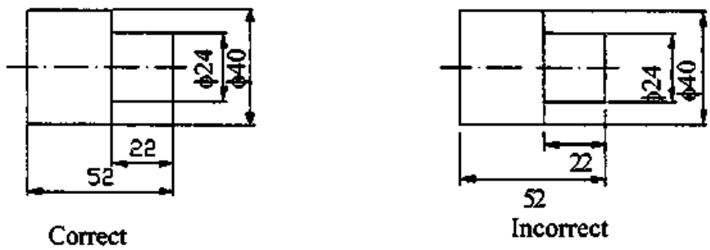


Fig. 2.17 Marking of Extension Lines

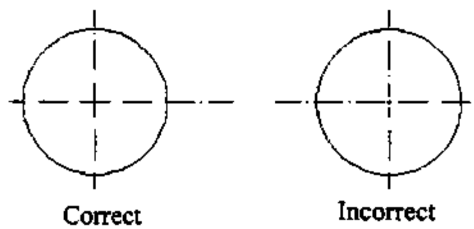


Fig. 2.18 Crossing of Centre Lines

2.4.2 Execution of Dimensions

1. Prejection and dimension lines should be drawn as thin continuous lines. projection lines should extend slightly beyond the respective dimension line. Projection lines should be drawn perpendicular to the feature being dimensioned. If the space for dimensioning is insufficient, the arrow heads may be reversed and the adjacent arrow heads may be replaced by a dot (Fig.2.19). However, they may be drawn obliquely, but parallel to each other in special cases, such as on tapered feature (Fig.2.20).

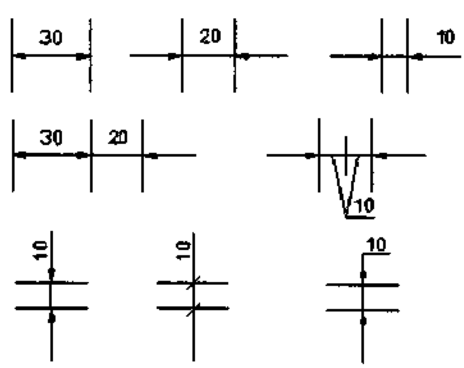


Fig. 2.19 Dimensioning in Narrow Spaces

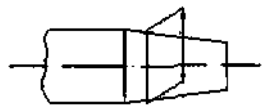
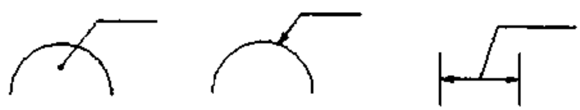


Fig. 2.20 Dimensioning a Tapered Feature

2. A leader line is a line referring to a feature (object, outline, dimension). Leader lines should be inclined to the horizontal at an angle greater than 30°. Leader line should terminate,
   (a) with a dot, if they end within the outline of an object (Fig.2.21a).
   (b) with an arrow head, if they end on outside of the object (Fig.2.21b).
   (c) without a dot or arrow head, if they end on dimension line (Fig.2.21c).



(a) (b) (c)

Fig. 2.21 Termination of leader lines

Dimension Termination and Origin Indication

Dimension lines should show distinct termination in the form of arrow heads or oblique strokes or where applicable an origin indication (Fig.2.22). The arrow head included angle is 15°. The origin indication is drawn as a small open circle of approximately 3 mm in diameter. The proportion lenght to depth 3 : 1 of arrow head is shown in Fig.2.23.

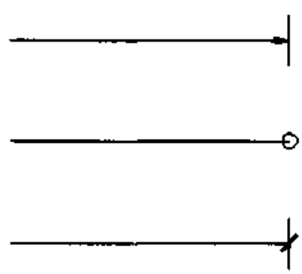


Fig. 2.22 Termination of Dimension Line

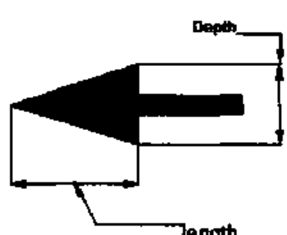


Fig. 2.23 Proportions of an Arrow Head

When a radius is dimensioned only one arrow head, with its point on the arc end of the dimension line should be used (Fig.2.24). The arrow head termination may be either on the inside or outside of the feature outline, depending on the size of the feature.

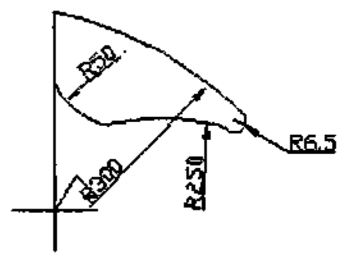


Fig. 2.24 Dimensioning of Radii

2.4.3 Methods of Indicating Dimensions

The dimensions are indicated on the drawings according to one of the following two methods.

Method - 1 (Aligned method)

Dimensions should be placed parallel to and above their dimension lines and preferably at the middle, and clear of the line. (Fig.2.25).

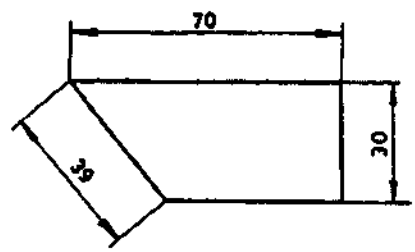


Fig. 2.25 Aligned Method

Dimensions may be written so that they can be read from the bottom or from the right side of the drawing. Dimensions on oblique dimension lines should be oriented as shown in Fig.2.26a and except where unavoidable, they shall not be placed in the 30^0 zone. Angular dimensions are oriented as shown in Fig.2.26b

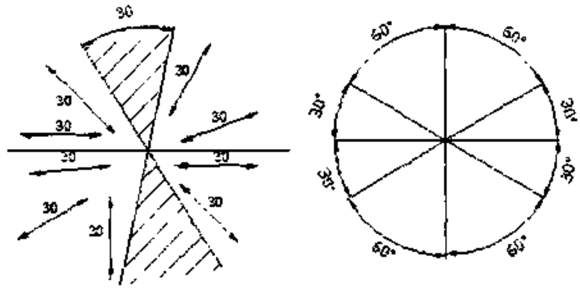
Method - 2 (uni-directional method)

Dimensions should be indicated so that they can be read from the bottom of the drawing only.

Non-horizontal dimension lines are interrupted, preferably in the middle for insertion of the dimension (Fig.2.27a).

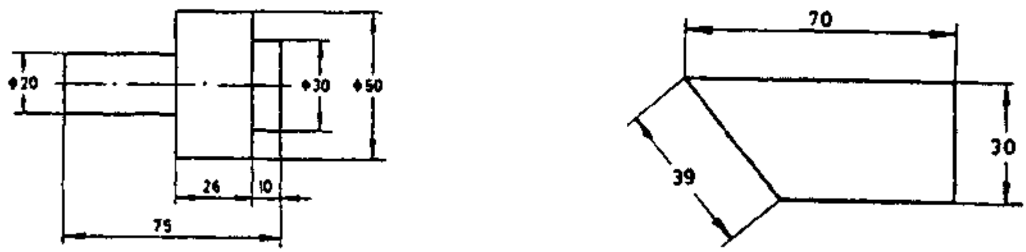
Angular dimensions may be oriented as in Fig.2.27b

Note : Horizontal dimensional lines are not broken to place the dimension in both cases.



(a) (b)

Fig.2.26 Angular Dimensioning



(a) (b)

Fig.2.27 Uni-directional Method

2.4.4 Identification of Shapes

The following indications are used with dimensions to show applicable shape identification and to improve drawing interpretation. The diameter and square symbols may be omitted where the shape is clearly indicated. The applicable indication (symbol) shall precede the value for dimension (Fig. 2.28 to 2.32).

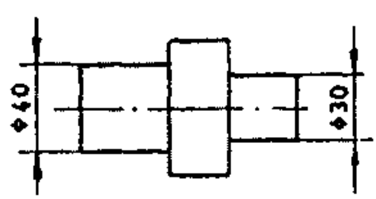


Fig. 2.28

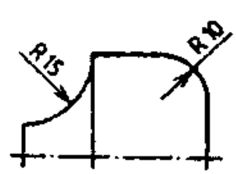


Fig. 2.29

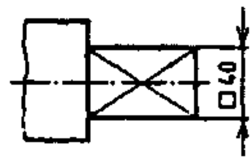


Fig. 2.30

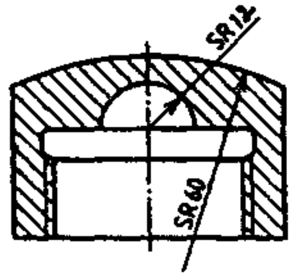


Fig. 2.31

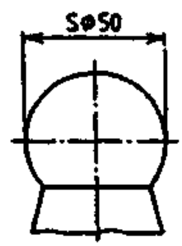


Fig. 2.32

2.5 Arrangement of Dimensions

The arrangement of dimensions on a drawing must indicate clearly the purpose of the design of the object. They are arranged in three ways.

1. Chain dimensioning
2. Parallel dimensioning
3. Combined dimensioning.

1. Chain dimensioning

Chain of single dimensioning should be used only where the possible accumulation of tolerances does not endanger the fundamental requirement of the component (Fig.2.33)

2. Parallel dimensioning

In parallel dimensioning, a number of dimension lines parallel to one another and spaced out, are used. This method is used where a number of dimensions have a common datum feature (Fig.2.34).

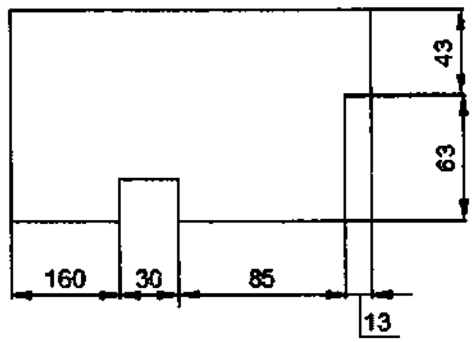


Fig. 2.33 Chain Dimensioning

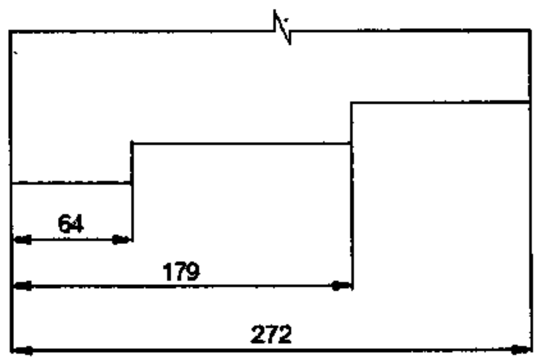


Fig. 2.34 Parallel Dimensioning

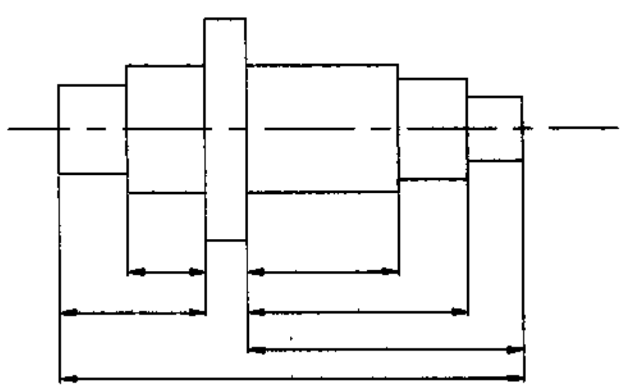
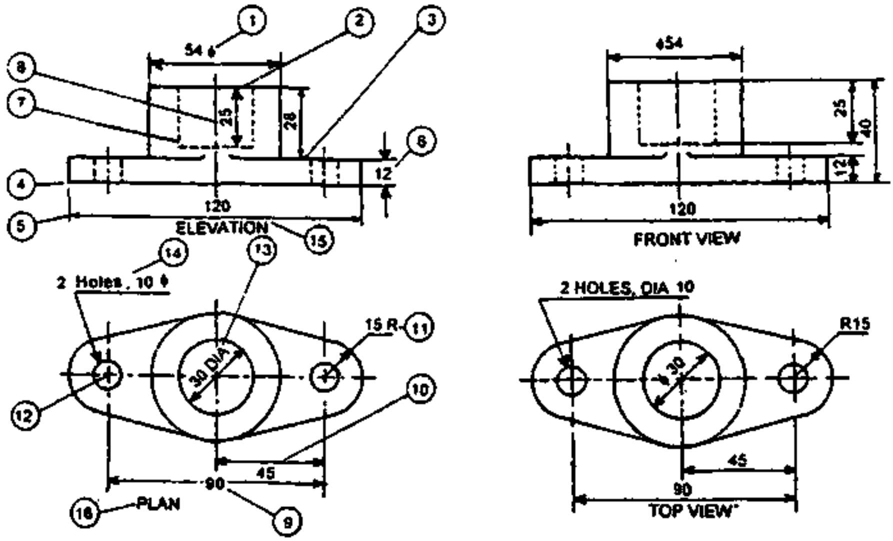


Fig. 2.35 Combined Dimensioning

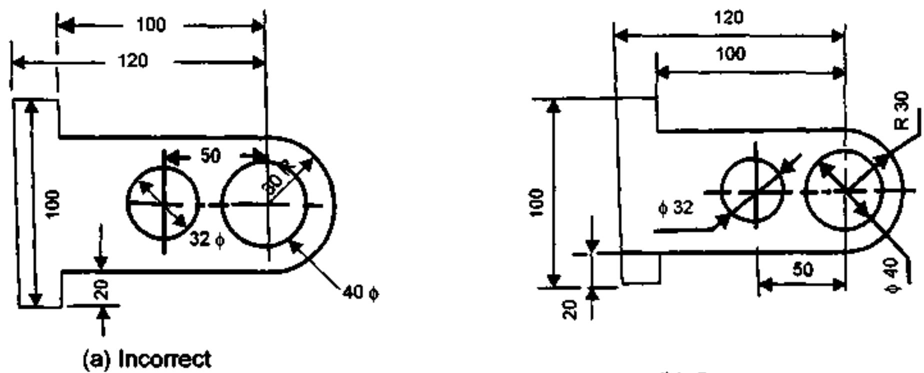
Violation of some of the principles of drawing are indicated in Fig.2.36a. The corrected version of the same as per BIS SP 46-2003 is given is Fig.2.36b. The violations from 1 to 16 indicated in the figure are explained below.



(a) (b)

Fig. 2.36

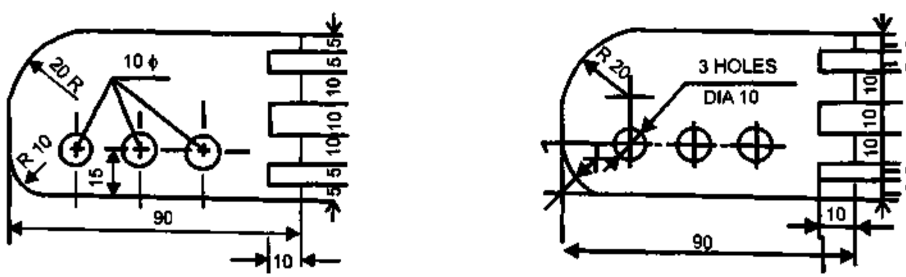
1. Dimension should follow the shape symbol.
2. and 3. As far as possible, features should not be used as extension lines for dimensioning.
4. Extension line should touch the feature.
5. Extension line should project beyond the dimension line.
6. Writing the dimension is not as per aligned method.
7. Hidden lines should meet without a gap.
8. Centre line representation is wrong. Dots should be replaced by small dashes.
9. Horizontal dimension line should not be broken to insert the value of dimension in both aligned and uni-direction methods.
10. Dimension should be placed above the dimension line.
11. Radius symbol should precede the dimension.
12. Centre line should cross with long dashes not short dashes.
13. Dimension should be written by symbol followed by its values and not abbreviation.
14. Note with dimensions should be written in capitals.
15. Elevation is not correct usage.
16. Plan is obsolete in graphic language



(a) Incorrect

(b) Correct

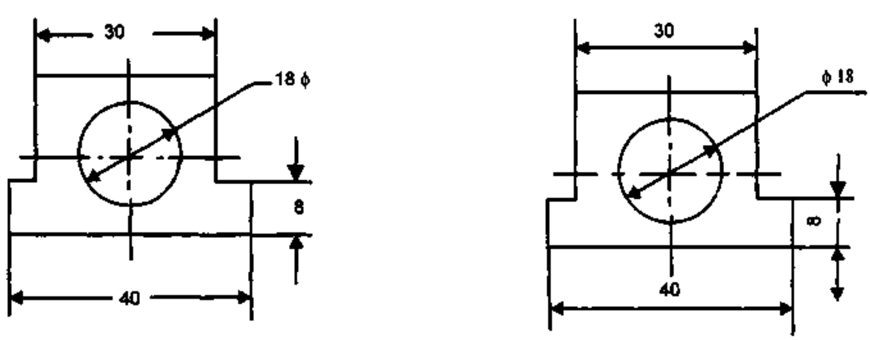
Fig. 2.37



(a) Incorrect

(b) Correct

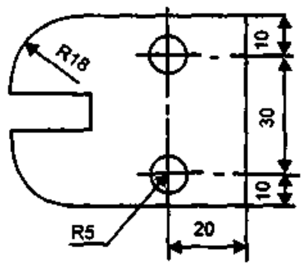
Fig. 2.38



(a) Incorrect

(b) Correct

Fig. 2.39



(b) Correct

Fig. 2.40

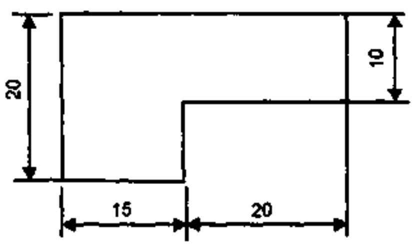


Fig. 2.41

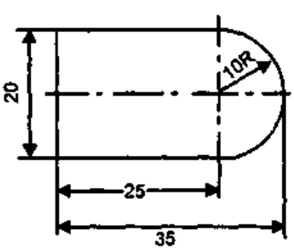


Fig. 2.42

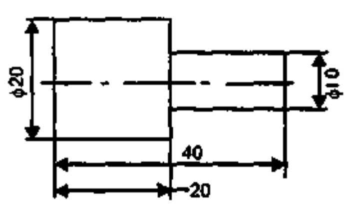


Fig. 2.43

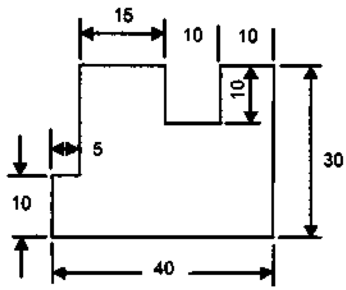


Fig. 2.44

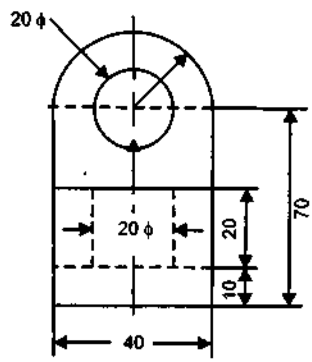


Fig. 2.45

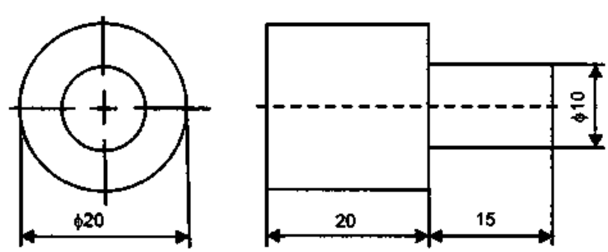


Fig. 2.46

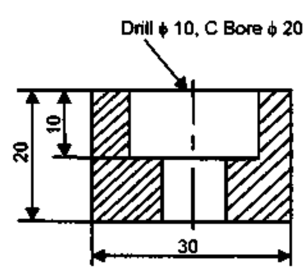


Fig. 2.47

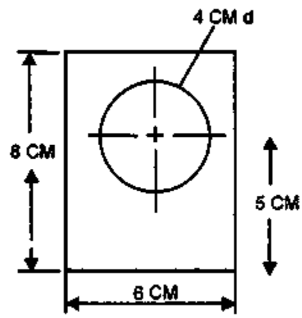


Fig. 2.48

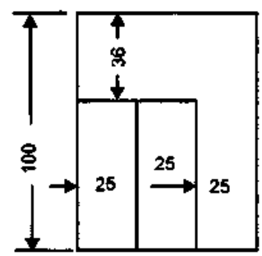


Fig. 2.49

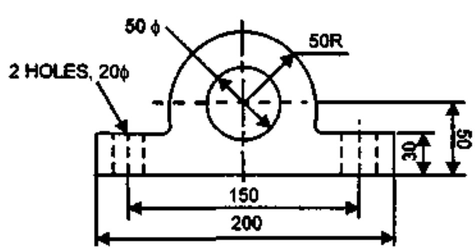


Fig. 2.50

EXERCISE

Write freehand the following, using single stroke vertical (CAPITAL and lower-case) letters:

1. Alphabets (Upper-case & Lower-case) and Numerals 0 to 9 (h = 5 and 7 mm)
2. PRACTICE MAKES A PERSON PERFECT (h = 3.5 and 5)
3. BE A LEADER NOT A FOLLOWER (h = 5)
4. LETTERING SHOULD BE DONE FREEHAND WITH SPEED (h = 5)

CHAPTER 3

Scales

3.1 Introduction

It is not possible always to make drawings of an object to its actual size. If the actual linear dimensions of an object are shown in its drawing, the scale used is said to be a **full size scale.** Wherever possible, it is desirable to make drawings to full size.

3.2 Reducing and Enlarging Scales

Objects which are very big in size can not be represented in drawing to full size. In such cases the object is represented in reduced size by making use of reducing scales. Reducing scales are used to represent objects such as large machine parts, buildings, town plans etc. A reducing scale, say 1:10 means that 10 units length on the object is represented by 1 unit length on the drawing.

Similarly, for drawing small objects such as watch parts, instrument components etc., use of full scale may not be useful to represent the object clearly. In those cases enlarging scales are used. An enlarging scale, say 10:1 means one unit length on the object is represented by 10 units on the drawing.

The designation of a scale consists of the word. SCALE, followed by the indication of its ratio as follows. (Standard scales are shown in Fig. 3.1)

Scale 1:1 for full size scale

Scale 1: x for reducing scales (x = 10,20......etc.,)

Scale x:1 for enlarging scales.

Note : For all drawings the scale has to be mentioned without fail.

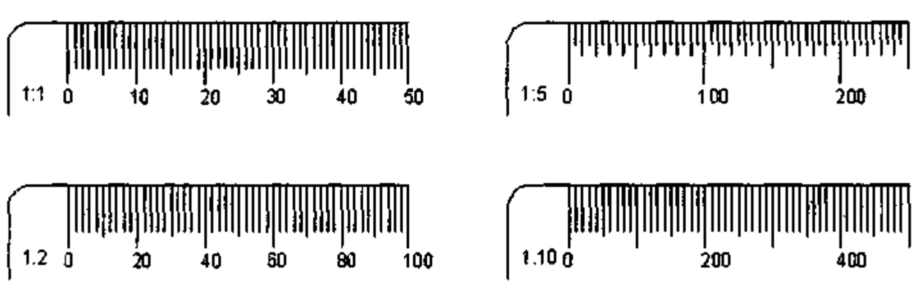


Fig. 3.1 Scales

3.3 Representative Fraction

The ratio of the dimension of the object shown on the drawing to its actual size is called the Representative Fraction (RF).

$$RF = \frac{\text{Drawing size of an object}}{\text{Its actual size}} \text{ (in same units)}$$

For example, if an actual length of 3 metres of an object is represented by a line of 15mm length on the drawing

$$RF = \frac{15\text{mm}}{3\text{m}} = \frac{15\text{mm}}{(3\times1000)\text{mm}} = \frac{1}{200} \text{ or } 1:200$$

If the desired scale is not available in the set of scales it may be constructed and then used.

Metric Measurements

10 millimetres (mm) = 1 centimetre(cm)

10 centimetres (cm) = 1 decimetre(dm)

10 decimetre (dm) = 1 metre(m)

10 metres (m) = 1 decametre (dam)

10 decametre (dam) = 1 hectometre (hm)

10 hectometres (hm) = 1 kilometre (km)

1 hectare = 10,000 m^2

3.4 Types of Scales

The types of scales normally used are:

1. Plain scales.
2. Diagonal Scales.
3. Vernier Scales.

3.4.1 Plain Scales

A plain scale is simply a line which is divided into a suitable number of equal parts, the first of which is further sub-divided into small parts. It is used to represent either two units or a unit and its fraction such as km and hm, m and dm, cm and mm etc.

Problem 1 : *On a survey map the distance between two places 1km apart is 5 cm. Construct the scale to read 4.6 km.*

Solution : (Fig 3.2)

$$RF = \frac{5\text{cm}}{1\times1000\times100\text{cm}} = \frac{1}{20000}$$

If x is the drawing size required $x = 5(1000)(100) \times \frac{1}{20000}$

Therefore, x = 25 cm

Note : If 4.6 km itself were to be taken x = 23 cm. To get 1 km divisions this length has to be divided into 4.6 parts which is difficult. Therefore, the nearest round figure 5 km is considered. When this length is divided into 5 equal parts each part will be 1 km.

1. Draw a line of length 25 cm.
2. Divide this into 5 equal parts. Now each part is 1 km.
3. Divide the first part into 10 equal divisions. Each division is 0.1 km.
4. Mark on the scale the required distance 4.6 km.

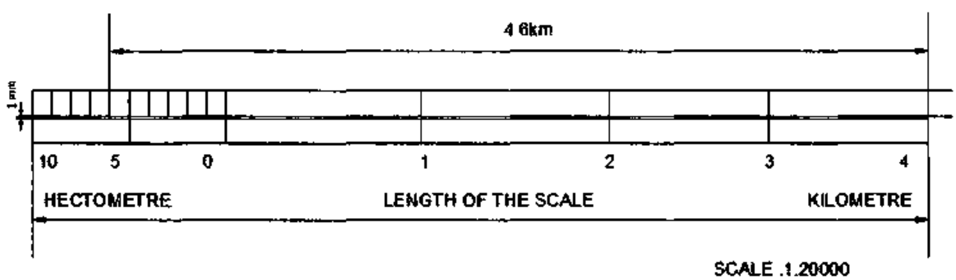


Fig. 3.2 Plain Scale

Problem 2 : *Construct a scale of 1:50 to read metres and decimetres and long enough to measure 6 m. Mark on it a distance of 5.5 m.*

Construction (Fig. 3.3)

1. Obtairr the length of the scale as: RF x 6m = $\frac{1}{50} \times 6 \times 100 = 12$ cm
2. Draw a rectangle strip of length 12 cm and width 0.5 cm.
3. Divide the length into 6 equal parts, by geometrical method each part representing 1m.
4. Mark 0(zero) after the first division and continue 1,2,3 etc., to the right of the scale.
5. Divide the first division into 10 equal parts (secondary divisions), each representing 1 cm.
6. Mark the above division points from right to left.
7. Write the units at the bottom of the scale in their respective positions.
8. Indicate RF at the bottom of the figure.
9. Mark the distance 5.5 m as shown.

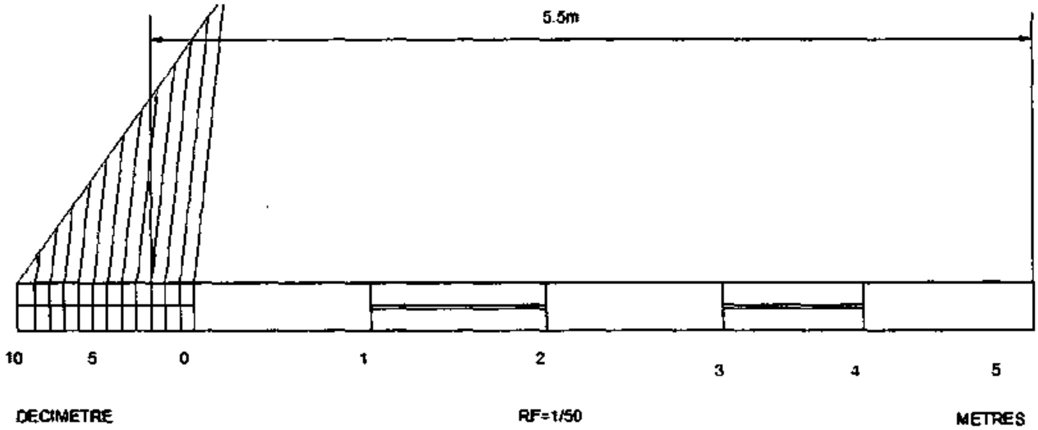


Fig. 3.3

Problem 3 : *The distance between two towns is 250 km and is represented by a line of length 50mm on a map. Construct a scale to read 600 km and indicate a distance of 530 km on it.*

Solution : (Fig 3.4)

1. Determine the RF value as $\frac{50\text{mm}}{250\text{km}} = \frac{50}{250 \times 1000 \times 1000} = \frac{1}{5 \times 10^6}$
2. Obtain the length of the scale as: $\frac{1}{5 \times 10^6} \times 600\text{km} = 120\text{mm}$.
3. Draw a rectangular strip of length 120 mm and width 5 mm.
4. Divide the length into 6 equal parts, each part representing 10 km.
5. Repeat the steps 4 to 8 of construction in Fig 3.2. suitably.
6. Mark the distance 530 km as shown.

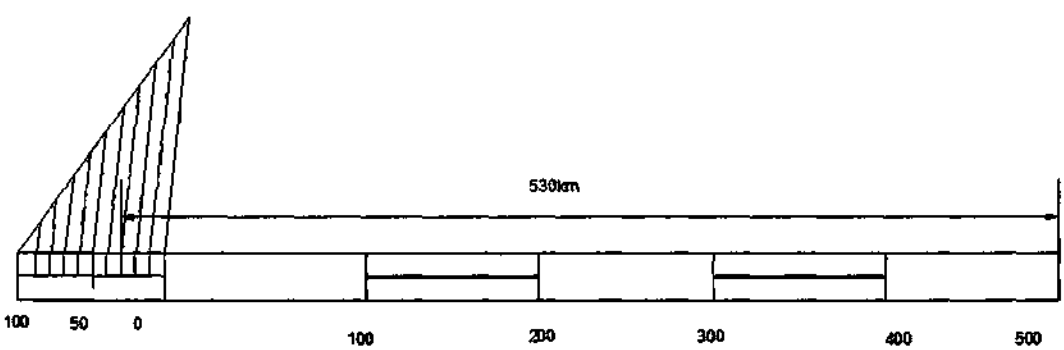


Fig. 3.4

Problem 4 : *Construct a plain scale of convenient length to measure a distance of 1 cm and mark on it a distance of 0.94 cm.*

Solution : (Fig 3.5)

This is a problem of enlarged scale.

1. Take the length of the scale as 10 cm
2. RF = 10/1, scale is 10:1
3. The construction is shown in Fig 3.5

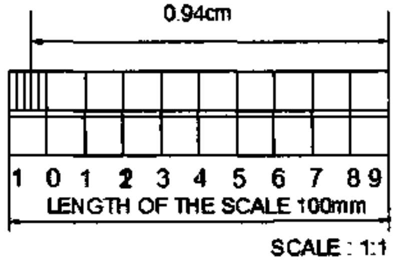


Fig. 3.5

3.4.2 Diagonal Scales

Plain scales are used to read lengths in two units such as metres and decimetres, centimetres and millimetres etc., or to read to the accuracy correct to first decimal.

Diagonal scales are used to represent either three units of measurements such as metres, decimetres, centimetres or to read to the accuracy correct to two decimals.

Principle of Diagonal Scale (Fig 3.6)

1. Draw a line AB and errect a perperrdicular at B.
2. Mark 10 equi-distant points (1,2,3, etc) of any suitable length along this perpendicular and mark C.
3. Complete the rectangle ABCD
4. Draw the diagonal BD.
5. Draw horizontals through the division points to meet BD at 1′, 2′, 3′ etc.

Considering the similar triangles say BCD and B44′

$$\frac{B4'}{CD}=\frac{B4}{BC}; \ =\frac{4}{10}\times BC\times\frac{1}{BC}=\frac{4}{10}; \ 44'=0.4CD$$

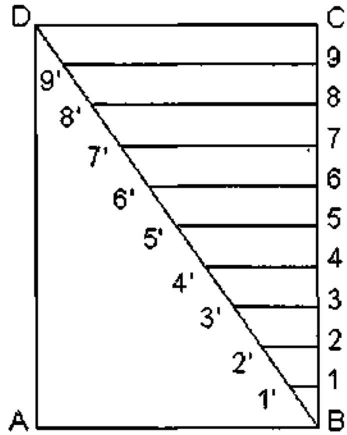


Fig. 3.6 Principle of Diagonal Scale

Thus, the lines $1-1', 2-2', 3-3'$ etc., measure 0.1CD, 0.2CD, 0.3CD etc. respectively. Thus, CD is divided into 1/10 the divisions by the diagonal BD, i.e., each horizontal line is a multiple of 1/ 10 CD.

This principle is used in the construction of diagonal scales.

Note : B C must be divided into the same number of parts as there are units of the third dimension in one unit of the secondary division.

Problem 5 : *on a plan, a line of 22 cm long represents a distance of 440 metres. Draw a diagonal scale for the plan to read upto a single metre. Measure and mark a distance of 187 m on the scale.*

Solution : (Fig 3.7)

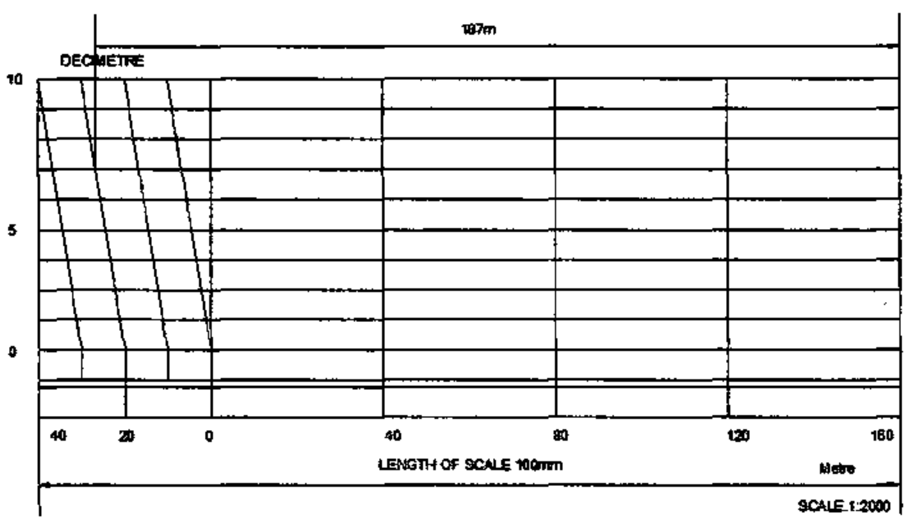


Fig. 3.7 Diagonal Scale.

1. $RF = \dfrac{22}{440 \times 100} = \dfrac{1}{2000}$

2. As 187 m are required consider 200 m.

   Therefore drawing size = R F x actual size = $\dfrac{1}{2000} \times 200 \times 100 = 10\,\text{cm}$

   When a length of 10 cm representing 200 m is divided into 5 equal parts, each part represents 40 m as marked in the figure.

3. The first part is sub-divided into 4 divisions so that each division is 10 cm

4. On the diagonal portion 10 divisions are taken to get 1 m.

5. Mark on it 187 m as shown.

Problem 6 : *An area of 144 sq cm on a map represents an area of 36 sq km on the field. Find the RF of the scale of the map and draw a diagonal scale to show Km, hectometres and decametres and to measure upto 10 km. Indicate on the scale a distance 7 km, 5 hectometres and 6 decemetres.*

Solution : (Fig. 3.8)

1. 144 sq cm represents 36 sq km or 12 cm represent 6 km

$$RF = \frac{12}{6 \times 1000 \times 100} = \frac{1}{50000}$$

Drawing size x = R F x actual size = $\dfrac{10 \times 1000 \times 100}{50000} = 20\,\text{cm}$

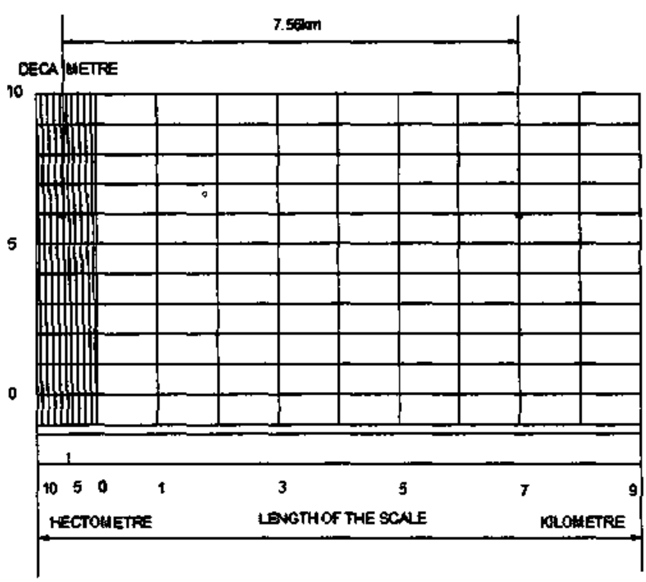


Fig. 3.8

2. Draw a length of 20 cm and divide it into 10 equal parts. Each part represents 1 km.
3. Divide the first part into 10 equal subdivisions. Each secondary division represents 1 hecometre
4. On the diagonal scale portion take 10 eqal divisions so that 1/10 of hectometre = 1 decametre is obtained.
5. Mark on it 7.56 km. as shown.

Problem 7 : *Construct a diagonal scale 1/50, showing metres, decimetres and centimetres, to measure upto 5 metres. Mark a length 4.75 m on it.*

Solution : (Fig 3.9)

1. Obatin the length of the scale as $\frac{1}{50} \times 5 \times 100 = 10\,\text{cm}$
2. Draw a line A B, 10 cm long and divide it into 5 equal parts, each representing 1 m.
3. Divide the first part into 10 equal parts, to represent decimetres.
4. Choosing any convenient length, draw 10 equi-distant parallel lines above AB and complete the rectangle A B C D.
5. Erect perpendiculars to the line A B, through 0, 1, 2, 3 etc., to meet the line C D.
6. Join D to 9, the first sub-division from A on the main scale AB, forming the first diagonal.
7. Draw the remaining diagonals, parallel to the first. Thus, each decimetre is divided into 1/10th division by diagonals.
8. Mark the length 4.75m as shown.

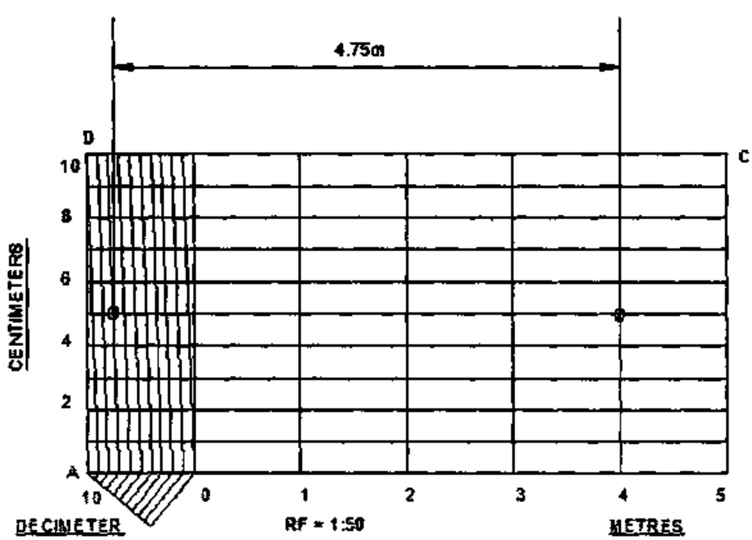


Fig. 3.9

3.4.3 Vernier Scales

The vernier scale is a short auxiliary scale constructed along the plain or main scale, which can read upto two decimal places.

The smallest division on the main scale and vernier scale are 1 msd or 1 vsd repectively. Generally (n+1) or (n-1) divisions on the main scale is divided into **n** equal parts on the vernier scale.

Thus, $1 \text{ vsd} = \frac{(n-1)}{n}\text{msd or}\left(1-\frac{1}{n}\right)\text{msd}$

When 1 vsd < 1 it is called forward or direct vernier. The vernier divisions are numbered in the same direction as those on the main scale.

When 1 vsd > 1 or (1+1/n), It is called backward or retrograde vernier. The vernier divisions are numbered in the opposite direction compared to those on the main scale.

The least count (LC) is the smallest dimension correct to which a measurement can be made with a vernier.

For forward vernier, L C = (1 msd - 1 vsd)

For backward viermier, LC = (1 vsd - 1 msd)

Problem 8 : *Construct a forward reading vernier scale to read distance correct to decametre on a map in which the actual distances are reduced in the ratio of 1 : 40,000. The scale should be long enough to measure upto 6 km. Mark on the scale a length of 3.34 km and 0.59 km.*

Solution : (Fig. 3.10)

1. RF = 1/40000; length of drawing = $\frac{6\times1000\times100}{40000}=15\text{ cm}$
2. 15 cm is divided into 6 parts and each part is 1 km
3. This is further divided into 10 divitions and each division is equal to 0.1 km = 1 hectometre.
   1ms d = 0.1 km = 1 hectometre
   L.C expressed in terms of m s d = (1/10) m s d
   L C is 1 decametre = 1 m s d - 1 v s d
   1 v s d = 1 - 1/10 = 9/10 m s d = 0.09 km
4. 9 m sd are taken and divided into 10 divisions as shown. Thus 1 vsd = 9/10 = 0.09 km
5. Mark on it by taking 6vsd = 6 x 0.9 = 0.54 km, 28msd (27 + 1 on the LHS of 1) = 2.8 km and Total 2.8 + 0.54 = 3.34 km.
6. Mark on it 5 msd = 0.5 km and add to it one vsd = 0.09, total 0.59 km as marked.

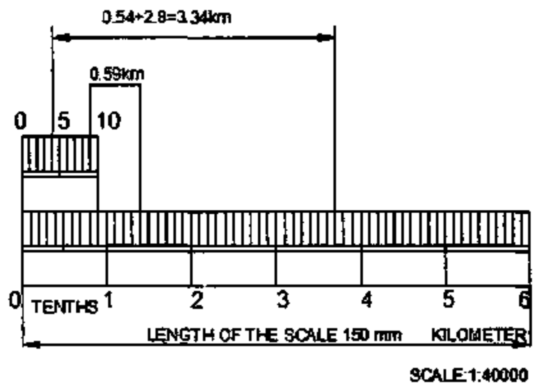


Fig. 3.10 Forward Reading Vernier Scale

Problem 9 : *construct a vernier scale to read metres, decimetres and centimetres and long enough to measure upto 4m. The RF of the scale in 1/20. Mark on it a distance of 2.28 m.*

Solution : **(Fig 3.11)**

Backward or Retrograde Vernier scale

1. The smallest measurement in the scale is cm.

   Therefore LC = 0.01m

2. Length of the scale = RF x Max. Distance to be measured

$$= \frac{1}{20} \times 4\text{m} = \frac{1}{20} \times 400 = 20\,\text{cm}$$

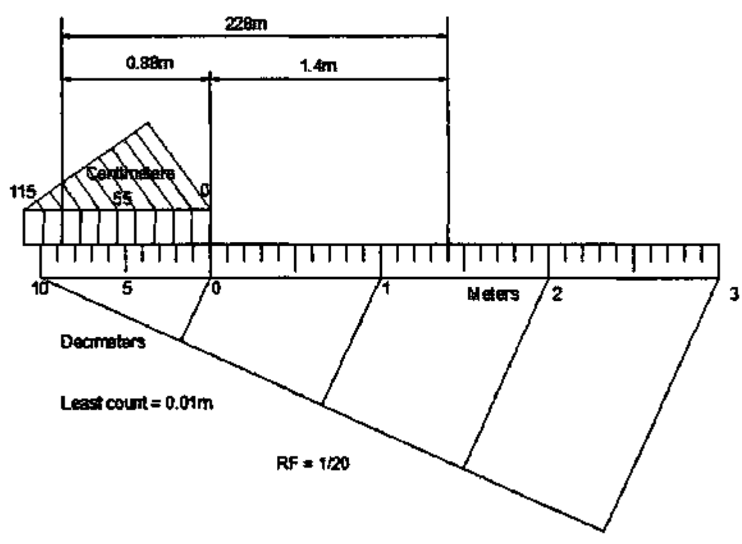


Fig. 3.11 Backward or Retrograde Vernier Scale

3. Draw a line of 20 cm length. Complete the rectangle of 20 cm x 0.5 cm and divide it into 4 equal parts each representing 1 metre. Sub divide all into 10 main scale divisions.

   1 msd = 1m/10 = 1dm.

4. Take 10 + 1 = 11 divisions on the main scale and divide it into 10 equal parts on the vernier scale by geometrical construction.

   Thus 1vsd = 11msd/10 = 1.1dm = 11cm

5. Mark 0, 55, 110 towards the left from 0 (zero) on the vernier scale as shown.

6. Name the units of the divisions as shown.

7. 2.28m = (8 x vsd) + 14msd)
   = (8 x 0.11m) + (14 x 0.1m)
   = 0.88 + 1.4 = 2.28m.

EXERCISES

1. Construct a plain scale of 1:50 to measure a distance of 7 meters. Mark a distance of 3.6 metres on it.
2. The length of a scale with a RF of 2:3 is 20 cm. Construct this scale and mark a distance of 16.5 cm on it.
3. Construct a scale of 2 cm = 1 decimetre to read upto 1 metre and mark on it a length of 0.67 metre.
4. Construct a plain scale of RF = 1:50,000 to show kilometres and hectometres and long enough to measure upto 7 km. Mark a distance of 5:3 kilometres on the scale.
5. On a map, the distance between two places 5 km apart is 10 cm. Construct the scale to read 8 km. What is the RF of the scale?
6. Construct a diagonal scale of RF = 1/50, to read metres, decimetres and centimetres. Mark a distance of 4.35 km on it.
7. Construct a diagonal scale of five times full size, to read accurately upto 0.2 mm and mark a distance of 3.65 cm on it.
8. Construct a diagonal scale to read upto 0.1 mm and mark on it a distance of 1.63 cm and 6.77 cm. Take the scale as 3:1.
9. Draw a diagonal scale of 1 cm = 2.5km and mark on the scale a length of 26.7 km.
10. Construct a diagonal scale to read 2km when its RF=1:20,000. Mark on it a distance of 1:15 km.
11. Draw a venier scale of metres when 1mm represents 25cm and mark on it a length of 24.4 cm and 23.1 mm. What is the RF?
12. The LC of a forward reading vernier scale is 1 cm. Its vernier scale division represents 9 cm. There are 40 msd on the scale. It is drawn to 1:25 scale. Construct the scale and mark on it a distance of 0.91m.
13. 15cm of a vernier scale represents 1cm. Construct a backward reading vernier scale of RF 1:4.8 to show decimetres cm and mm. The scale should be capable of reading upto 12 decimeters. Mark on the scale 2.69 decimetres and 5.57 decimetres.

CHAPTER 4

Geometrical Constructions

4.1 Introduction

Engineering drawing consists of a number of geometrical constructions. A few methods are illustrated here without mathematical proofs.

1. **To divide a straight line into a given number of equal parts say 5.**
   construction (Fig.4.1)

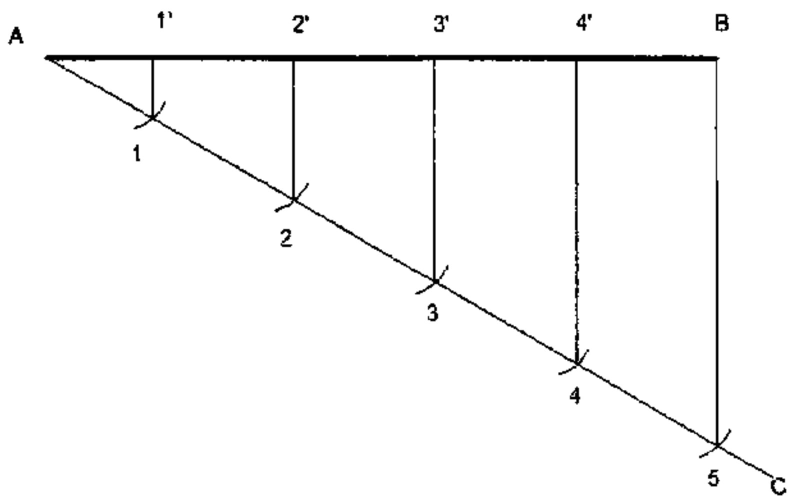


Fig. 4.1 Dividing a line

1. Draw AC at any angle θ to AB.
2. Construct the required number of equal parts of convenient length on AC like 1, 2, 3.
3. Join the last point 5 to B
4. Through 4, 3, 2, 1 draw lines parallel to 5B to intersect AB at $4', 3', 2'$ and $1'$

2. **To divide a line in the ratio 1 : 3 : 4.**
   construction (Fig.4.2)

As the line is to be divided in the ratio 1:3:4 it has to be divided into 8 equal divisions. By following the previous example divide AC into 8 equal parts and obtain P and Q to divide the line AB in the ratio 1:3:4.

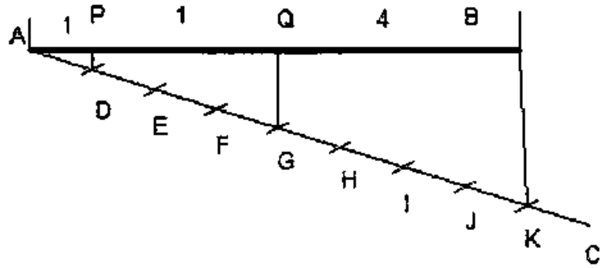


Fig. 4.2

3. **To bisect a given angle.**

   construction (Fig.4.3)

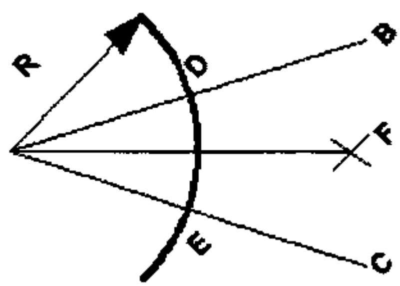


Fig. 4.3

1. Draw a line AB and AC making the given angle.
2. With centre A and any convenient radius R draw an arc intersecting the sides at D and E.
3. With centres D and E and radius larger than half the chord length DE, draw arcs intersecting at F
4. Join AF, <BAF = <FAC.

4. **To inscribe a square in a given circle.**

   construction (Fig. 4.4)

1. With centre O, draw a circle of diameter D.
2. Through the centre O, drwaw two diameters, say AC and BD at right angle to each other.
3. Join A-B, B-C, C- D, and D-A. ABCD is the required square.

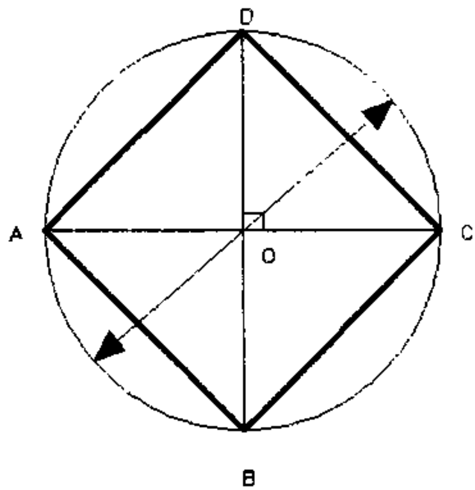


Fig. 4.4

5. To inscribe a regular polygon of any number of sides in a given circle. construction (Fig. 4.5)

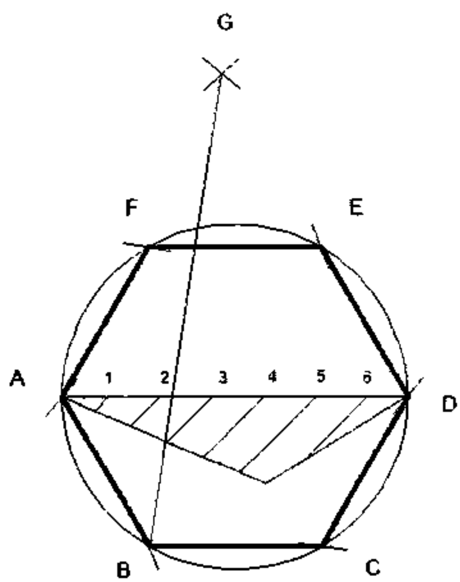


Fig. 4.5

1. Draw the given circle with AD as diameter.
2. Divide the diameter AD into N equal parts say 6.
3. With AD as radius and A and D as centres, draw arcs intersecting each other at G.
4. Join G-2 and extend to intesect the circle at B.

5. Join A-B which is the length of the side of the required polygon.
6. Set the compass to the length AB and strating from B mark off on the circuference of the circles, obtaining the points C, D, etc.

   The figure obtained by joing the points A,B, C etc., is the required polygon.

6. To inscribe a hexagon in a given circle.

(a) Construction (Fig. 4.6) by using a set-square or mini-draughter

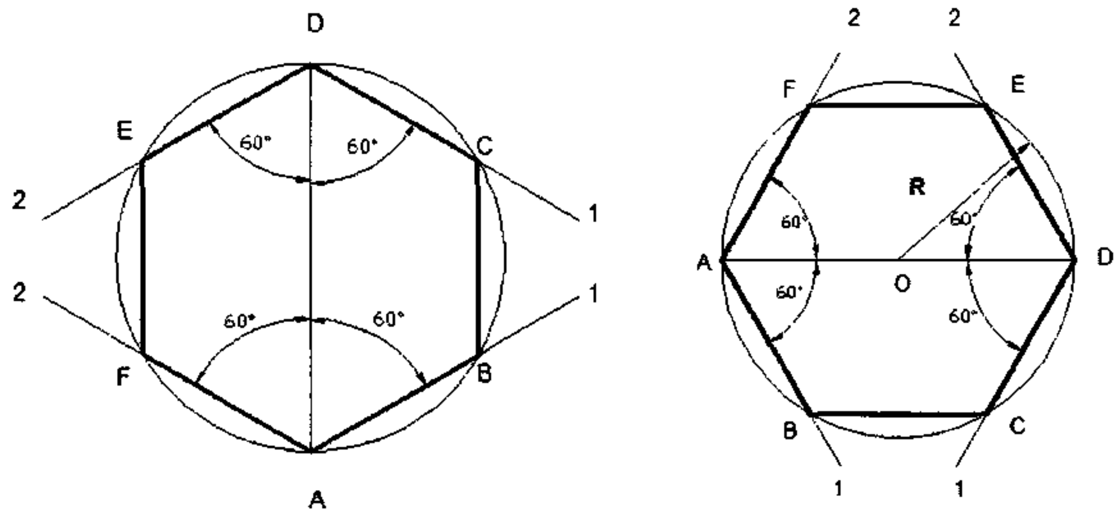


Fig. 4.6

1. With centre O and radius R draw the given crcle.
2. Draw any diameter AD to the circle.
3. Using 30^0 - 60^0 set-square and through the point A draw lines A1, A2 at an angle 60^0 with AD, intesecting the circle at B and F respectively.
4. Using 30^0 - 60^0 and through the point D draw lines D1, D2 at an angle 60^0 with DA, intersecting the circle at C and E respectively.

   By joining A,B,C,D,E,F, and A the required hexagon is obtained.

(b) Construction (Fig.4.7) By using campass

1. With centre O and radius R draw the given circle.
2. Draw any diameter AD to the circle.
3. With centres A and D and radius equal to the radius of the circle draw arcs intesecting the circles at B, F, C and E respectively.
4. A B C D E F is the required hexagon.

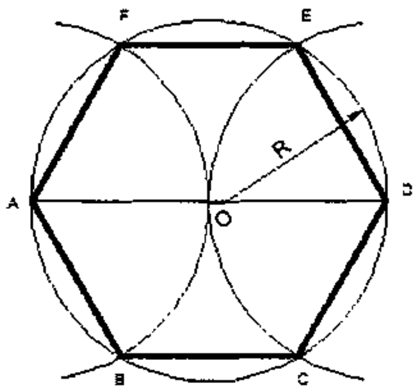


Fig. 4.7

7. To circumscribe a hexagon on a given circle of radius R construction (Fig. 4.8)

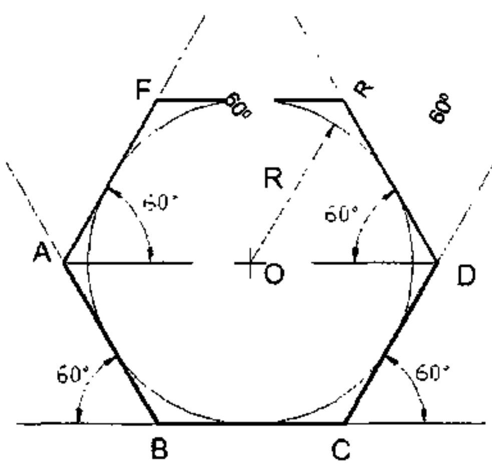


Fig. 4.8

1. With centre O and radius R draw the given circle.
2. Using 60^0 position of the mini draughter or 30^0-60^0set square, circumscribe the hexagon as shown.

8. To construct a hexagon, given the length of the side.

(a) contruction (Fig. 4.9) Using set square

1. Draw a line AB equal to the side of the hexagon.
2. Using 30^0 - 60^0 set-square draw lines A1, A2, and B1, B2.

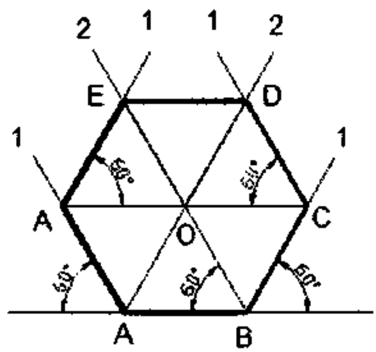


Fig. 4.9

3. Through O, the point of intesection between the lines A2 at D and B2 at E.
4. Join D,E
5. A B C D E F is the required hexagon.

(b) By using compass (Fig.4.10)

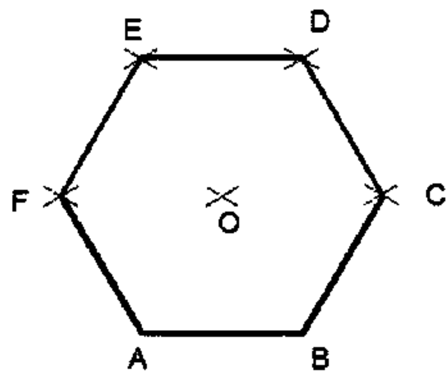


Fig. 4.10

1. Draw a line AB equal to the of side of the hexagon.
2. With centres A and B and radius AB, draw arcs intersecting at O, the centre of the hexagon.
3. With centres O and B and radius OB (=AB) draw arcs intersecting at C.
4. Obtain points D, E and F in a sinilar manner.

9. To construct a regular polygon (say a pentagon) given the length of the side. construction (Fig.4.11)

1. Draw a line AB equal to the side and extend to P such that AB = BP
2. Draw a semicircle on AP and divide it into 5 equal parts by trial and error.

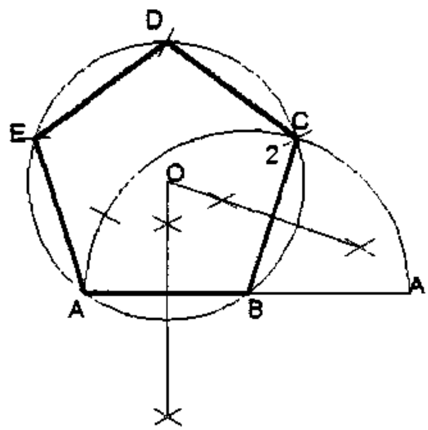


Fig. 4.11

3. Join B to second division
2. Irrespective of the number of sides of the polygon B is always joined to the second division.
4. Draw the perpendicular bisectors of AB and B2 to intersect at O.
5. Draw a circle with O as centre and OB as radius.
6. With AB as radius intersect the circle successively at D and E. Then join CD. DE and EA.

10. To construct a regular polygon (say a hexagon) given the side AB - alternate method.

construction (Fig.4.12)

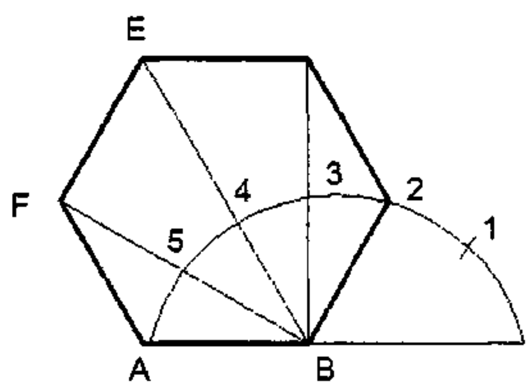


Fig. 4.12

1. Steps 1 to 3 are same as above
2. Join B- 3, B-4, B-5 and produce them.
3. With 2 as centre and radius AB intersect the line B, 3 produced at D. Similarly get the point E and F.
4. Join 2- D, D-E, E-F and F-A to get the required hexagon.