CHAPTER 2

# Map Scales

## SCALE

THE size of a map is very small as compared with the size of the earth it represents. Before pr a map of the earth or a part of it we decide how much ground distance should be represent map distance, *i.e.*, we establish a relation between map distance and ground distance. The relation b the map distance and the ground distance is called a scale and it is *defined* as a proportion between a c on the map and the corresponding distance on the ground. Thus, if a length between two points on t is 1 cm. and the distance between the same two points on the ground is 5 km, the scale of the m cm. to 5 km; and if the scale of a map is 1 cm. to 5 km. it means that a distance of 1 cm. betwe points on a map represents a distance of 5 km. between the same two points on the ground.

Scale is appended to every map generally at its southern margin in three ways.

## METHODS OF EXPRESSING A SCALE

A scale is expressed in three ways. It is (a) stated in words; (b) expressed as a fraction; (c) as a line divided into certain parts.

(a) When stated in words it is called *statement of scale*. Evidently it is the simplest way of exp a scale and is expressed as

1 cm to 2.5 km, 2 cm to 1 km, 1 inch to 4 miles.

Map distances are represented by a centimetre, centimetres, an inch or inches and the ground dis by a kilometre or kilometres, a mile or miles. It may be noted that either map distance or ground d is represented by unity. It is very easy to calculate ground distances with the help of a statement of As for example, a distance of 6 cm. on a map on the scale of 1 cm. to 2.5 km, represents a dista 15 km. on the ground. Its main drawbacks are :

(i) The fractional distances involve mathematical calculations.

(ii) Since different countries have different units of length in use, the statement of scale m be understood by the foreigners.

(b) When expressed as a fraction, the scale is called *representative fraction* (R.F.). In some cou it is also called a *numerical scale*.

The scale is represented by a vulgar fraction $\left(\text{as for example, } \frac{1}{100{,}000}\right)$ the numera which is always unity. The numerator indicates the length on the map and the denominator indica length on the ground.

$$\text{R.F.} = \frac{\text{Distance between two points on the map}}{\text{Distance between the same two points on the ground}}$$

It should be borne in mind that the numerator and the denominator are in the same measure of length (denomination). Thus if the representative fraction of a map is $\frac{1}{63360}$, it means that one unit of length on the map represents 63,360 units of length (in the same denomination in which the numerator represents the map distance) on the ground. If the numerator *i.e.* the distance on the map, in this case is 1 inch, the denominator *i.e.* the distance on the ground will be 63,360 inches or one mile.

The ground distances are measured in kilometres, miles, metres, etc., and not in centimetres or inches. As the denominator is to be converted into kilometres or miles, evidently this method of expressing a scale involves calculations as well. However, it has a great advantage in that, it can be interpreted in different units of length very easily. When a scale of a map is appended as 1/100,000, it will mean a distance of 1 cm. on the map represents 100,000 cm. or 1 kilometre on the ground. It will also mean that if the distance between two objects on the map is 1 inch, the distance between the same two objects on the ground is 100,000 inches or 1.578 miles.

The representative fraction when printed in fractional form such as $\frac{1}{50,000}$, occupies much space. It is, therefore, adjusted in a line by using a small type. These figures are often so small as to make it difficult to read the fraction. In view of this difficulty, the R.F. is printed in books as 1/50,000 or 1 : 50,000.

## CONVERSION OF THE STATEMENT OF SCALE INTO R.F.

As already stated a centimetre or centimetres of a statement of scale represent map distance and a kilometre or kilometres ground distance. Now

$$\text{R.F.} = \frac{\text{Map distance}}{\text{Ground distance}}$$

To convert a statement of scale into R.F., take the distance on the map as numerator and the distance on the ground after converting it into centimetres or inches as the case may be as denominator and change the fraction so formed to a fraction whose numerator is unity.

***Example*.** Find out the R.F. of a map which is drawn to the scale of 2 cm to 1 km.

$$\text{R.F.} = \frac{\text{Map distance}}{\text{Ground distance}}$$

Now 2 cm. on the map represent 1 km or 100,000 cm on the ground.

$$\therefore \quad \text{R.F.} = \frac{2}{100,000} \quad \text{or} \quad \frac{1}{50,000} \quad \text{or} \quad 1:50,000$$

## CONVERSION OF R.F. INTO THE STATEMENT OF SCALE

Now $$\text{R.F.} = \frac{\text{Map distance}}{\text{Ground distance}}$$

Both the map distance and the ground distance are in inches or centimetres. Since ground distance is

1 Yard = 36 inch
1 Furlong = 220 yard
1 mile = 8 Furlong
1m = 100 cm
1Km = 1000m
1Km = 100000 cm
1 yard = 3 feet



is either in kilometres or miles, the denominator is changed into kilometres or miles.

***Example 1.*** The R.F. of a map is 1: 10,560. What is the statement of scale?

1 inch on the map represents 10,560 inches or $\frac{10,560}{63,360}$ mile or $\frac{1}{6}$ mile on

In other words 6 inches on the map represent 1 mile on the ground. Therefore, t
of scale is 6 inches to a mile.

***Example 2.*** Distance between two points on a map is 1.25 cm. The distance between the sam on the ground is 2.50 km. Find out the R.F. and the statement of scale.

(i) $\text{R.F.} = \frac{\text{Map distance}}{\text{Ground distance}}$

Now 1.25 cm. on the map represent 2.50 km. or 250,000 cm. on the

$\therefore$ $\text{R.F.} = \frac{1.25}{250,000}$ or $\frac{1}{200,000}$ or 1 : 200,000.

(ii) 1.25 cm on the map represent 2.50 km on the ground or 1 cm on the ma 2.50÷1.25 or 2 km on the ground.

$\therefore$ Statement of scale is 1 cm to 2 km.

(c) When shown as a line the scale is called a *plain scale, graphic scale* or *linear sca*

A plain scale is a graduated straight line showing ground distances in kilometres, metres Ground distances can readily be found out from a plain scale and thus mathematical calcula avoided. Therefore, every map has a plain scale.

Sometimes we reduce or enlarge maps photographically. When we do so, the plain scale reduced or enlarged in the same proportion in which the map is reduced or enlarged. In the reduction and enlargement, the statement of the scale and representative fraction will not change on some maps in the atlases the plain scale without the statement of scale and representative appended.

***Use of scale.*** Map scale is the basis of drawing maps. It enables us to represent correctly of the ground on a map of a convenient size. The distances between various objects on the map to those on the ground. We can also calculate ground distances and ground areas from the m help of its scale.

***Large and small scales.*** To determine which one of any two scales is large or small, we i them into representative fractions. Then the sizes of the two representative fractions are com fraction which is greater in value is called a large scale and the other as a small scale. To explain one R.F. is $\frac{1}{500}$ and the other R.F. is $\frac{1}{1,000}$

Now $\frac{1}{500} = 0.002$

and $\frac{1}{1000} = 0.001$

Thus among these two fractions, the fraction $\frac{1}{500}$ is greater in value than the fractio

In other words the R.F. $\frac{1}{500}$ is larger than the R.F. $\frac{1}{1000}$ Exactly speaking the scale $\frac{1}{500}$ is twice as large as the scale $\frac{1}{1000}$.

*Categories of scale.* The words 'large', 'medium' and 'small' are frequently placed before scales to qualify them. Thus, a scale may be termed as a large-scale, medium-scale or a small-scale. Every country has its own way of categorising the scales and no definite system is followed for differentiating one category from the other. With the adoption of metric system of measurements, the 'Survey of India' has started publishing maps on the scales of 1 : 25,000, 1 : 50,000, 1 : 250,000, 1 : 1000,000, etc. It may be helpful to categorise the scales as under :

| | |
|---|---|
| Large-scale | 1 : 50,000 and larger |
| Medium-scale | 1 : 50,000 to 1 : 250,000 |
| Small-scale | Smaller than 1 : 250,000 |

A map drawn on a large-scale is known as a large-scale map and the one drawn on a medium-scale is known as a medium-scale map and that drawn on a small-scale is known as a small-scale map.

*Relation between scale and area.* If we have two maps of the same size but on different scales, the one on a smaller scale represents more ground area than the one on a larger scale. Thus, a map on the scale of 1 : 250,000 will represent more ground area than the map on the scale of 1 : 50,000. For example, the ground area shown on the map on the scale of 1 : 250,000 is 25 times as large as that shown on the map on the scale of 1 : 50,000.

Thus, if the scale is enlarged, less ground area is represented. If the scale is enlarged two times of the original scale, the area represented is one-fourth, if enlarged 3 times the area represented is one-ninth, if enlarged 4 times the area represented is one-sixteenth of the area represented by the original map of the same dimensions.

Similarly if the scale is reduced, more ground area is represented on the map of reduced scale but of similar dimensions. If the scale is reduced to one-half of the original scale, the area represented will be 4 times, if reduced to one-third, the area will be 9 times, if reduced to one-fourth the area represented will be 16 times of the area represented by the original map.

*Deduction of scales.* We need to deduce scale when scale is either not given on the map or the scale given on a foreign map shows distances in the units unknown to us.

(i) *From degrees or minutes of latitudes.* Length of 1° latitude is 111 km or 69 miles on the ground. Measure the length of 1° latitude along a straight meridian in the central part of the map. Suppose the length of 1° latitude on the map is 3 cm,

Now 3 cm. on the map represent 111 km or 11,100,000 cm on the ground. Therefore, R. F. of the map $= \frac{3}{11,100,000}$ or $\frac{1}{3,700,000}$

(ii) *By comparing map distance with ground distance.* Select two objects which are given on the map and also on the ground taking care that the distance on the ground is easily measurable and the ground is almost level. Measure the distance between the objects on the map as well as on the ground.

If the distance on the map is 1.5 cm and that on the ground is 450 metres

$$\text{R.F.} = \frac{1.5}{450 \times 100} \text{ or } \frac{1.5}{45,000} \text{ or } \frac{1}{30,000}$$

with AB. With the help of a pair of dividers, mark off five points a, b, c, d, and e at equal distances. Join e and B and draw lines parallel to eB and passing through the points d, c, b and a as shown in Fig. 2. The line AB is thus divided into 5 equal parts. Next divide the first division on the left hand side into 5 equal parts as shown in the Fig. 2 for marking the secondary divisions.

## EXAMPLES OF PLAIN SCALE

*Example 1.* Construct a graphic scale for a map drawn to the scale of 1 cm to 2 km.

***Solution.*** The usual length of a scale-line is about 15 cm. According to the problem

1 cm. on the map represents 2 km on the ground.

∴ 15 cm. on the map represent 15 × 2 or 30 km. on the ground.

Now 30 is a convenient round number in itself because it can be divided into quite a large number of equal parts (6) each of which represents ground distance by a whole number (5).

So draw a line 15 cm. long and divide it into 6 equal parts. Each part of the scale-line represents $\frac{30}{6}$ or 5 km. Divide the division on the left-hand side into 5 equal parts to read single kilometres as shown in Fig. 3.

*Example 2.* Construct a plain scale for a map drawn to the scale of 1" to 2.4 miles.

***Solution.*** We generally draw a scale-line of about 6" length.

Now 1" on the map represents 2.4 miles on the ground.

∴ 6" on the map represent 6 × 2.4 or 14.4 miles on the ground.

Now 14.4 is not divisible into such a number of equal parts each of which represents ground distance by a whole number. So we select 15 as a whole number.

15 is a convenient whole number because it is near to figure 14.4 and it can also be divided into 5 equal parts, each part representing $\frac{15}{5}$ or 3 miles (a whole number).

Now calculate the length of the scale-line which represents 15 miles.

14.4 miles are represented by 6" on the map.

∴ 15 miles are represented by $\frac{6}{14.4}$ × 15 or 6.25" on the map.

Draw a line 6.25" long and divide it into 5 equal parts. Divide the division on the left-hand side into 3 equal parts to read single miles (Fig. 4).


Fig. 4

*Example 3.* Draw a graphic scale for a map the R.F. of which is 1 : 17,000.

*Solution.* The usual length of a scale-line is about 6 inches.

According to the problem, 1" on the map represents 17,000" on the ground.

$\therefore$ 6" on the map represent $6 \times \frac{17000}{36}$ yards or 2833.33 yards on the ground.

It is evident that 2833.33 is not divisible into such a number of equal parts each of which gives ground distance by a whole number. So we select 3000 as a round number.

3000 is a convenient round number because it is near to the figure of 2833.33 and at the same time it can be divided into 6 equal parts, each part representing 500 yards.

Now 2833.33 yards on the ground are represented by 6" on the map.

$\therefore$ 3000 yards on the ground are represented by $\frac{6 \times 3000}{2833.33}$ inches or 6.35" on the map.

Draw a line 6.35 inches long and divide it into 6 equal parts. Divide the division on the left hand side into 5 equal parts to read 100 yards (Fig. 5).

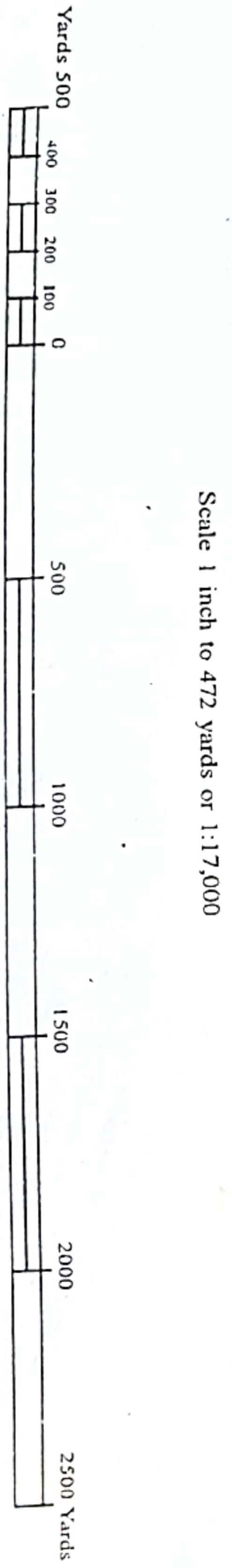

Fig. 5

## SPECIAL FORMS OF PLAIN SCALE

There are numerous forms of plain scale. We shall construct only the following special forms of plain scale.

(i) Comparative scale, (ii) Time scale, (iii) Scale of revolutions, (iv) Diagonal scale.

*(i) Comparative scale.* To avoid the botheration of converting one unit of measurement into another such as miles into kilometres or miles into yards, kilometres into metres, metres into yards, etc., two graphic scales on the same scale but one scale-line showing one unit of measurement and the other scale-line the other unit of measurement are placed side by side in such a way that 'zero' of one scale-line lies immediately above that of the other scale-line.

*Example 1.* Draw a comparative scale showing kilometres and miles for a map, the R.F. of which is 1 : 250,000.

*Solution.* The usual length of a scale-line is 15 cm. or 6 inches.

(a) 1 cm. on the map represents 250,000 cm. or 2.5 km. on the ground.

$\therefore$ 15 cm. on the map represent 2.5 × 15 or 37.5 km. on the ground.

It is evident that 37.5 is not divisible into such a number of equal parts each of which represents ground distance by a whole number. So we select 35 as our whole number because it is close to the figure 37.5 and is also divisible into 7 equal parts, each part of which represents 5 km.

Now 37.5 km. on the ground are represented by 15 cm. on the map.

$\therefore$ 35 km. on the ground are represented by $\frac{15}{37.5} \times 35$ or 14 cm. on the map.

(b) 1" on the map represents 250,000" or 3.946 miles on the ground.

$\therefore$ 6" on the map represent 3.946 × 6 or 23.676 miles on the ground.

We select 25 as our whole number because it is close to the figure 23.676 and is also divisible into 5 equal parts, each part of which represents 5 miles.

Now 23.676 miles on the ground are represented by 6" on the map.

$\therefore$ 25 miles on the ground are represented by $\frac{6 \times 25}{23.676}$ or 6.335" on the map.

First draw a line 14 cm. long to represent 35 km. and divide it into 7 equal parts. Divide the division on the left hand side into 5 equal parts to read single kilometres. This scale shows distances in kilometres (Fig. 6).

To show distances in miles, draw a line parallel to and very close to the scale-line showing kilometres. Produce the perpendicular tick at '0' downwards to cross the scale-line showing the ground distances in miles and mark another '0' on the lower end of the perpendicular.

The scale-line showing miles is 6.335"* long and if divided into 5 equal parts, the length of each part will be equal to $\frac{6.335}{5}$ or 1.267".

On the scale-line showing miles, let the length to the left of '0' be equal to one part i.e. 1.267" and to the right of it the remainder i.e. 6.335—1.267 or 5.068". Divide the part to the right of '0' i.e. 5.068" long part into 4 equal parts and complete the scale as shown in Fig. 6.

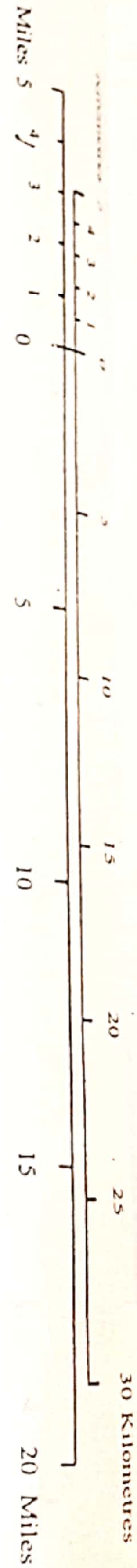


Fig. 6

* With an ordinary ruler, it is not possible to draw lines showing lengths accurately up to the third place of decimal. Therefore, students may draw lines showing lengths up to the second place of decimal only.

*Example 2.* If 250 paces are equal to 210 yards and are represented by 0.75 inch on a map, construct a comparative scale to show yards and paces.

*Solution.* The usual length of a scale-line is about 6".

(a) 0.75" on the map represents 250 paces on the ground.

$\therefore$ 6" on the map represent $\frac{250 \times 6}{0.75}$ or 2000 paces on the ground.

Now 2000 is a convenient round number.

(b) 0.75" on the map represent 210 yards on the ground.

$\therefore$ 6" on the map represent $\frac{210 \times 6}{0.75}$ or 1680 yards on the ground.

Now 1680 is not a convenient number, So we select 1500 as a round number.

Calculate the length of the scale-line which will represent 1500 yards.

1680 yards on the ground are represented by 6" on the map.

1500 yards on the ground are represented by $\frac{6 \times 1500}{1680}$ or 5.357" on the map.

First draw a line 6" long to represent 2000 paces and divide the line into 4 equal parts. Divide the division on the left-hand side into 5 equal parts to read hundreds of paces. This scale-line will show distance in paces (Fig. 7).

To show distance in yards draw a line parallel and very close to the scale-line showing paces. Produce the perpendicular tick at '0' downwards to cross the scale-line showing the ground distance in yards and mark another '0' on the lower end of the perpendicular. The scale-line showing yards is 5.357" long and if divided into 5 equal parts, the length of each part will be equal to $\frac{5.357}{5}$ or 1.071". On the scale-line showing yards, let the length to the left of '0' be equal to one part i.e. 1.071" and to the right of it the remainder i.e. 5.357—1.071 or 4.286". Divide the part to the right of '0' i.e. 4.286" long part into 4 equal parts and complete the scale as shown in Fig. 7.

(ii) *Time scale.* It is composed of two plain scales one showing the ground distance and the other showing time. We can know directly from this scale the time spent in covering a certain distance. This scale is particularly useful for aeroplanes, seagoing ships and army marching over short or long routes.

*Example 1.* The scale of a map is 1 inch to 4 miles. Construct a time scale for a motor lorry travelling at 15 miles per hour.

Scale 1 inch to 280 yards or 1 : 10,080

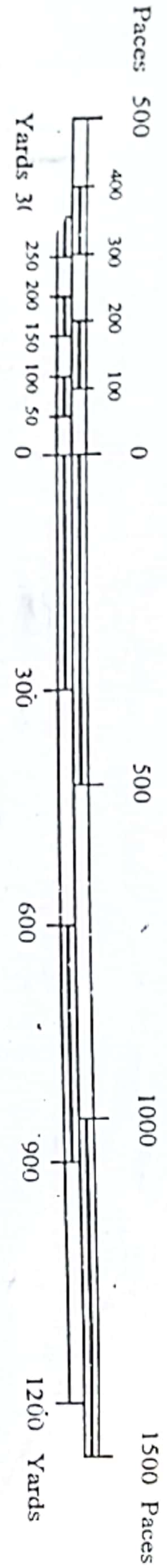


Fig. 7

***Solution.*** The usual length of a scale-line is 6 inches.

1" on the map represent 4 miles on the ground.

∴ 6" on the map represents 4 × 6 or 24 miles on the ground.

Convenient whole number is 25.

Now 24 miles on the ground are represented by 6" on the map.

∴ 25 miles on the ground are represented by $\frac{6 \times 25}{24}$ or 6.25" on the map.

15 miles are travelled in one hour or 60 minutes.

∴ 25 miles are travelled in $\frac{60 \times 25}{15}$ or 100 minutes.

Now 25 miles are represented by 6.25" and are covered in 100 minutes. Draw a line 6.25" long and divide it into 5 equal parts. Each part represents 5 miles or 20 minutes (Fig. 8).

***Note.*** The scale-line showing distance and the one showing time should as far as possible be of the same length. Further the scale-line showing distance and the one showing time should as far as possible have the same number of divisions.

***Example 2.*** A motorist travelling at a speed of 80 km. an hour covers a certain distance in 11 minutes. The distance when measured on the map is found to be 10 cm. long. Draw a time scale and find the R.F.

***Solution.*** The usual length of the scale-line is 15 cm.

A motorist covers in 60 minutes a distance of 80 km.

∴ the motorist covers in 11 minutes a distance of $\frac{80}{60}$ × 11 or 14.666 km.

Now a distance covered in 11 minutes is represented by a 10 cm. long line on the map.

Thus 10 cm. on the map represent 14.666 km. on the ground.

∴ 15 cm. on the map represent 14.666 × $\frac{15}{10}$ or 21.999 km. on the ground.

20 km. is a convenient round number because it is close to 21.999 km. and it is also covered in $\frac{60}{80}$ × 20 or 15 minutes which again is a convenient whole number.

Now 21.999 km. are represented by 15 cm.

∴ 20 km. are represented by $\frac{15 \times 20}{21.999}$ or 13.637 cm.

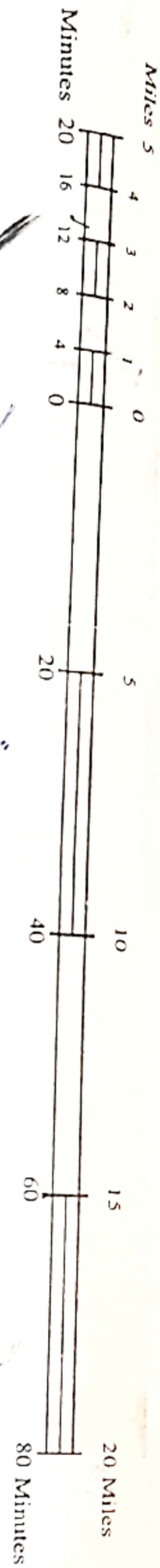


Fig. 8

20 km. are represented by 13.637 cm. and are covered in 15 minutes. Draw a line 13.637 cm. long and divide it into 5 equal parts. Each part represents 4 km. and 3 minutes (Fig. 9).

10 cm. on the map represent 14.666 km or 1,466,600 cm. on the ground.

$$\therefore \text{R.F.} = \frac{\text{Map distance}}{\text{Ground distance}}$$

$$= \frac{10}{1466600} \text{ or } \frac{1}{146,660}$$

(iii) ***Scale of Revolutions.*** We can measure distances on the ground with a wheel whose radius is known. A wheel rolling over the ground will cover a distance equal to its circumference after completing one revolution. The circumference of a wheel is equal to $2\pi r$ where r is the radius of the wheel. This is a quick but a rough method of measuring distances on the ground. Scale of revolutions is thus a scale composed of two graphic scales, one showing the ground distance and the other showing the number of revolutions.

***Example.*** The radius of a wheel of bicycle is 38.5 cm. and the R.F. of the map is 1:20,000. Construct a scale of revolutions for the cyclist.

***Solution.*** Radius of the wheel = 38.5 cm.

∴ circumference of the wheel = $2\pi r$ where r is the radius of the wheel

$$= 2 \times \frac{22}{7} \times 38.5 \text{ cm}$$

= 242 cm.

Thus the distance covered by one revolution of the wheel = 242 cm.

According to the scale of the map

1 cm. on the map represents 20,000 cm. on the ground.

∴ 15 cm. on the map represent $\frac{20,000 \times 15}{242}$ revolutions or $1239\frac{81}{121}$ revolutions.

Now 1000 revolutions is a convenient round number.

1 revolution = 242 cm.

∴ 1000 revolutions = 1000 × 242 cm.

$$= \frac{1000 \times 242}{100} \text{ or } 2420 \text{ metres}$$

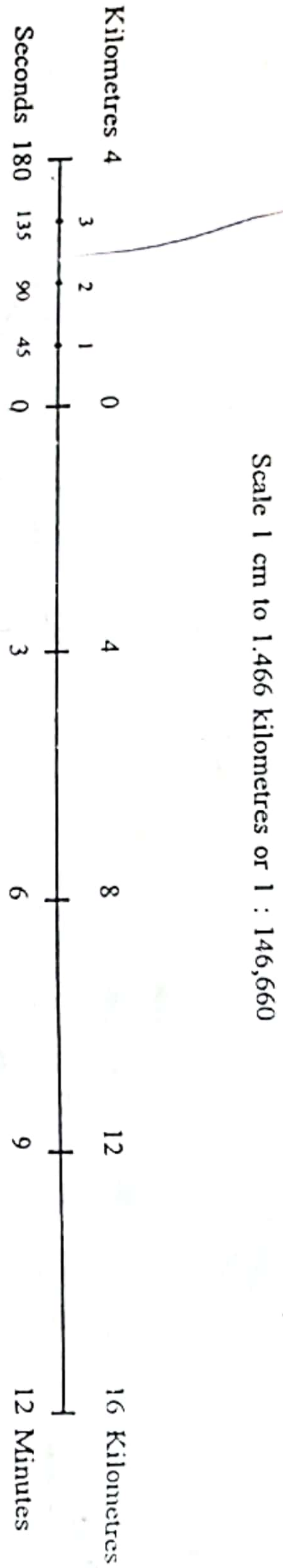


Fig. 9

Now $\frac{20,000 \times 15}{242}$ revolutions are represented by 15 cm.

$\therefore$ 1000 revolutions are represented by $\frac{15 \times 242}{20000 \times 15} \times 1000$ cm. or 12.1 cm.

A line 12.1 cm. long represents 1000 revolutions as well as a ground distance of 2420 metres. Draw a line 12.1 cm. long and divide it into 4 equal parts. Each part will represent 250 revolutions and 605 metres. Divide the division on the left hand side into 5 equal parts. Each part of these divisions will represent 50 revolutions and 121 metres (Fig. 10).

*Note.* It can be seen that 2420 metres is not a very convenient round number. It would also be correct if we draw two scale-lines separately one representing revolutions and the other representing metres. 2000 metres is a convenient round number. Now find out the length of the scale-line representing 2000 metres.

2420 metres are represented by a line of 12.1 cm. length.

2000 metres are represented by a line of $\frac{12.1 \times 2000}{2420}$ or 10 cm.

Now draw a line 12.1 cm. long to represent 1000 revolutions. Divide this line into 4. equal parts. Each part will show 250 revolutions. Divide the division on the left-hand side into 5 equal parts, each part representing 50 revolutions.

To show the distances in metres, draw a line parallel and close to the scale-line showing revolutions. Produce the perpendicular tick at '0' downwards to cross the scale-line showing metres and mark another '0' on the lower end of the perpendicular. The scale-line showing metres is 10 cm. long and if divided into 4 equal parts, the length of each part will be equal to 2.5 cm. Let the length to the left of '0' on the scale-line showing metres be 2.5 cm. and to the right of it the remainder 7.5 cm. Divide the part to the right side of '0' into 3 equal parts and complete the scale as shown in Fig. 11.

*(iv)* ***Diagonal scale.*** It is a plain scale the secondary divisions of which are further divided into smaller parts diagonally for measuring very small distances correctly. For example, distance up to a hundredth part (i.e. up to second place of decimal) of a mile when each primary division indicates one mile, can be measured accurately from a diagonal scale. This scale is constructed primarily for maps drawn to large-scales.

***Example 1.*** Construct a diagonal scale for a map drawn on the scale of 1 : 50,000 to read ground distance correctly up to 20 metres.

***Solution.*** The usual length of a scale-line is 15 cm.

1 cm. on the map represents 50,000 cm. or 1/2 km. on the ground.

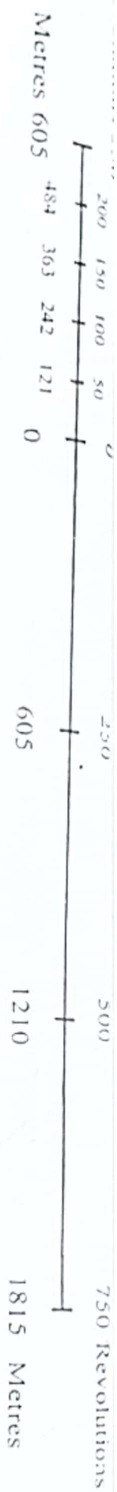


Fig. 10

∴ 15 cm. on the map represent ½ × 15 or 7.5 km. on the ground.

7 is a convenient whole number.

Now 7.5 km. on the ground are represented by 15 cm. on the map.

∴ 7 km. on the ground are represented by $\frac{15 \times 7}{7.5}$ or 14 cm. on the map.

Draw a line 14 cm. long and divide it into 7 equal parts. Each division represents 1 km. Divide the division on the left hand side into 5 equal parts so that each division represents 200 metres. To read distances correctly up to 20 metres, divide each secondary division into further 10 equal parts diagonally as illustrated in Fig. 12.

Erect perpendicular DA at A. Let its height be a little more than the length of A0. Erect also perpendicular CB at B. Let its height be equal to the height of DA. Join DC. Divide AD into 10 equal parts i.e. in the same number of equal parts in which each secondary division is to be further divided diagonally. Draw lines parallel to AB and passing through the points of divisions of AD. Draw perpendiculars at the figures showing 0, 1, 2, 3, 4 and 5 km. Each of these perpendiculars is equal to DA. Divide DE into 5 equal parts i.e., in the same number of equal parts into which A0 is divided. Join a0, ba′, cb′, dc′ and Dd′.

*Note 1.* If it is required to read distances correctly up to 25 metres, divide A0 into four equal parts so that each part represents 250 metres and AD into 10 equal parts and if it is required to read distances correctly up to 10 metres, divide A0 into 10 equal parts and AD also into 10 equal parts.

*Note 2.* It is not necessary that A0ED be a square. AD should be longer than A0 in the cases when A0 is very short in length and when AD is to be divided into several equal parts. By doing so we can avoid the jumbling up of the parallel lines passing through the points of division of AD. When aa′ are joined with a straight line, aa′0E becomes a rectangle and a0 its diagonal.

Map distance LM indicates a ground distance of 3 km. and 560 metres.

## GEOMETRY OF THE DIAGONAL SCALE

To understand the geometry of the diagonal scale join a with a′ (Fig. 13), and reproduce the rectangle aa′0E (of Fig. 12).

Now a0 is the diagonal of this rectangle.

Consider the triangle aa′0.

We draw 10 lines parallel to a′0 at equal distances.

Now consider the line LH.

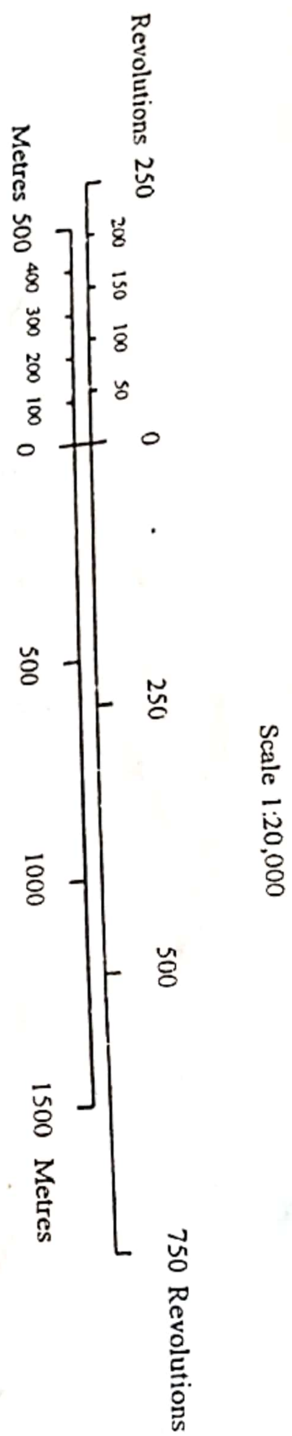


Fig. 11

aa'0 and aLH are similar triangles

$$\therefore \frac{aL}{aa'} = \frac{LH}{a'0}$$

$$\text{But } aL = \frac{1}{10} aa'$$

$$\therefore \frac{aL}{aa'} = \frac{1}{10}$$

$$\text{Now } \frac{aL}{aa'} = \frac{LH}{a'0} = \frac{1}{10}$$

$$\text{or } \frac{LH}{a'0} = \frac{1}{10}$$

$$\therefore LH = \frac{1}{10} \times a'0$$

Thus LH is = $\frac{1}{10}$ of a'0 or $\frac{1}{10}$ × 200 or 20 metres.

(Not to Scale)

Fig. 13

Similarly PQ is $\frac{2}{10}$ of a'0 or $\frac{2}{10}$ ×200 or 40 metres and so on.

Similarly in the triangle a0E, RS is $\frac{1}{10}$ of aE or $\frac{1}{10}$ ×200 or 20 metres, XY is $\frac{2}{10}$ of aE

or $\frac{2}{10}$ ×200 or 40 metres and so on.

***Example 2.*** Draw a diagonal scale for a map drawn to the scale of 1 : 63,360 to read distance up to a hundredth part of a mile.

***Solution.*** The usual length of a scale-line is 6".

1" on the map represents 63,360" or 1 mile on the ground.

∴ 6" on the map represent 1×6 or 6 miles on the ground.

Draw a line 6" long and divide it into six equal parts. Divide the division on the left-hand side into 10 equal parts to read distances up to one-tenth of a mile. To read up to one-hundredth part of a mile divide each secondary division into further 10 equal parts diagonally as illustrated in Fig. 14.

Divide DE into the same number of equal parts into which AO has been divided. Also divide AD into the same number of equal part (10) into which each secondary division is to be further divided. LM represents 2.47 miles.

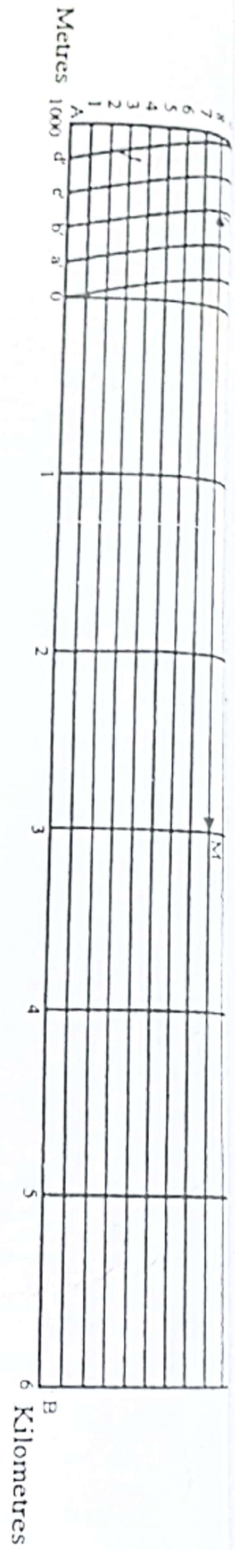

Fig. 12

*Example* 3. Draw a diagonal scale for a map drawn to the scale of 1 inch to 1 yard to read the ground distance correctly up to inches.

***Solution.*** The usual length of a scale-line is 6".

1" on the map represents 1 yard on the ground.

∴ 6" on the map represent 1×6 or 6 yards on the ground.

Draw a line 6 inches long and divide it into six equal parts. Divide the division on the left hand side into 3 equal parts to read distances in feet. To read distances correctly up to inches construct the diagonal scale as shown in Fig. 15.

AD is divided into 12 equal parts because each of the secondary divisions when divided into 12 equal parts, will enable us to read distance in inches. DE has been divided into 3 equal parts because A0 has also been divided into 3 equal parts.

The distance represented by the length LM is 3 yards, 1 foot and 8 inches.

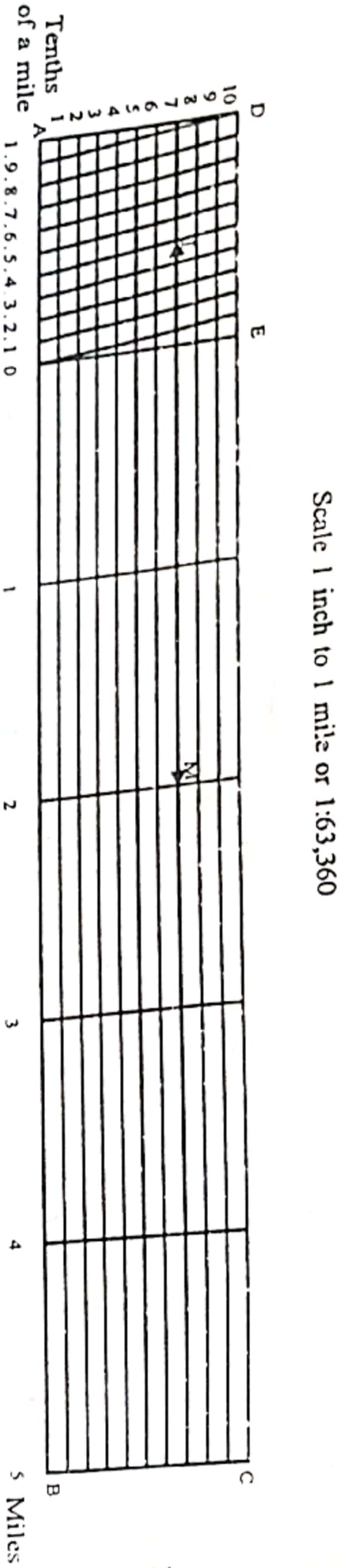


Fig. 14