CHAPTER-3

SCALES

What is a scale?

- Drawings of small objects can be drawn on a drawing sheet as the actual size they represent. For example, a paper of size 20cmX 25cm can be shown by a rectangle of size 20cmX25cm on a drawing sheet. Drawings drawn of the same size as the objects are called full-size drawings. The ordinary full size scales are used for the above drawings.
- It is not always possible to draw drawing of an object to its actual size. For instance, drawings of large objects like buildings, large equipments, machines etc. cannot be prepared full size as they would be too large to accommodate on the drawing sheet. Similarly, drawings of small objects like small watches with its parts, small electronic instruments etc. cannot be prepared full size because they would be too small to draw as well as to read.
- *A scale is defined as the ratio of the linear dimensions of element of the object as represented in a drawing to the actual dimensions of the same element of the object.*
- A suitable scale is always chosen to draw the drawings of big as well as small objects in proportionally smaller or larger sizes. Thus, scale can be expressed in the following three ways.
    - Full size scale
    - Reducing scale
    - Increasing scale

Full size scale:

- If actual dimension of an object is shown in the drawing then the scale used is said to be full size scale.
- IT can be represented as 1cm=1cm.

Reducing scale

- If actual dimension of an object is reduced so as to accommodate that object in the drawing to be drawn on the provided drawing sheet, then the scale used is called reducing scale.
- Such scales are used for drawing the large machine parts, buildings, bridges, survey maps, etc.
- Civil Engineers and Architects generally use reducing scale.
- This scale is represented as for example, 1cm=2m. This indicates that the linear dimension of 2m of an actual object is represented by 1cm in the drawing of that object.

Increasing or Enlarging scale

- When the drawings of very small objects are made larger than their actual dimension in the drawing sheet, the scale used is called increasing/enlarging scale.
- Such scales are used for drawing small machine parts, mechanical/electronic instruments, watches, etc.

- Mechanical, Electrical and Electronics Engineers use both reducing as well as enlarging scales as per their requirements.
- This scale is represented as for example, 1cm=2mm. This indicates that the linear dimension of 2mm of an actual object is represented by 1cm in the drawing of that object.

Representative Fraction (R.F.)

- Representative Fraction (R.F.) is the ratio of drawing size of an object to its actual size.
- This is another method of representing scale.
- For reducing scale, the R.F. value is less than unity.
- For enlarging scale, the R.F. value is greater than unity.
- For full size scale, the R.F. value is equal to unity.

Types of scales

- Simple or Plain Scales
- Diagonal Scales
- Vernier Scales

Out of the above three scales Plain Scales and Diagonal Scales are be presented in detail in the following sections.

Plain Scales

- A plain scale is simply a line, which is divided into a suitable number of equal parts.
- The first part is again sub-divided into small parts.
- This is used to represent either two units or a unit and its fraction such as metre and decimeter, kilometre and hectometer, etc.

When a particular scale of our requirement is not available, it becomes necessary to construct a scale.

Construction of Plain Scales

For construction of plain scales following information are required.

- R.F. of scale to be constructed
- Maximum length to be measured
- Divisions to be shown
- If the length of scale and distance to be measured are not mentioned in the problem, then the scale length of 15cm is taken.

Problem 1: *Construct a plain scale to show metres if the R.F is 1:400 and long enough to measure 50metres. Show a distance of 28m on the constructed scale.*

Procedure of Construction of Plain Scale:

- First step is to find out R. F. of the scale to be constructed. In the present problem R.F. is given as 1:400.
- Determination of length of scale(L).

L= R.F x Maximum length to be measured = (1/400)x 50x 100cm =12.5cm

- Draw horizontal line of length 12.5cm (L)
- Then draw a rectangle of size 12.5cm x 0.5cm on the above horizontal line. *Width of scale is usually taken as 5mm*
- As the total length to be measured is 50m, divide the above rectangle into 5 equal divisions, each division representing 10m.
- Mark 0 at the end of first division.
- From 0, number 10, 20, 30 and 40 at the end of each main division as shown in Fig.1.
- Sub-divide the first main division into 10 sub-divisions to represent meters using any of geometrical construction method.
- Number the subdivisions as shown in Fig.1
- Write the names of main unit and sub-unit below the scale with R.F. below the scale as shown.
- Indicate on the scale a distance of 28m (=2 main divisions to the right side of 0 +8 sub-divisions to the left of 0.

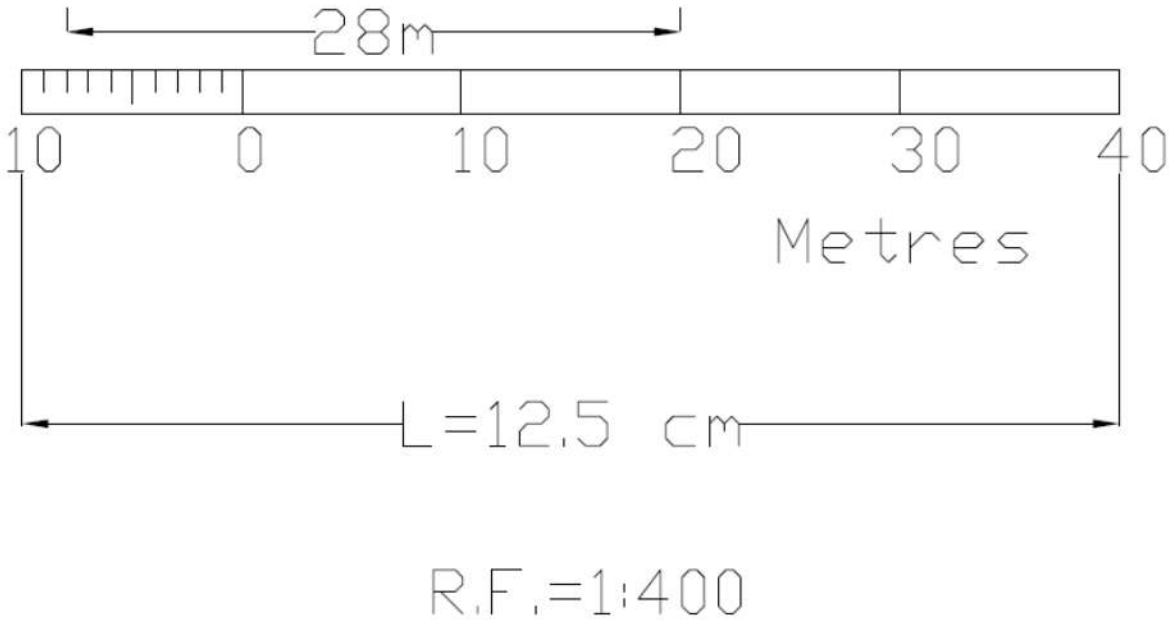


Fig. 1 PLAIN SCALE

Diagonal Scales

Diagonal scales are used to represent either three consecutive units (i.e. m, dcm, cm) or to read to the accuracy correct to two decimals.

Principle of diagonal scale

- It consists of a line divided into required number of equal parts.
- The first part is sub-divided into small parts by diagonals.

- In Fig.2, let AB be the small length (sub-division) to be further divided into 10 equal parts.
- Draw verticals at A and B. Divide AD into 10 equal divisions of any convenient length (say 5cm) and complete the rectangle ABCD.
- Join the diagonal AC. draw horizontal lines through the division points to meet c at 1', 2', 3', …,9'.
- Let consider similar triangle ADC and A66'.

  66'/DC=AB/AD;

  But, A6=(6/10)AD;

  Thus, (66'/DC) =6/10; 66'=(6/10)DC=0.6DC=0.8AB.

  Similarly it can be shown that the horizontal lengths 11', 22', 33' etc. are equal to 0.1AB, 0.2AB, 0.3AB etc. respectively. This principle is used in constructing the diagonal scale.

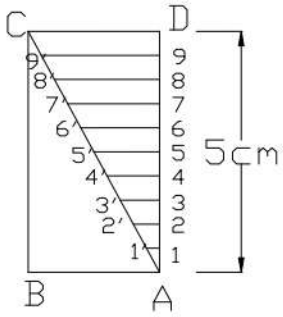


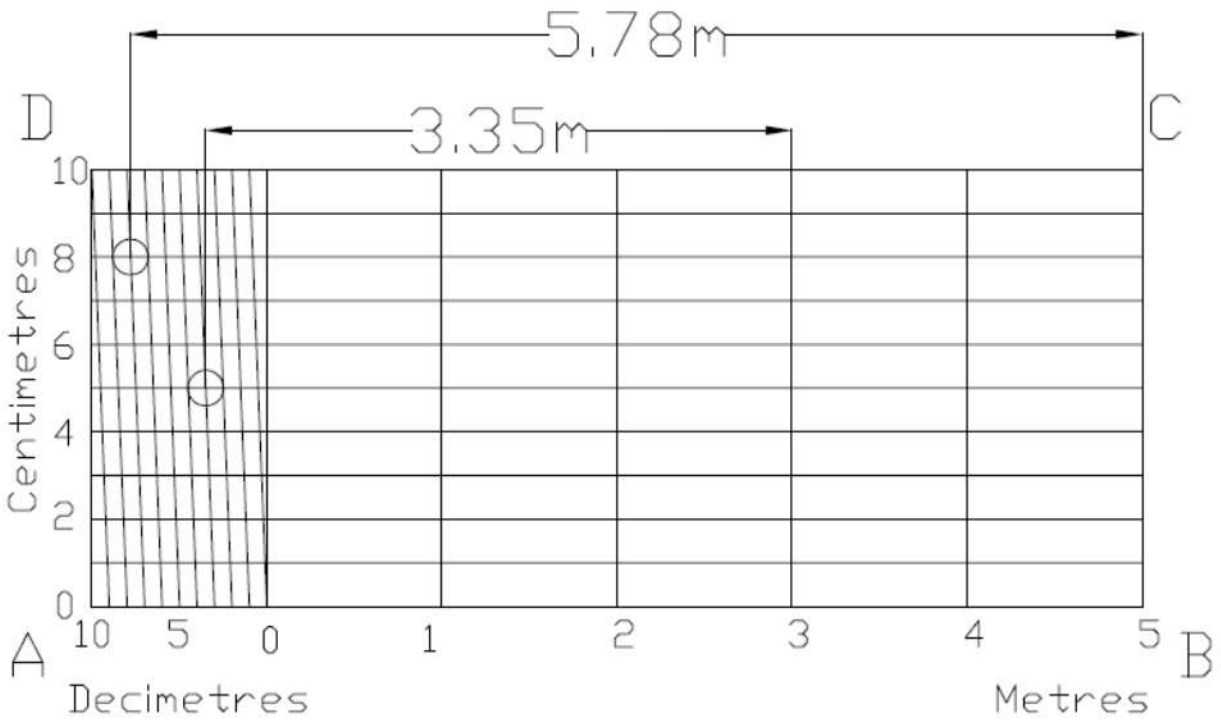
Fig.2

Problem 2: *On a building plan a line 10cm long represents a distance of 5m. Construct a diagonal scale for the plan to read up to 6m, showing metres, decimetres and centimetres. Indicate the lengths 3.35m and 5.78m on the constructed scale.*

Procedure of Construction of Diagonal Scale:

- R.F. = 10cm/5x100cm = 1/50
- Length of scale, L= (1/50)x 6 x 100 cm =12 cm
- Draw a rectangle ABCD of size 12cm x 5cm.
- Max/ min = (6 x100 cm)/1cm =600 =6 x 10 x 10.
- Divide AB into 6 main divisions, each representing 1m. Mark 0, 1, 2, 3, 4, 5 and draw the vertical lines through each point.
- Sub-divide the first main division into 10 equal sub-divisions each representing decimeter. Mark 0 to 10 towards the left of 0.
- Divide AD into 10 equal parts and draw horizontal lines from each division on AD.

- Join D to the first sub-division from A on the main scale AB. Thus, first diagonal is drawn.
- Similarly remaining 9 diagonals parallel to the first diagonal are drawn.
- 3.35m and 5.78m are shown on the constructed diagonal scale (Fig. 3).



R.F. = 1:50

Fig. 3 DIAGONAL SCALE

EXERCISES

1. Construct a plain scale with R.F. of 1: 4 to show centimeters and long enough to measure upto 5 decimetres.
2. Construct a plain scale of R.F. 1:50,000 to show kilometers and hectometers and long enough to measure upto 7 kilometres. Indicate a distance of 56 hectometres on your scale.
3. Construct a diagonal scale of R.F, = 1 : 32,00,000 to show kilometers and long enough to measure upto 400km. Show distances of 238 km and 375km on your scale.
4. Construct a diagonal scale of R. F. 1 : 4000 to show metres and long enough to measure upto 500m. Show a distance of 376m on your scale.

   The area of afield is 50,000 sqm. The length and breadth of the field on the map is 10 cm and 8 cm respectively. Construct a diagonal scale which can read upto one metre. Mark the length of 244m on the scale. What is the R.F. of the scale?