

4.1. INTRODUCTION

Drawing of very big objects cannot be prepared in full size because they would be too big to accommodate on the drawing sheet. Drawing of very small objects also cannot be prepared in full size because they would be too small to draw and to read. Hence a convenient scale is chosen to prepare the drawings of big as well as small objects in proportionately smaller or larger size. So the scales are used to prepare a drawing at a full size, reduced size, or enlarged size.

4.2. REPRESENTATIVE FRACTION

The ratio of the length of an object in the drawing to the actual length of the object is called the **Representative Fraction**. It is denoted by R.F. Thus,

$$\text{R.F.} = \frac{\text{Length of an object in the drawing}}{\text{Actual length of the object}}$$

4.3. CLASSIFICATION OF SCALES

Scales may be divided into the following categories :

1. Plain scale.
2. Diagonal scale.
3. Vernier scale.
4. Comparative scale.
5. Scale of chords.
6. Isometric scale.

4.4. PLAIN SCALE

A plain scale represents either two units or only one unit and its fraction. It consists of a line divided into suitable number of equal parts or unit, the first of which is sub-divided into smaller parts.

In a plain scale,

1. The zero is placed at the end of the first main division, i.e., between the units and its sub-units.
2. From the zero mark, the units are numbered to the right and its sub-division to the left.
3. Units of the divisions and sub-divisions are stated below at the respective ends.
4. R.F. of the scale must be mentioned with it.

5. The length of the scale is obtained by the following formula :

Length of scale = R.F. \times maximum length to be measured by the scale.

6. If the maximum length to be measured by the scale is not given, take the length of the scale near about 15 cm.

4.5. METRIC MEASUREMENTS

1. Liner measurements :

10 millimetres (mm)	= 1 centimetre (cm)
10 centimetre (cm)	= 1 decimetre (dm)
10 decimetres (dm)	= 1 metre (m)
10 metres (m)	= 1 decametre (dam)
10 decametres (dam)	= 1 hectometre (hm)
10 hectometres (hm)	= 1 kilometres (km)

2. Square measurements :

100 square millimetres (mm ²)	= 1 square centimetre (cm ²)
100 square centimetres (cm ²)	= 1 square decimetre (dm ²)
100 square decimetres (dm ²)	= 1 square metre (m ²)
100 square metres (m ²)	= 1 are (a)
100 acres (a) = 1 hectare (ha)	= 10 ⁴ square metres
100 hectares (ha)	= 1 square kilometre (km ²) = 10 ⁶ square metres

metres

3. Cubic measurements :

1000 cubic millimetres (mm ³)	= 1 cubic centimetre (cm ³)
1000 cubic centimetres (cm ³)	= 1 cubic decimetre (dm ³)
1000 cubic decimetres (dm ³)	= 1 cubic metre (m ³)

Problem 4.1. Construct a scale of 1 cm = 1 m to show metres and decimetres and long enough to measure up to 8 metres.

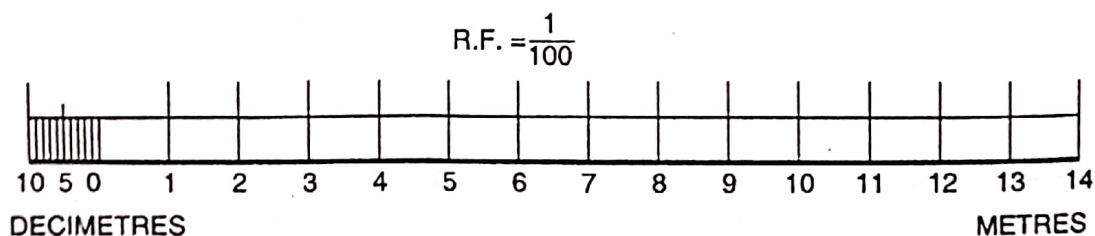


Fig. 4.1.

Solution.
$$\text{R.F.} = \frac{1 \text{ cm}}{1 \text{ m}} = \frac{1 \text{ m}}{100 \text{ cm}} = \frac{1}{100}$$

Length of the scale = R.F. \times max. length to be measured = $\frac{1}{100} \times 8 \text{ m} = 8 \text{ cm}$

Draw a line 8 cm long and divide it into 8 equal parts, each representing 1 m. Divide the first division into 10 equal parts, each representing 1 dm. Complete the scale as shown in the Fig. 4.1.

Problem 4.2. (Fig. 4.2). Construct a scale R.F. = $\frac{1}{50000}$ to read kilometres and hectometres, and long enough to measure up 8 kilometres. Measure a length of 6 km 3 hm on the scale.

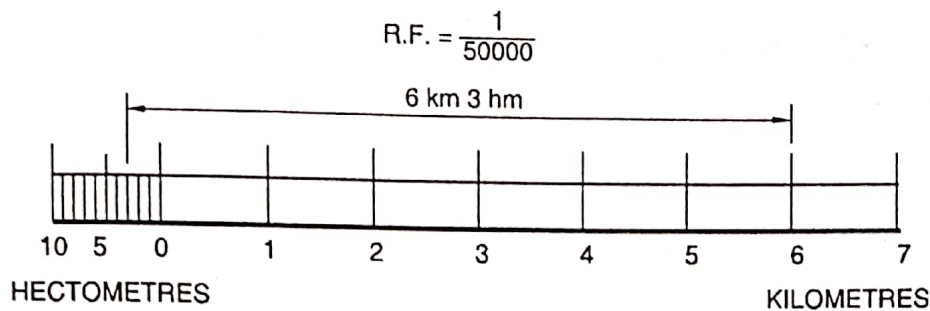


Fig. 4.2.

Solution.

$$R.F. = \frac{1}{50000}$$

$$\text{Length of the scale} = \frac{1}{50000} \times 8 \text{ km} = \frac{1}{50000} \times 8 \times 100000 \text{ cm} = 16 \text{ cm}$$

Draw a line 16 cm long and divide it into 8 equal parts, each representing 1 km. Divide the first division into 10 equal parts, each representing 1 hm. Complete the scale as shown in the figure.

The length of 6 km 3 hm is measured on the scale.

Problem 4.3. (Fig. 4.3). Construct a scale of 1 : 400 to show metres and long enough to measure upto 60 metres. Measure a distance of 44 metres on the scale.

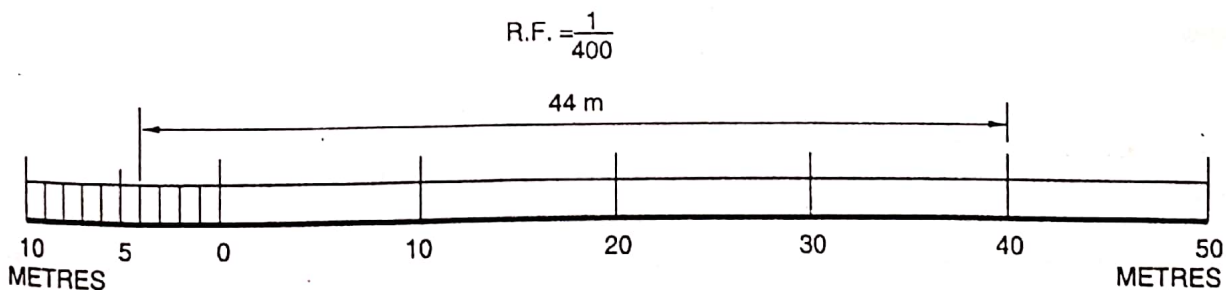


Fig. 4.3.

Solution.

$$R.F. = \frac{1}{400}$$

$$\text{Length of the scale} = R.F. \times \text{Max. length} = \frac{1}{400} \times 60 \text{ m} = \frac{1}{400} \times 60 \times 100 \text{ cm} = 15 \text{ cm}$$

Draw a line 15 cm long and divide it into 6 equal parts, each representing 10 metres. Divide the first division into 10 equal parts, each representing 1 metre. Complete the scale as shown in the Fig. 4.3.

A distance of 44 metres is measured on the scale.

Problem 4.4. Construct a plain scale of $\frac{1}{5000}$ to measure upto 10 hectometres. Measure a distance of 6 hm 5 dam on the scale.

of decimal point. It consists of a line divided into suitable number of equal parts, the first of which is sub-divided into smallest parts by diagonals.

Small division of short lines are obtained by the principle of diagonal division, as shown in Fig. 4.13.

To obtain division of a given short line AB in multiples of $1/10$ its length e.g. $0.1 AB$, $0.2 AB$, $0.3 AB$, $0.6 AB$, etc.

At B , draw a perpendicular BC to AB and step of 10 equal divisions of any convenient length, join AC . Through these division points 1, 2, 3 etc. draw lines $1-1'$, $2-2'$, $3-3'$, etc. parallel to AB .

It is clear that triangles $C-1-1'$, $C-2-2'$, $C-3-3'$, CBA are all similar.

$$\text{Since } C5 = \frac{1}{2}CB, \quad 5-5' = \frac{1}{2}AB = 0.5AB.$$

$$\text{Similarly, } C4 = 0.4CB, \quad 4-4' = 0.4AB$$

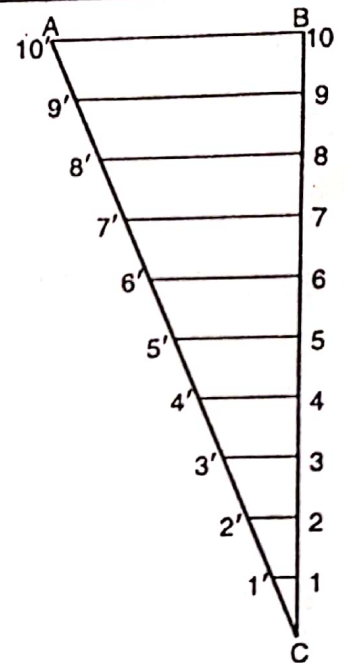


Fig. 4.13.

Thus, each horizontal line becomes progressively shorter in length by $\frac{1}{10} AB$.

Problem 4.13. Construct a diagonal scale of $R.F. = \frac{1}{40000}$ showing km, hm and dam; and long enough to measure upto 5 km. Measure a distance of 3 km 5 hm 3 dam on the scale.

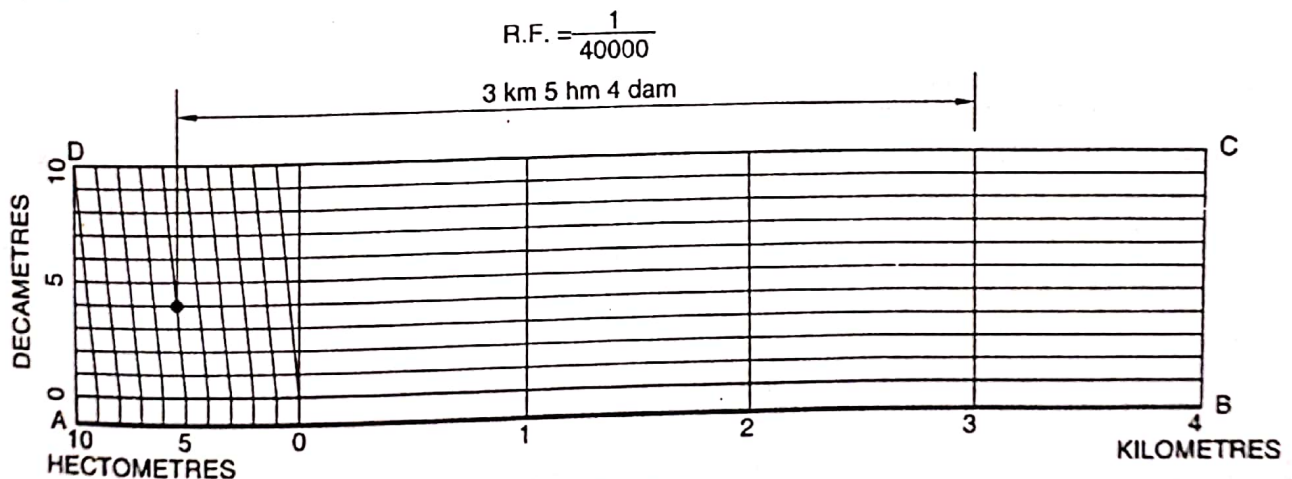


Fig. 4.14.

Solution.

$$R.F. = \frac{1}{40000}$$

$$\text{Length of the scale.} = \frac{1}{40000} \times 5 \text{ km} = \frac{1}{40000} \times 5 \times 100000 \text{ cm} = 12.5 \text{ cm}$$

Draw a line AB 12.5 cm long and divide it into 5 equal parts each representing 1 kilometre. Divide the first division into 10 equal parts each representing 1 hectometre. At A , erect a perpendicular AD of any convenient length and divide it into 10 equal parts, through all of them

draw lines parallel to AB and to meet at BC . Complete the rectangle $ABCD$. Through all the division points of hectometres, draw diagonals as shown in the figure. Thus, each hectometre is divided into 10 equal parts by the diagonals. Complete the scale as shown in the figure.

The distance of 3 km 5 hm 3 dam is measured on the scale.

Problem 4.14. Construct a diagonal scale of $R.F. = \frac{1}{5000}$ to show metres and long enough to measure upto 500 metres.

$$R.F. = \frac{1}{5000}$$

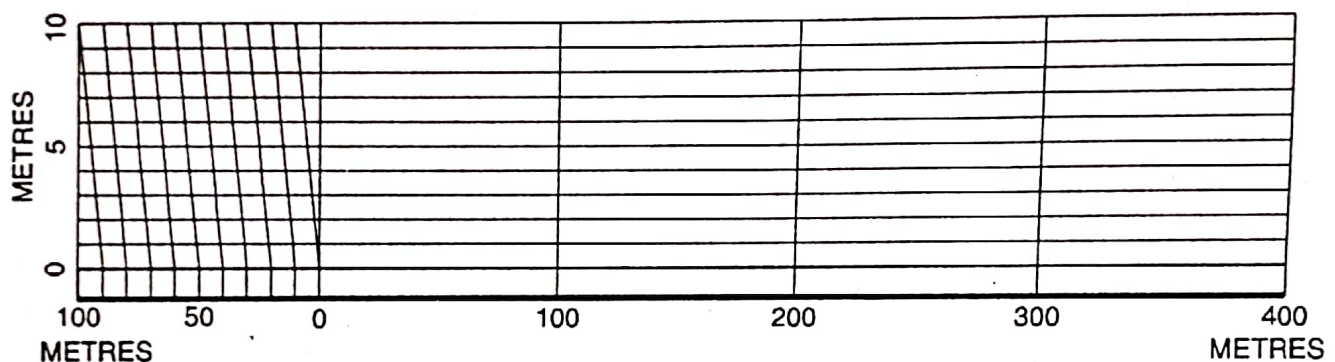


Fig. 4.15.

Solution.

$$R.F. = \frac{1}{5000}$$

$$\text{Length of the scale} = \frac{1}{5000} \times 500 \times 100 \text{ cm} = 10 \text{ cm}$$

Draw a line 10 cm long and divide it into 5 equal parts each representing 100 metres. Divide the first division into 10 equal parts each representing 10 metres. Each of them divide into 10 equal parts by diagonals each representing 1 metre. Complete the scale as shown in the Fig. 4.15.

Problem 4.15. Construct a diagonal scale of 1 : 500 to show metres and decimetres, and long enough to measure upto 80 metres. Measure a distance of 54.5 metres.

$$R.F. = \frac{1}{500}$$

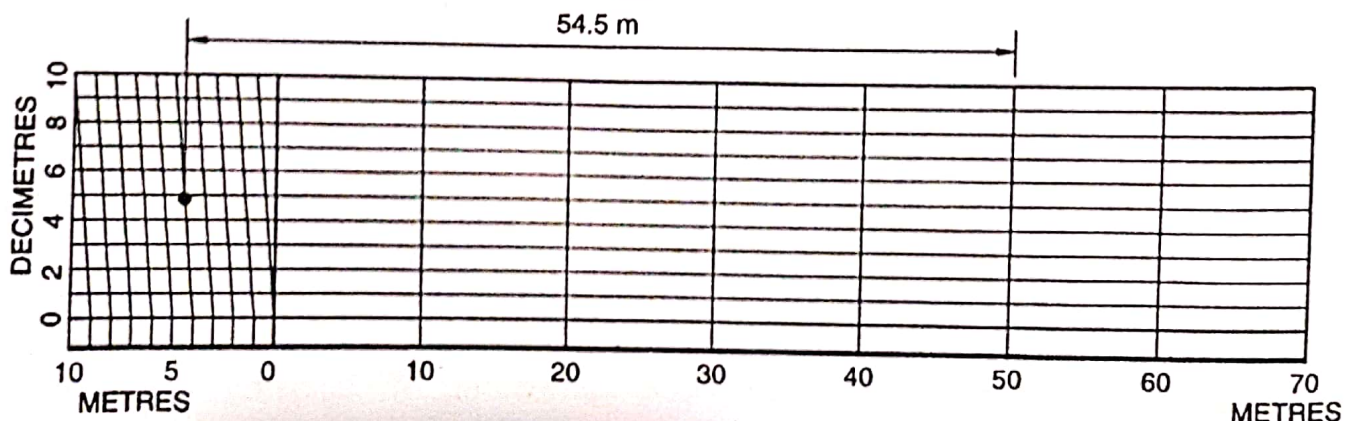


Fig. 4.16.

Solution. $R.F. = \frac{1}{500}$

$$\text{Length of the scale} = \frac{1}{500} \times 80 \text{ m} = \frac{1}{500} \times 80 \times 100 \text{ cm} = 16 \text{ cm}$$

Draw a line 16 cm long and divide it into 8 equal parts each representing 10 m. Divide the first into 10 equal parts each representing 1 m. Divide these parts by diagonals into 10 equal parts each representing 1 decimetre. Complete the scale as shown in Fig. 4.16.

Problem 4.16. Construct a diagonal scale of $R.F. = \frac{1}{50}$ to read metres, decimetres and centimetres, and long enough to measure upto 9 metres. Show a distance of 6 m 5 dm 4 cm on the scale.

Solution. $R.F. = \frac{1}{50}$

$$\text{Length of the scale} = \frac{1}{50} \times 9 \text{ m} = \frac{1}{50} \times 9 \times 100 \text{ cm} = 18 \text{ cm}$$

Draw a line 18 cm long. Divide it into 9 equal parts each representing a metre. Divide the first part into 10 equal parts each representing a decimetre. Further divide each part on diagonals into 10 equal parts each representing centimetre. Complete the scale as shown in Fig. 4.17. Measure a distance of 6 m 5 dm 4 cm on the scale.

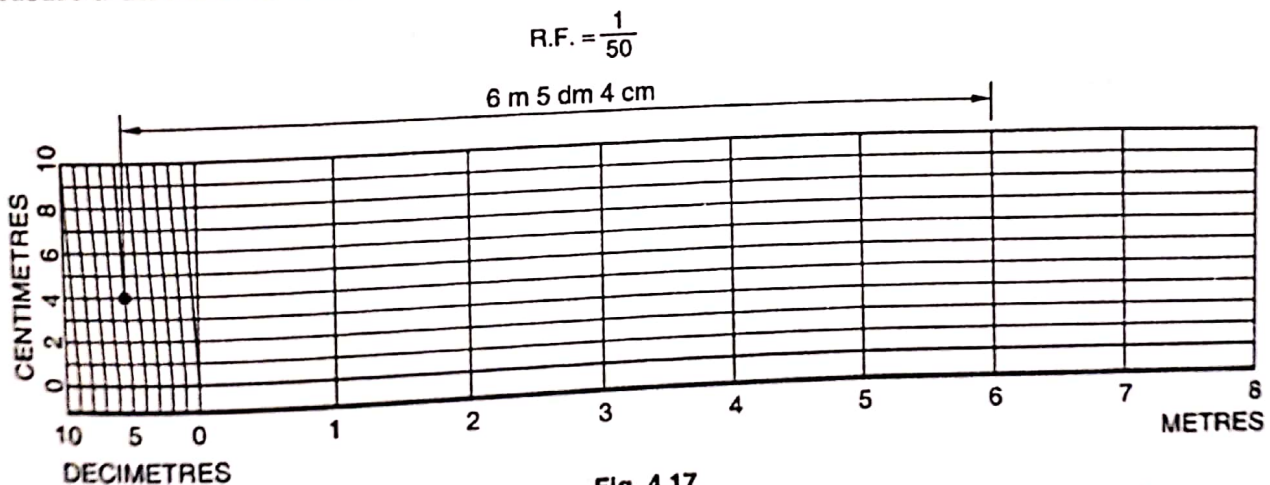


Fig. 4.17.

Problem 4.17. (Fig. 4.18). Construct a diagonal scale to show centimetre, decimetres and metres, and long enough to measure upto 9 metres. Measure a distance of 6 m 5 dm 4 cm on the

scale. $R.F. = \frac{1}{100}$

Solution. Length of the scale = $R.F. \times \text{max. length to be measured.}$

$$= \frac{1}{100} \times 9 \text{ m} = \frac{1}{100} \times 9 \times 100 \text{ cm} = 9 \text{ cm}$$

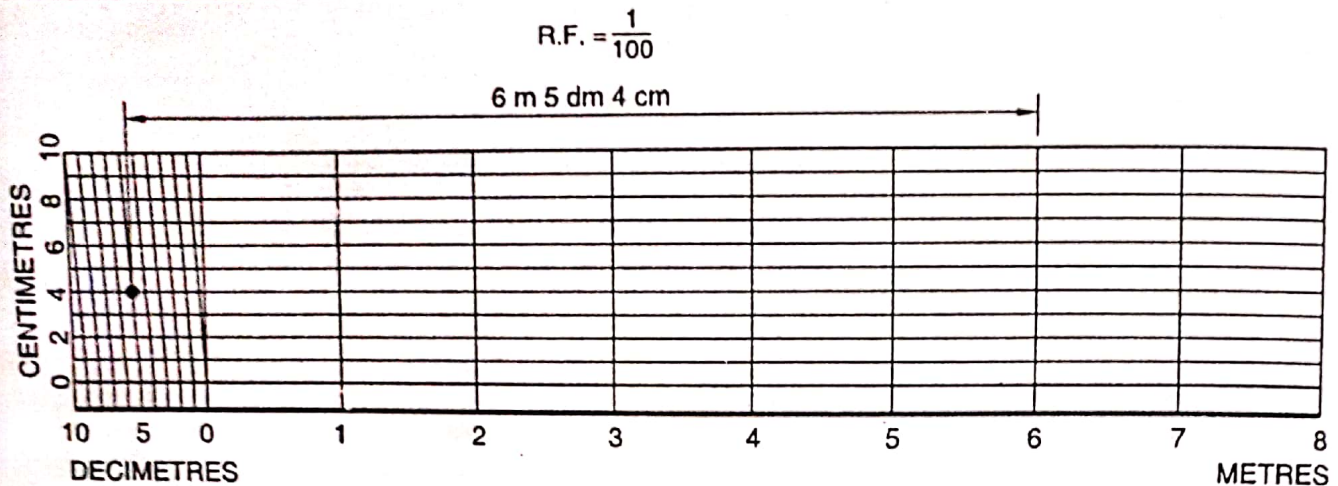


Fig. 4.18.

Draw a line 9 cm long and divide it into 9 equal parts each representing 1 metre. Divide the first part into 10 equal parts each representing 1 decimetre. Divide each decimetre into 10 centimetres by diagonals. Complete the scale as shown in the Fig. 4.18.

The distance of 6 m 5 dm 4 cm is measured on the scale.

Problem 4.18. The distance between two stations is 500 km. It is represented on railway map by 10 cm. Construct a diagonal scale to measure kilometres. Measure a distance of 215 km on the map.

Solution.
$$R.F. = \frac{10 \text{ cm}}{500 \text{ km}} = \frac{10 \text{ cm}}{500000 \text{ m}} = \frac{10 \text{ cm}}{50000000 \text{ cm}} = \frac{1}{5000000}$$

Take length of the scale as 10 cm to represent 500 km. Draw a line 10 cm long, divide it into 5 equal parts each representing 100 km. Divide the first part into 10 equal parts each representing 10 km. Divide these parts into 10 equal parts by diagonals to represent single km. Complete the scale as shown in the Fig. 4.19.

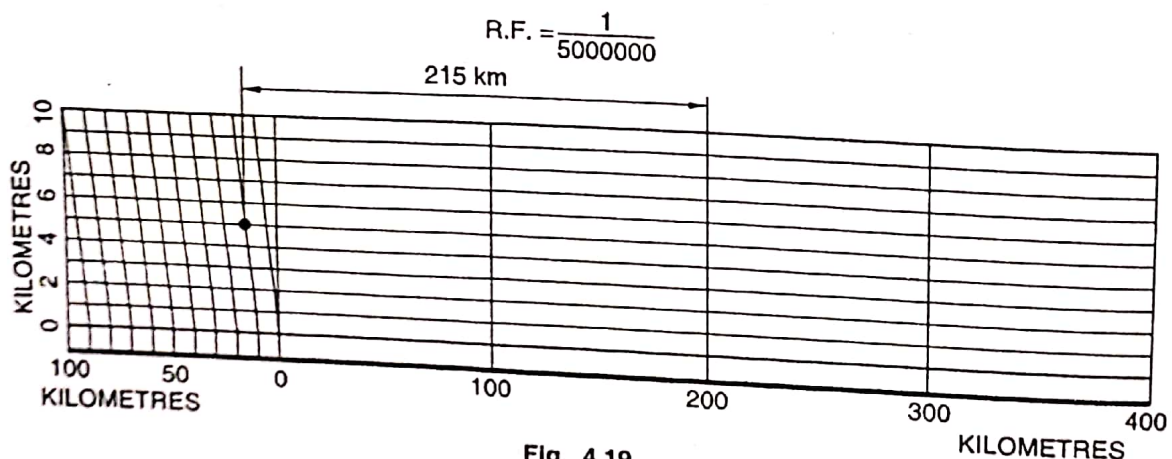


Fig. 4.19.

The distance of 215 km is measured on the scale.

Problem 4.19. (Fig. 4.20). Construct a diagonal scale to read kilometres having spaces of 150 kilometres and long enough to read upto 900 kilometres. $R.F. = \frac{1}{5000000}$. Measure distance of 515 km on the scale.