Unit-I: Part-5: Scales (Plain scales, Diagonal scales and Vernier scales)

Theory Questions

1. What is meant by Representative Fraction (RF) for a scale?
A: It is the ratio of the length of the drawing on the chart to the actual length of the object.

For lengths, RF = Length of drawing / actual length.

For areas, RF = $\sqrt{\dfrac{Area\ of\ the\ drawing}{Actual\ Area}}$

For volumes, RF = $\sqrt[3]{\dfrac{Volume\ of\ the\ drawing}{Actual\ Volume}}$

2. In a scale, if RF < 1, it is _____ scale (reducing scale)
3. In a scale, if RF = 1, it is called as _____ scale (full scale)
4. In a scale, if RF > 1, it is called as _____ scale (Enlarging scale).
5.   Match the following :
       1) Reduction scale   a) 1 : 1
       2) Full scale   b) 100 : 1
       3) Enlargement scale   c) 1 : 100   (Ans: 1-c;2-a;3-b)
6. When dimensions are to be measured in 3 units, _____ scale is used. (Vernier and diagonal scales may be used)
7. Explain the principle of diagonal scale. (refer to text book Art 4.3.(ii), use similar triangles concept)
8. Explain the principle of vernier scale. (refer to solutions or Art 4.3.(iv) from textbook)
9. What are the differences between
   (i) plain scales and vernier scales (ii) a plain scale and diagonal scale.
   (iii) Diagonal scale and vernier scale?   (refer to solutions)

10. A room of 1728 m³ volume is shown by a cube of 216 cm³ volume. Find its RF
A: RF = $\sqrt[3]{\dfrac{Volume\ of\ the\ drawing}{Actual\ Volume}} = \sqrt[3]{\dfrac{216\ cm^3}{1728\ m^3}} = \dfrac{1\ cm}{2\ m} = \dfrac{1}{200}$

11. An area of 144 sq.cm on a map represents an area of 36 sq.km on the field. Find the RF.
A. For areas, RF = $\sqrt{\dfrac{Area\ of\ the\ drawing}{Actual\ Area}} = \sqrt{\dfrac{144\ cm^2}{36 km^2}} = \dfrac{4\ cm}{1\ km} = \dfrac{1}{50000}$

12. A 3.2 cm long line represents a length of 4 meters. What is its RF? (ans: 3.2/400= 1/125)
13. Construct a plain scale to show meters & decimeters, when 3 cms are equal to 2 meters & long enough to measure up to 5 meters.
A: RF = 3cm/2 m = 3/200; ML = 5 m; Length of Scale = (3/200)* 5*100 = 7.5 cm.
(As it is asked under short answers, in the OU exam, this may be drawn with free hand to save time.)
14. What is the difference between forward vernier and backward vernier?
A. In forward vernier, the vernier scale is marked length of 9mm and this 9 mm is divided into 10 parts so that each vernier division will read 0.9 mm. (as VSD =(10-1)/10). Hence all the VSD readings will be multiples of 9. i.e. 9, 18, 27, 36,..90.

Backward Vernier

In backward vernier, the vernier scale is marked length of 11 mm and this 11 mm is divided into 10 equal parts so that each vernier division will read 1.1 mm. Hence all the VSD readings will be multiples of 11.i.e. 11,22,33,44,...110.
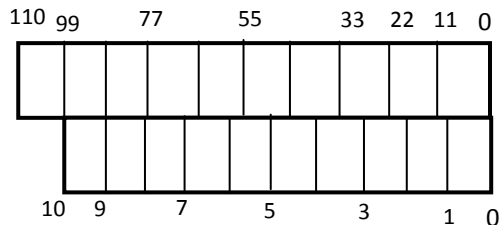
Backward Vernier   *Forward Vernier*
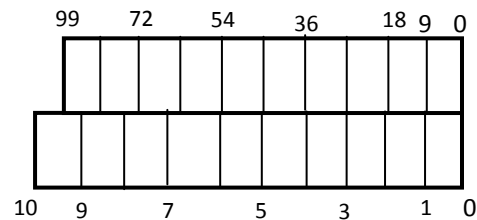
Problems
I. Plain Scales

15. Construct a scale of 1:5 to show decimeters and centimeters and to read up to 1 meter. Show the length of 7.6 dm on it. (Refer Solutions)

16. Construct a scale of 1.5cm = 1 dm to read up to 1 meter. Show on it a length of 0.6m. (Refer Solutions)

17. Draw a scale of 1:50 showing meters & decimeters & to measure up to 8 meters. Show the length of 5.4 m on it. (Refer solutions)

18. A 3.2 cm long line represents a length of 4 meters. Extend this line to measure lengths up to 25 meters and show on it units of <u>meter</u> and <u>5 meters</u>. Show the length of 17 meters on this line. (Refer solutions)

19. Construct a plain scale of 1 cm = 0.5 km to read kilometers and hectameters and long enough to measure up to 8 kilometers. Find its RF and measure a distance of 6 km and 4 hectameters on this scale.
(RF = (1/0.5*100,000) = 1/50,000; ML = 8 km; LOS = RF x ML = 16 cm; 8 divisions)

20. Construct a plain scale to show meters & decimeters, when 3 cms are equal to 2 meters & long enough to measure up to 5 meters.
(hint: RF = 3 cm/ 2 m = 3/200; LOS = (3/200) *5*100 = 7.5 cm;
Divide 7.5 cm into 5 parts)

21. A room of 1728 m³ volume is shown by a cube of 216 cm³ volume. Find the RF and construct a plain scale to measure up to 42 m. Mark a distance of 22m on this scale. (Refer Solutions)

22. The distance between Hyderabad and Nizamabad is 180 km. A passenger train covers this distance in 6 hours. Construct a plain scale to measure time up to a single minute. The RF of this scale is 1/200000. Indicate on this scale the distance covered by the train in 34 minutes. (Refer comparative scales Prob No 4.15 in text book).

II. Diagonal Scales

23. Draw a diagonal scale of RF = 3/100, showing meters, decimeters & centimeters & to measure up to 5 meters. Show the length of 3.69 meters on it.

24. Construct a diagonal scale of RF = 1/6250 to read up to 1 kilometer and to read meters on it. Show a length of 653 meters on it. Hint: Use 1km= 1000m = 10x100m; 10 parts division, each of 100m and sub scale also 10 parts of each 10m)

25. On a building plan, a line 20 cm long represents a distance of 10 m. Device a diagonal scale for the plan to read up to 12 m, showing meters, decimeters and centimeters. Show on your scale the lengths 6.48 m & 11.14 m.

26. Construct a diagonal scale of RF = 1x 10^{-3} to show meters and long enough to measure up to 100 m. Indicate points 66.6 m on it.
   (RF = (1/1000)* 100m *100 = 10 cm; 100m = 10 x 10m; Hence, No. of divisions = 10; Labelling is 0,10m, 20m, 30m, ...90 m on main scale and 0,1m, 2m, 3m,.etc on sub scale)

27. On a map, the distance between two points is 14 cm. The real distance between them is 20 km. Draw a diagonal scale of this map to read kilometers and hectameters & to measure up to 25 km. Show a distance of 17.6 km on this scale.
   (Hint: use 25m= 5 x 5m; 5 parts of division, each of 5m and sub units also into 5 parts)

28. 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 for this map and draw a diagonal scale to show kilometers, hectameters and decameters and to measure up to 10 kilometers. Indicate on the scale a distance of 7 kilometers, 5 hectameters and 6 decameters.

29. On a building plan, 10 cm long line represents a distance of 5m. Construct a diagonal scale for the plan to read upto 6m, showing meters, decimeter, and centimeter. Indicate on your scale the length of 4.76m, 5.57m and 3.24m.

30. Construct a diagonal scale to measure 800 m. Use suitable RF. Show 605 m & 783 m on it. (hint: 800m = 8 x 100m; 8 divisions of each 100 m; sub scale into 10 parts of 10 m)

III: Vernier Scales

31. Construct a scale of R.F = 1/ (2.5) to show decimeters & centimeters and by a vernier to read millimeters, to measure up to 4 decimeters. Show on it lengths 2.34 dm, 1.42 dm & 0.38 dm.

32. A 10 m distance in the field is represented by a line of 20 cm on a building plan. Construct a vernier scale for the plan to read up to 5m. Show on it the lengths of 2.09 m and 4.44m.

33. A building plan is prepared such that, a true length of 30 m is represented by a line of 30 cm. Construct a vernier scale for the above plan to read up to 10 m. Indicate on it the lengths (a) 2.02 m (b) 6.66 m.

34. Construct a vernier scale of 1: 40,000 to show kilometers, hectameters & decameters & long enough to measure 5 km. Mark distances of 1.86 km & 4.91 km on it.

35. The actual length of 500 m is represented by a line of 15 cm on a drawing. Construct a vernier scale to read up to 600 m. Mark on it a length of 568 m. (hint: 600m=6x100m; 6 divisions of main scale of 100m each, sub scale 10 parts of 10 m each).

36. Draw a vernier scale or RF = 1/20 to read up to 300 cm on it. Show lengths of 91 cm & 239 cm on it. (hint: 300=3x100 cm;3 parts of 100 cm and subscale 10 parts of 10cm)

37. An actual distance of 960 km between two points on a map is shown by a line 26 cm long. Construct the corresponding Vernier scale of kilometers and miles. Show on the scale of a distance of 692 and 891 km. Find the corresponding length in miles using the scale. Take 1 mile – 1.6km.

A.   Hint: the scale is to be drawn in two parts; 1 is Km scale and other is Mile scale;
Step 1: Construct KM scale using 1000km as Max Length; 10 parts of 100km each with sub scale of 10 parts of 10km each;
Step 2: For mile scale, ML=1000km/1.6 = 625 miles and construct a vernier scale. Then mark distance as 692/1.6 and 891/1.6 on this scale(Refer solutions)