S.RAMANATHAN ASST PROF MVSREC
Mob: 9989717732 rama_bhp@yahoo.com

Scales- Important Theory questions

1) What is the **Representative fraction (R.F)** of the problem?

(A) The **R.F** is calculated by the following formula:

$$R.F = \frac{\text{Length of the object on drawing sheet (in cm)(or) in mm}}{\text{Actual length of the object (in cm)}}$$

This may be given in a statement form as shown below:

(i) On a map, 1 cm represents 10 meters of actual length. Find the RF?
(ii) An area of 144 sq cm on a map represents an area of 36 sq km on the field. Find the RF?
(iii) A room of 1728 m^3 volume is shown as 216 cm^3 volume on a drawing sheet. What is the RF?

For calculating RF, always consider the linear dimension only. If **square units** are mentioned in dimensions, find the **square root** and if **cubes** (volumes) are mentioned, find the **cube root** of the ratio to get the RF.

E.g.: for (i), RF= 1 cm/10 m = 1 cm /10 m * 100 (in cm)

= **1/1000**.

For (ii), RF = $\sqrt{\mathbf{144}\ cm^2 \ / \ (\mathbf{36\ X\ (1000\ x\ 100)}^2\ cm^2)}$

= 2 / 100000
= **1/50000**

For (iii), RF = $\sqrt[3]{\mathbf{216}\ cm^3 \ / \ \mathbf{1728\ X\ (100)}^3\ cm^3}$

= **1 / 200.**

RF is representative of the proportion of the drawings with respect to the actual size.

Sometimes, RF is also called as scales but is expressed in terms of ratios.

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2) What is a scale? What are the different types of scales?

Ans) Scale is also same as RF but only difference is that RF is always expressed as **1/x** or **x/1** in terms of fraction but scale is always expressed in terms of ratio **1:x** or **x:1**

Types of scale:

Sometimes, a large object may have to be reduced in size and drawn on the drawing sheet or a small object may have to be enlarged & drawn on the drawing sheet.

Thus depending on the relative size of the object on the drawing sheet, scales may be classified into 3 types. They are:

1) ***Reduced scales***: The size of the object is reduced and drawn on the drawing sheet. Scale is shown as **1: x**. For e.g. 1:2, 1:5, 1:10, 1:20, etc. The reduced scales are used when very large objects are to be shown on the drawing sheet. E.g. Large machine parts, Buildings and fields, residential plans, bridges etc are drawn on reduced scales.

2) **Enlarged scales:** The size of the object is enlarged and drawn on the drawing sheet. Scale is shown as **x: 1**. For E.g. 2:1, 5:1, 10:1, 20:1, etc. The enlarged scales are used when very tiny components are to be shown on drawing sheet. E.g. small gears of wrist watches, drawings of Microprocessors & chips used in computers, etc.

3) **Full Scales:** The size of the object is drawn as it is on the drawing sheet without any changes in dimensions. It is shown as **1:1 or Full Scale. E.g.** Small standard machine parts which are within the size of the drawing sheet.

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3) What are the differences between plain scales and vernier scales?

Ans) The following table gives the differences between plain scales and vernier scales.

Plain scales	**Vernier scales**
1) It measures only a unit and its sub-unit; it can measure dimensions in maximum of two units.	1) It measures a unit and its 2 sub-units, i.e. a sub unit and a sub-sub unit; it can measure dimensions in 3 units.
2) It consists of only a main scale & a sub-scale.	It consists of a main scale and a vernier scale.
3) The main scale does not have sub-divisions. Say, between 1 & 2, or 0-1, etc, there aren't any sub-divisions. Only the sub scale is divided into some equal parts. Only whole numbers are selected from main scale and decimals are selected from sub-scale.	The main scale is compulsorily made into sub-divisions so that measurements of 1.5, 2.3, etc can be obtained from main scale itself & the rest of dimensions from vernier scale.
4) The sub-scale is divided into say 10 equal parts.	The sub-scale is also divided into 10 parts, but the vernier scale reads always in multiples of 11…say 11,22,3,44,etc.
5) It can be used for measuring up to 1 decimal place after point. E.g. 3.4, 2.6,etc.	It can be used for measuring up to 2 decimal places after point. E.g. 2.56, 3.48,etc.

4) What are the differences between plain scales and diagonal scales?

Ans) The following table gives the differences between plain scales and vernier scales.

Plain scales	**Diagonal scales**
1) It measures only a unit and its sub-unit; it can measure dimensions in maximum of two units.	1) It measures a unit and its 2 sub-units, i.e. a sub unit and a sub-sub unit; it can measure dimensions in 3 units.
2) It consists of only a main scale & a sub-scale.	It consists of a main scale, a sub-scale and a diagonal scale.
3) The main scale does not have sub-divisions. Say, between 1 & 2, or 0-1, etc, there aren't any sub-divisions. Only the sub scale is divided into some equal parts.	The main scale also doesn't have sub divisions. Only the sub-scale and vertical sub-sub scale are divided into equal no. of parts.
4) It can be used for measuring up to 1 decimal place after point. E.g. 3.4, 2.6,etc.	It can be used for measuring up to 2 decimal places after point. E.g. 2.56, 3.48,etc.

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5) Compare Diagonal scales and Vernier scales?

Ans) The following table gives the comparison between diagonal scales and vernier scales.

Diagonal scales	**Vernier scales**
1) It measures a main unit and its 2 sub-unit; it can measure dimensions in maximum of 3 units.	1) It measures a main unit and its 2 sub-units, i.e. a sub unit and a sub sub unit; it can measure dimensions in 3 units.
2) It consists of only a main scale, a sub-scale & a vertical sub-scale for the 3rd unit.	It consists of a main scale and a vernier scale for the 3rd unit.
3) The main scale does not have sub-divisions. Say, between 1 & 2, or 0-1, etc, there aren't any sub-divisions. Only the sub scale is divided into some equal parts. Only whole numbers are selected from main scale and decimals are selected from sub-scale & diagonal scale.	The main scale is compulsorily made into sub-divisions so that measurements of 1.5, 2.3, etc can be obtained from main scale itself & the rest of dimensions from vernier scale.
4) The sub-scale is divided into say 10 equal parts. Sometimes, subscale can be divided into 5 parts or 6 parts when multiples of 5 or 6 or 7 are used in the division of main scale. E.g. If ML is 42 m, it can be divided into 7 equal parts of 6m each so that the sub-scale can be divided into 6 parts.	The sub-scale can be divided into 10 parts only and not in any other parts as the vernier scale would not be able to constructed other than this to get multiples of 11 on it. The vernier scale reads always in multiples of 11…say 11,22,33,44,etc.
5) It can be used for measuring up to 2 decimal places after point. E.g. 3.45, 2.68,etc.	It can be used for measuring up to 2 decimal places after point. E.g. 2.56, 3.48,etc.

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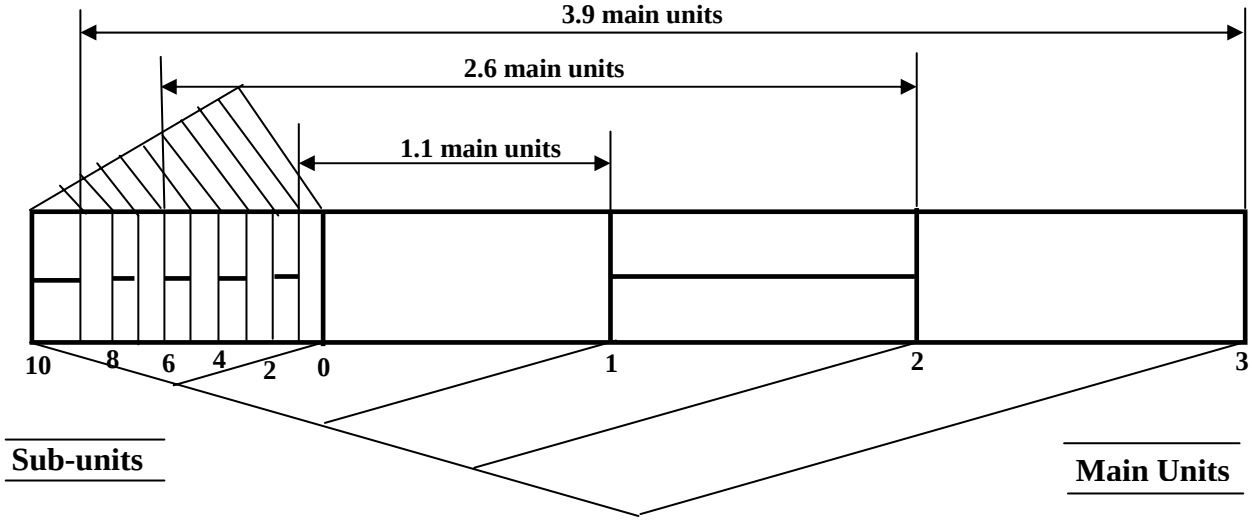
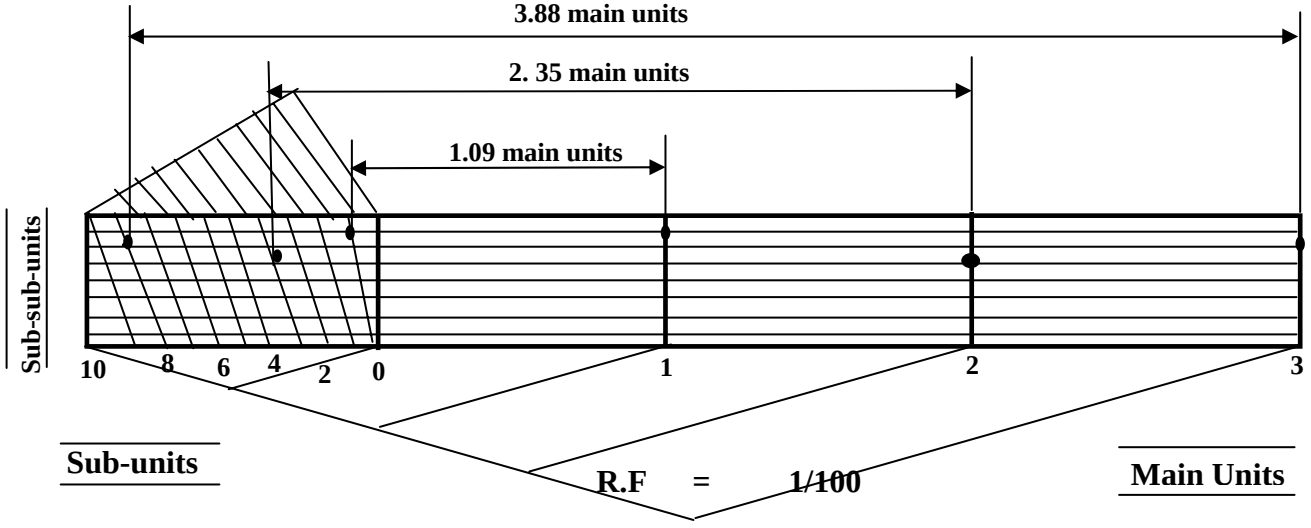
***Example of a Plain Scale*:**



R.F = 1/100

***Example of a Diagonal Scale*:**

Mark the given value of dimension based on problem.



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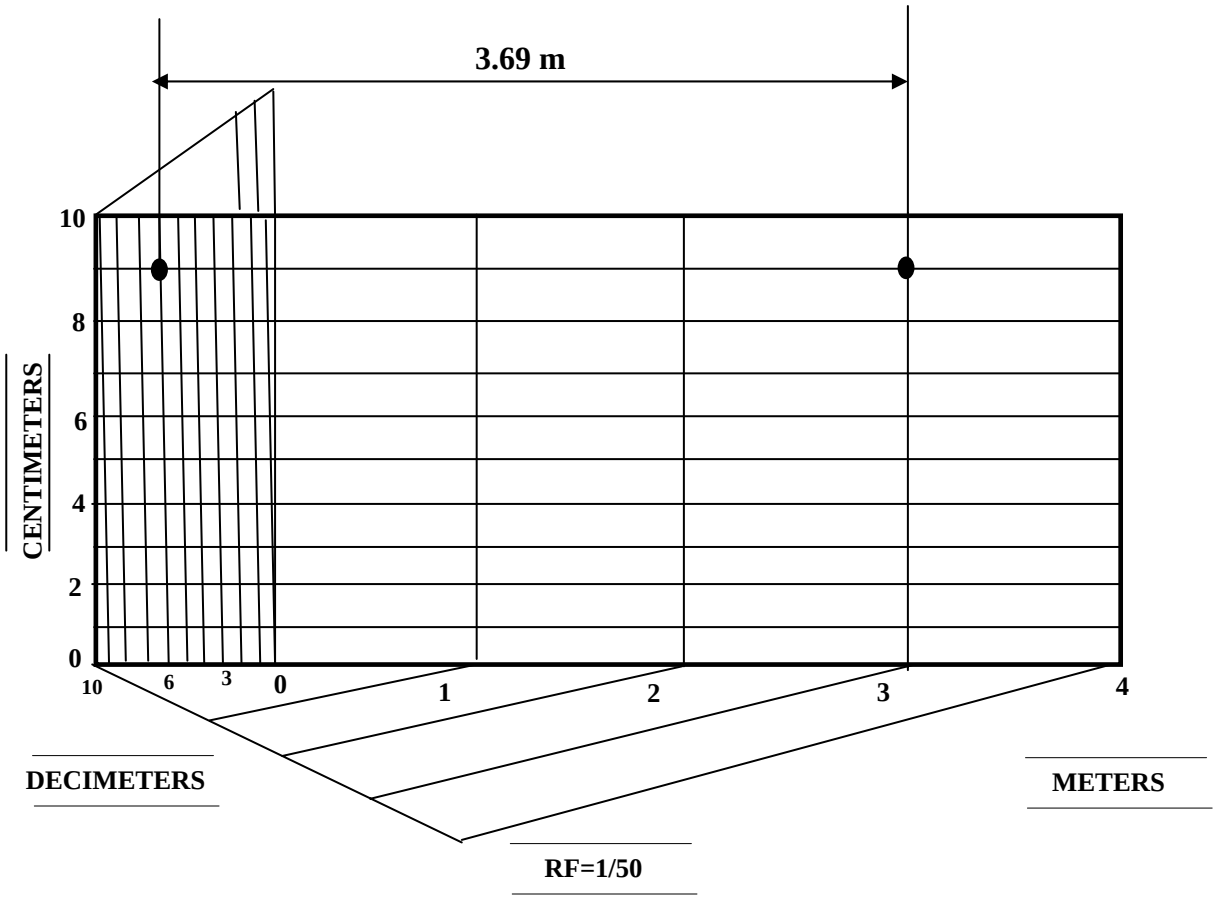
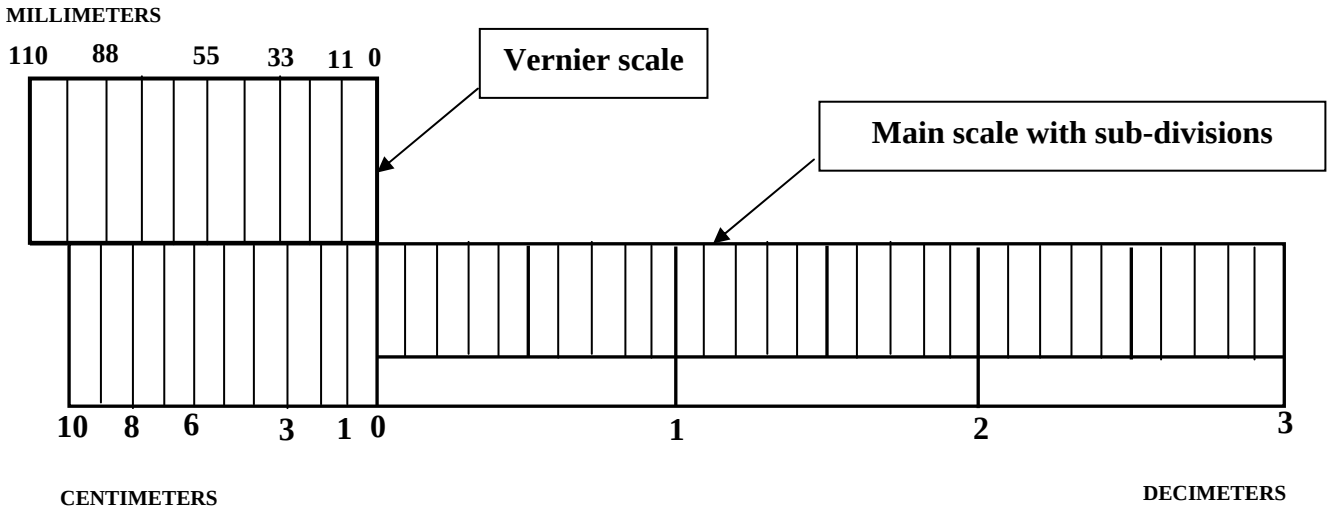
Example of a diagonal scale with measurements.



Example of a Vernier scale (*Sub-units readings will be multiples of 11 cm or 1.1 dm)*



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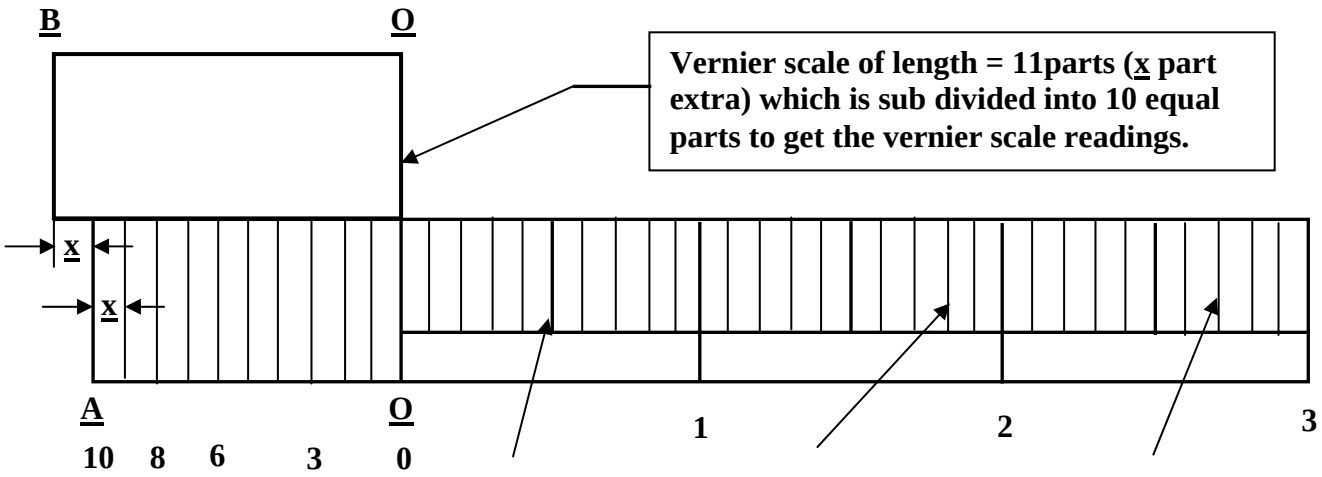
6) Explain the principle of Vernier scale.

Ans) The following is the vernier scale principle:

Let the length of each division of **AO** be ***x.*** Above the first sub-division AO, extend the line by ***x*** & draw a box ***BO*** of 5 mm height & of length = ***AO + x.***



Now BO should be divided into 10 equal parts to get the vernier scale.

Each division on this vernier scale = **(BO)/10 = (AO+x)/10 = (10+1)/10= 1.1** sub units or 11 sub-sub-units. (E.g.: if meters, decimeters & centimeters are the units considered in the problem, then each sub-unit is 1 dm and each vernier unit is 1.1 dm or 11 cm.)