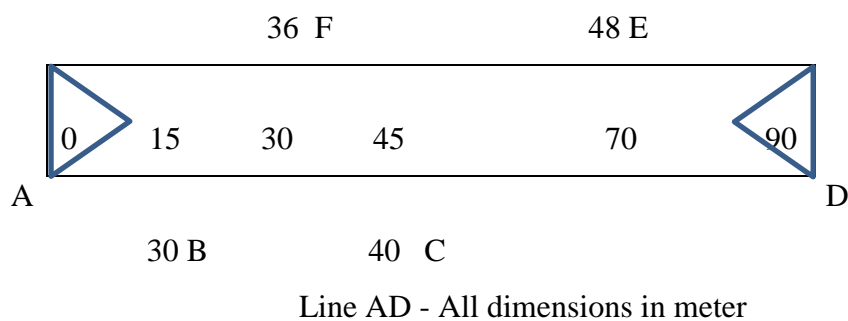Measured distance = 1230 m

Correct length = L1/L x Measured distance

= 29.88/30 x 1230

= 1225.08 m
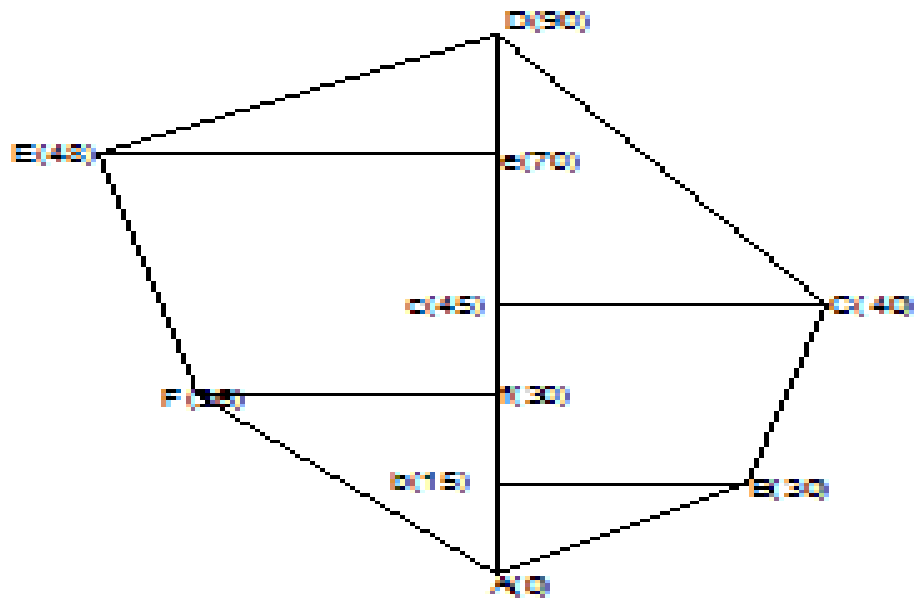
02

c)Plot the following cross staff survey of a field and calculates its area in m^2 as shown in fig no 1

36 F   48 E

0   15   30   45   70   90

A   D

30 B   40 C

Line AD - All dimensions in meter

01

| Sr.No. | Fig. | Chaining | | Base | Offset | | Mean Offset | Area (Sq.m) |
		From	To		No.1	No.2		
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**(5x8)**
I	ΔABb	0	15	**15**	0	30	**15**	**225**
II	[] bBCc	15	45	**30**	30	40	**35**	**1050**
III	ΔcCD	45	90	**45**	40	0	**20**	**900**
IV	ΔEeD	70	90	**20**	48	0	**24**	**480**
V	[] EefF	30	70	**40**	36	48	**42**	**1680**
VI	ΔFfA	0	30	**30**	36	0	**18**	**540**
Total								**4875 Sq.m**

(For Table Base 1 marks, For Mean offset 1 marks, Area 1 marks)

d)What is temporary adjustment of prismatic compass?

The following procedure should be adopted for temporary adjustment of prismatic compass.
1) **Fixing the compass with tripod stand:-** The tripod stand is placed at the required station with its legs well apart. Then the prismatic compass is held by the left hand and placed over the threaded top of the stand. After this, the compass box is turned clockwise by the right hand. Thus the threaded base of the compass box is fixed with the threaded top of the stand.
2) **Centering:-** The compass is centered by dropping a piece of stone from the bottom

of the compass box. Centering may also be done with the aid of a plumb bob held centrally below the compass box.

3) **Levelling :-** Levelling is done with the help of a ball-and-socket arrangement provided on top of the tripod stand. This arrangement is loosened and the box is placed in such way that the graduated ring rotates freely without touching either the bottom of the box or the glass cover on top.

4) **Adjustment of Prism :** The prism is moved up and down till the figure on the graduated ring are seen sharp and clear by using focusing stud.

5) **Observation of Bearing :-** After centering and leveling the compass box over the station, the ranging rod at the required station is bisected perfectly by sighting through the slit of the prism and horsehair at the sight vane.

(any four each 01 marks)

e)What is fore bearing back bearing of line and give their relationship ?	

Fore Bearing :- The Bearing of a line measured in the direction of the progress of the survey or forward direction is called as Fore Bearing (FB) of the line

01

Back Bearing :- The Bearing of a line measured in the direction of the opposite to the survey or backward direction is called as Back Bearing (BB) of the line

01

The relation between Fore Bearing and Back Bearing
Back Bearing = Fore Bearing $\pm 180^0$ (If F B is less than 180^0 use + sign.
If F B is more than 180^0 use - sign   )

02

f) Given below are the bearings observed in a closed travels .Determine which of the stations are affected by local attraction. State the values of corrected bearings.

Line	FB	BB
AB	124^0 30'	304^0 30'
BC	68^0 15'	246^0 00'
CD	310^0 30'	135^0 15'
DA	200^0 15'	17^0 45'

At the line AB,   W.C.B. of BA –W.C.B. of AB = 304^0 30' – 124^0 30'= 180^0
Therefore A and B are free from local attraction
Corrected W.C.B. of CB = 68^0 15' + 180^0 = 248^0 15'
Correction at C = 248^0 15' - 246^0 = 2^0 15'
Corrected W.C.B. of CD = W.C.B. of CD + correction at C
                = 310^0 30' + 2^0 15' = 312^0 45'
Corrected W.C.B. of DC = 312^0 45' + 180^0 = 132^0 45'
Correction at D = 132^0 45' + 135^0 15' = - 2^0 30'
Corrected W.C.B. of DA = 200^0 15' + 2^0 30' = 197^0 45'
Corrected W.C.B. of AB = 197^0 45' + 180^0 = 17^0 45'

01

01

Line	W.C.B.	Correction	Corrected Bearing	
AB	124^0 30'	**0**	124^0 30'	02
BA	304^0 30'	**0**	304^0 30'	
BC	68^0 15'	**0**	68^0 15'	
CB	246^0 0'	**2^0 15'@ C**	248^0 15'	
CD	310^0 30'	**2^0 15'@ C**	312^0 45'	
DC	135^0 15'	**-2^0 30'@ D**	132^0 45'	
DA	200^0 15'	**-2^0 30'@ D**	197^0 45'	
AD	17^0 45'	**0**	**17^0 45' (Check)**	
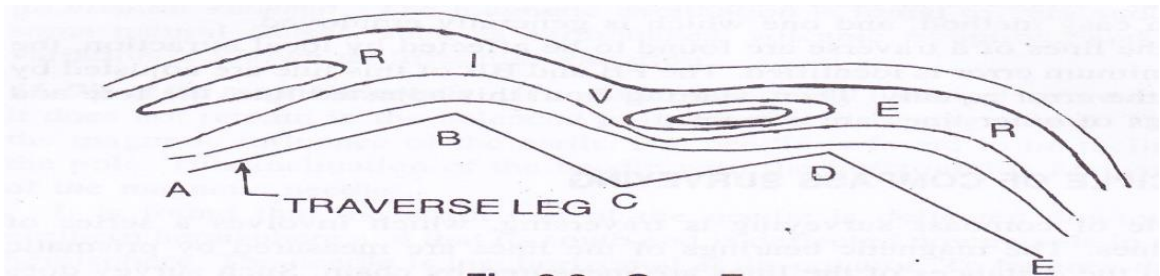
Q5) Attempt any FOUR of the following	16
a) Explain with neat sketch open and closed traverse.	

Open traverse :When sequence of connected lines of the traverse extends along a general direction and does not return to the starting point is known as open traverse. It is also known as unclosed traverse.

ABCDE in the fig. represents an open traverse.

Open traverse is suitable for the survey of roads, rivers, railways, Canals, Pipe lines, Coast lines etc.

Closed traverse : When a series of connected lines of the traverse form a closed circuit, i.e. When the finishing point coincides with the starting point of survey is known as closed traverse.

ABCDEA in the fig. represents a closed traverse.

01

01

01

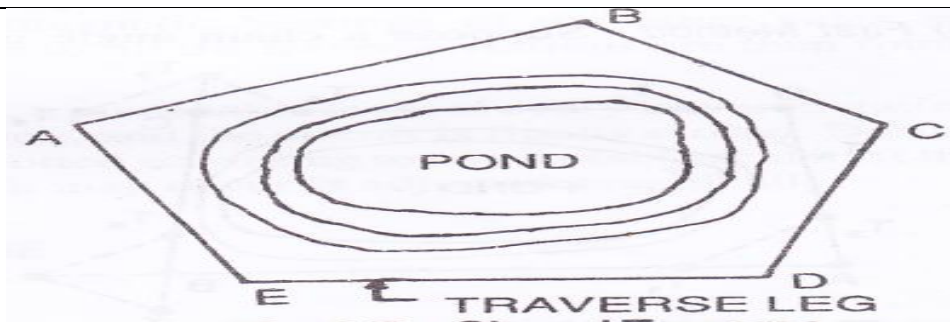|	
Closed traverse is suitable for the survey of boundaries of ponds forests, estates etc.	01
b) State the different accessories with their use for plane table survey.	
i) The plane table: It is used for fixing a drawing sheet over it. To locate the position of the objects on the sheet by drawing rays and plotting to suitable scale. ii) **The Alidade (plain Alidade, Telescopic Alidade):** It is used to sight the objects . To draw rays along the fiducial edge **iii) The spirit level:** It is used for leveling the plane table **iv) The compass:** (Trough Compass, Circular compass): It is used for marking the North direction on the map. To orient the plane table **v)U-Fork or Plumbing fork with plumb bob:** It is used for centering the table over the station. *(Any four 1/2 mark for name of accessories and ½ for function.)*	*
c) What is orientation of plane table? Explain back sighting method of orientation of plane table survey.	
Orientation: The method of setting up the plane table at each of the successive stations parallel to the position it occupied at the starting station is known as orientation. **Orientation by back sighting: Procedure**- Ref Fig. bellow	01

01
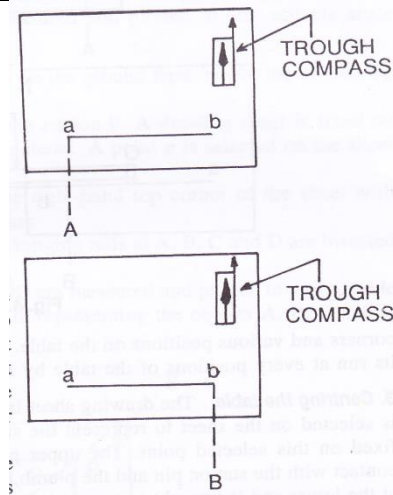
i)Suppose A and B are two stations. The plane table is set up over A. the table is leveled by spirit level and centered by U-fork so that point 'a' is just over station A. The north line is marked on the right hand top corner of the sheet by trough compass.

ii) With the alidade touching 'a', the ranging rod at B is bisected and a ray is drawn. The distance AB is measured and plotted to any suitable scale. So the point 'b' represents station B.

02

iii) The table is shifted and set up over B. It is leveled and centered so that 'b' just over B.Now the alidade is placed along the line 'ba' ,and the ranging rod at A is bisected by turning the table clockwise or anticlockwise. When the centering, leveling and bisection of the ranging rod at A are perfect, then the orientation is said to be perfect.

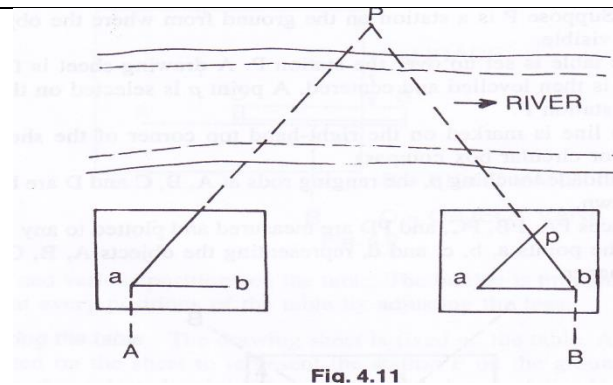| d) Explain intersection method of plane table survey .	
The intersection method: This method is suitable for locating inaccessible points by the intersection of the rays drawn from two instrument stations. Procedure: (Ref. Fig. below)	01

Fig. 4.11	01
i) Suppose A and B are two stations and 'p' is the object on the far bank of a river. Now it is required to fix the position of P on the sheet by the intersection of rays, drawn from A to B.	
ii) The table is set up at A. It is leveled and centered so that a point 'a' on the sheet is just over the station A. The north line is marked on the right-hand top corner. The table is then clamped.	02
iii) With the alidade touching 'a', the object P and the ranging rod at B are bisected and rays are drawn through the fiducial edge of the alidade.	
iv)The distance AB is measured and plotted to any suitable scale to obtain the point 'b'	
v) The table is shifted and centered over B and leveled properly. Now the alidade is placed along the line 'ba' and orientation is done by back sighting. At this time it should be remembered that the centering, leveling and orientation must be perfect simultaneously.	
vi) With the alidade touching 'b', the object P is bisected and a ray is drawn. Suppose this ray intersects the previous ray at a point 'p'. this point 'p' is the required plotted position.	
e) Define the following terms used in levelling	
i) Level surface:A surface parallel to the mean spheroidal surface of the earth is known as level surface .	01
ii) Datum line: An arbitrary (assumed)level line from which elevations of point may be referred is known as datum line.	01
iii) Reduced level (RL) : The vertical distance of a point above or below the datum line is known as the reduced level of that point.	01
iv) Axis of telescope: An imaginary line passing through the optical center of the object glass and the optical center of the eye piece is known as Axis of telescope.	01

f) What is temporary adjustment of dumpy level?	

Temporary adjustment: The adjustments made at every set up of the level before the staff readings are taken are known as temporary adjustments.
 	
The following are the different steps to be followed in temporary adjustment.
 	
Step-
 	
   i)   **Selection of suitable position:**
   ii)   **Fixing level with tripod stand:**
   iii)   **Approximate leveling by legs of tripod stand**
   iv)   **Perfect leveling by foot screws**
	02

i) Selection of suitable position: A suitable position is selected setting the level. From this position, it should be possible to take the greatest number of observations without any difficulty. The ground should be fairly leveled and firm.

ii) Fixing level with tripod stand: The tripod stand is placed at the required position with its leg well apart, and pressed firmly in to the ground.

The level is fixed on the top of the tripod stand according to the fixing arrangement provided for that particular level. It should be remembered that the level is not to be set up at any station or point along the alignment.

iii) Approximate leveling by legs of tripod stand: The foot screw are brought to the center of their run. Two legs of the tripod stand are firmly fixed in to the ground. The the third leg is moved to the left or right, in or out until the bubble is approximately at the center of its run.

iv) Perfect leveling by foot screws: As the longitudinal bubble is on the top of the telescope, the telescope is placed parallel to any pair of foot screws(i.e. first position) and the bubble is brought to the center by running the foot screws equally either both inwards or both outwards. The telescope is then turned through 90^0 (i.e. Second position) and brought over the third screw, and bubble is brought to the center by turning this foot screw clockwise or anticlockwise(as shown in fig bellow) The telescope is again brought to its original position (the first position) and the bubble is brought to the center. The process is repeated several times until the bubble remains in the central position in the first as well as the second position. Then the telescope is turned through 180^0.If the bubble still remains in the central position, the temporary adjustment is perfect and so is the permanent adjustment.

But if the bubble is deflected from its central position, the permanent adjustment is not perfect and need to be modified.

02
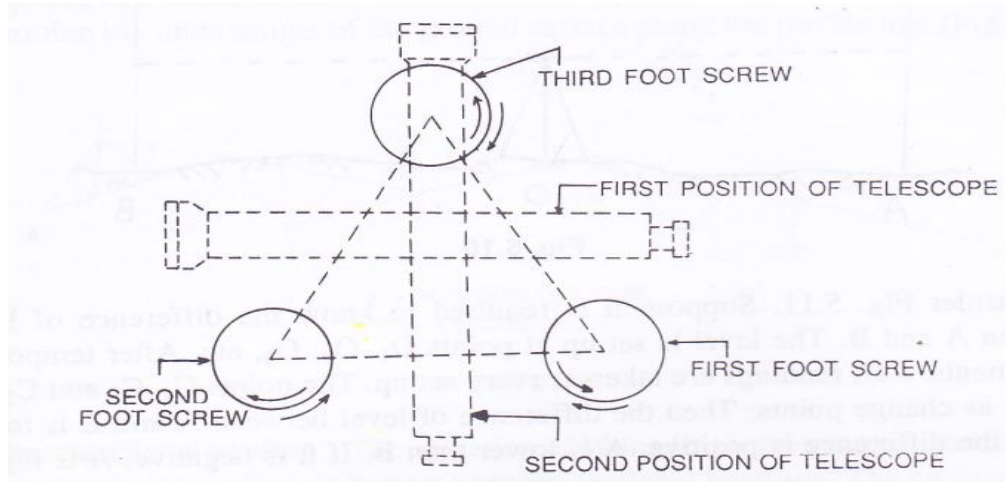
v)Focusing of eye pice & object glass.focusing of eye pice is done by keeping a piece of white paper in front of the object glass. And the eye is moved in or out by turing it clockwise and anticlockwise until the cross hair can be seen clearly.

The telescopic is directed towords the leveling staffs.Looking through the eye pice the focusing screw is turned clockwise or anticlockwise until graduation of the staff is distinctly visible and paralal is eliminated

Q6) Attempt any TWO of the following:	16

a) The following readings were taken with a level and 4m staff. Draw up a level book page and calculate reduced levels by height of instrument method.

0.578,0.933,1.768,2.450,3.005,0.567,1.181,1.888,3.679,0.612,0.705 and 1.810. The instrument was shifted after 5th and 9th reading. The R.L. of first station is 58.250. Apply usual checks.

Level Book Page :- (Height of Instrument method)

Staff Stn	Staff readings			H.I.	R.L.	Remarks
	B.S.	I,S.	F.S.			
1	0.578			58.828	58.250	
2		0.933			57.895	
3		1.768			57.060	
4		2.450			56.378	
5	0.567		3.005	56.390	55.823	C.P.1
6		1.181			55.209	
7		1.888			54.502	
8	0.612		3.679	53.323	52.711	C.P.2
9		0.705			52.618	
10			1.810		51.513	Last Staff Stn

H.I.= R.L.of first stn + B.S.　　　　　58.250+0.578=58.828

R.L. of a staff stn = H.I. – (I.S. or F.S.)　　R.L. of a staff stn 2= 58.828-0.933=57.895

　　　　　　　　　　　　　　　R.L. of a staff stn 3=58.828-1.768=57.060

　　　　　　　　　　　　　　　R.L. of a staff stn 4=58.828-2.450=56.378

 R.L.of change point 1 =　　　　　R.L.of a staff stn 5=58.828-3.005=55.823

H.I. at Change point 1= R.L.of C.P.1)+ B.S. H.I. at C.P.1   = 55.823+0.567=56.390

　　　　　　　　　　　　　　　R.L. of a staff stn 6=56.390-1.181=55.209

　　　　　　　　　　　　　　　R.L. of a staff stn 7=56.390-1.8888=55.502

 R.L.of change point 2 =　　　　　R.L. of a staff stn 8=56.390-3.679=52.711

H.I. at Change point 2= R.L.of C.P.2)+ B.S.H.I. at C.P.2   = 52.711+0.612=53.323

　　　　　　　　　　　　　　　R.L. of a staff stn 9=53.323-0.705=52.618

　　　　　　　　　　　　　R.L. of a last staff stn 10 =53.323-1.810=51.513

Arithmetic Check　　　$\sum$ B.S.　-　$\sum$ F.S.　　=　　Last R.L.　-　First R.L.

　　　　　　　　1.757　　-　8.494　　=　　51.513　-　58.250

　　　　　　　　　　　- 6.737　　　　=　　　　- 6.737

O.K. Check is verified.	

Note: Correct Level book page   *01 Mark,*
     Correct entry of the readings in level page   *01 mark*
     All RL 02 marks, Sample calculations of RLs and H.I.(any one each) 02 marks,
     Arithmetic check *02 mark*	

b) What are the sources of errors in leveling? What precautions should be taken to guard against it?	
Sources of errors in leveling are as follows: Classification of errors **I)Instrumental errors** **II)Personal errors** **III)Errors due to natural causes** **I)Instrumental errors:** Types i) The permanent adjustment of the instrument may not be perfect.(Line of collimation may not be parallel to the axis of the bubble tube, the axis of the bubble tube may not be perpendicular to the vertical axis precaution: check the permanent adjustment of the instrument periodically,if not found correct carryout permanent adjustment by suitable method. ii) The internal arrangement of the focusing tube is not perfect precaution: Check the working of the focusing screw, working of crack and pinion arrangement inside the telescope make it correct for smooth functioning. iii)The graduation of the leveling staff may not be perfect. Precaution: Check numbering of graduations, if any mistake make it correct, check the scale of graduation by standard scale if not correct change leveling staff. **II)Personal errors:** Types i)The instrument may not be leveled perfectly. Precaution: Level the instrument properly and perfect and check it. ii)The focusing of the eye piece and object glass may not be perfect and parallax may not be eliminated entirely. Precaution: Check the instrument for parallax and if found remove it proper focusing of eye piece and focusing screw. iii)The position of the staff may be displaced at the change point at the time of taking FS and BS readings	02 (Any two 02 Marks) (Any two 2 Marks)

Precaution: Take due care at change point and see that no displacement of staff.

iv) The staff may appear inverted when viewed through the telescope, by mistake the staff reading may be taken upward instead of downward and vice-versa.

Precaution: Check the specification of the instrument and use the reading method accordingly.

v) The reading of the stadia hair rather than central collimation hair may be taken by mistake.

Precaution: Take the reading at central collimation hair and not at stadia top and bottom hair

vi) A wrong entry may be made in the level book.

Precaution: Take care while entering the readings, first reading in BS column, intermediate readings in IS column, last reading in FS column. Listen the reading carefully and enter in respective column

vii) The staff may not be properly and fully extended.

Precaution: Before use extend the staff for required height properly

III) Errors due to natural causes: Types

i)When the distance of the sight is long,the curvature of the earth may affect the staff readings:

Precaution: Take suitable number of change point and if not possible apply corrections

ii) The effect of refraction may cause a wrong staff readings.

Precaution: Reduce length of sight or apply correction for refraction.

iii) The effect of high wind and shining sun may result in a wrong staff reading.

Precaution: If possible avoid taking reading in high wind and shining sun if not take due care   in instrument setting and stability, shelter over the instrument.

(Any two 02 marks)

c) Bellow is the page of a level book in which some of the readings are missing and are marked as 'X'. find the values of the missing readings. Calculate RL's of all points. Apply usual checks.

Level page of the field book

Stn	B.S.	I.S.	F.S.	Rise	Fall	R.L.	Remarks
A	X					275.000	B.M.
B	1.060		1.975		1.500	X	C.P.1
C		1.550			X	X	
D		X			X	272.440	
E	2.380		1.785	X		X	C.P.2
F	1.325		0.895	X		X	C.P.3
G			X	X		X	Last point

Stn	B.S.	I.S.	F.S.	Rise	Fall	R.L.	Remarks
A	X1=0.475					275.000	B.M.
B	1.060		1.975		1.500	X2=273.500	C.P.1
C		1.550			X3=0.490	X4=273.010	
D		X5=2.120			X6=0.570	272.440	
E	2.380		1.785	X7=0.335		X8=272.775	C.P.2
F	1.325		0.895	X9=1.485		X10=274.260	C.P.3
G			X11	X12		X13	Last point

*

Calculations:

X1= 1.975-1.500=0.475   ,X2 = 275.000-1.500 =273.500

X3 = 1.550-1.060 = 0.490   ,X4= 273.500-0.490 = 273.010

X6 = 273.010-272.440=0.570   ,X5= 1.55 + 0.570= 2.120

X7= 2.120-1.785=0.335 ,   X8 = 272.440 +0.335 = 272.775

X9=2.38-0.895=1.485 ,   X10=272.775+1.485 =274.260

*(*For finding missing readings X1 to X5 ,four marks and for X6 to X10 , four marks*)

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