

Chapter 5

# Scales and its Types

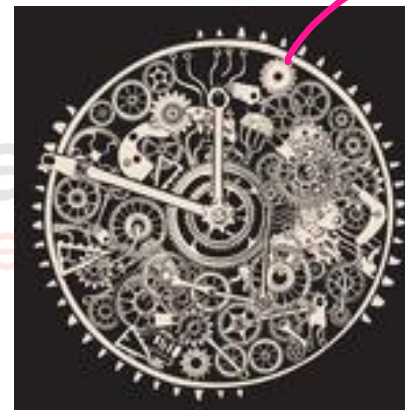
# 1. What is a Scale ?

## What is a Scale? *Enlarge*

Well let's see what it is.....



*MICRO  
OBJECTS*



You can clearly see that a wristwatch is made up of small gears and while drawing one needs to enlarge them depending on their actual sizes.

The radius of these gears are very small ( 1 mm to 5 mm). And here we need a scale (Enlarging) to magnify the dimensions so that it can be drawn easily.

# 1. What is a Scale ?



These objects are huge and its not possible for us to make drawings of such objects to their true dimensions.

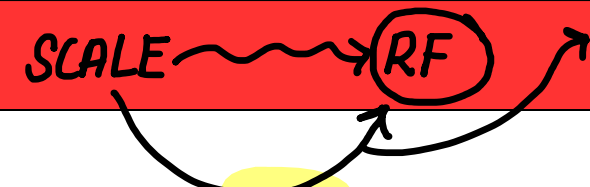
REDUCE

Dimensions



The best option is to reduce the dimensions by using a factor so that it fits into our drawing sheet perfectly.

# 2. What is a Representative Fraction ?



•The scale of a drawing is indicated by a ratio, called the Representative Fraction, popularly abbreviated as RF.

•RF is basically a ratio of the length of an object on drawing to the actual length of the object.

$$\frac{LOD}{AL} \rightarrow RF$$

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$$RF = \frac{\text{Length on Drawing}}{\text{Actual Length}}$$

For Example: If a 1.5 m long steel bar is shown by a 15 cm long line on drawing then find its RF.

DL → RF = 15 cm / 1.5 m = 15 cm / (1.5 × 100) cm = 1:10

AL ↙

$RF = \frac{1}{10} = 0.1$   
 This suggests that the original dimension has been shrunk 10 times.  
 $RF < 1 \rightarrow$  Red. Scale

### 3. What are the different Scale Types?

$$RF = \frac{LOD}{AL}$$

#### 1. Reducing Scales:

When large objects are to be drawn, they are reduced in size on the drawing sheet. And the scale used for such reductions are called Reducing Scales. For ex: Bridges, Ships, Buildings, Heavy Machinery. So when  $RF < 1$ , that's a Reducing Scale

$$LOD < AL$$

✓  
Screw

#### 2. Enlarging Scales:

When smaller objects are to be drawn, they are enlarged in size on the drawing sheet. And the scale used for such magnifications are called Enlarging Scales. For ex: screws, gears, small electronic gadgets, wristwatch parts etc. So when  $RF > 1$ , that's a Enlarging Scale.

$$LOD > AL$$

#### 3. Full Scales:

When an object is drawn on sheet to its actual size, it is said to be drawn to full scale. For ex: Cellphones, screwdriver, Coke Bottle, Laptop, Mouse, Pen etc.  $RF = 1$  obviously.

$$LOD = AL$$

## 4. Unit Conversions

$$10 \text{ mm} = 1 \text{ cm}$$

$$10 \text{ cm} = 1 \text{ dm (decimetre)}$$

$$10 \text{ dm} = 1 \text{ m}$$

$$10 \text{ m} = 1 \text{ dam (decametre)}$$

$$10 \text{ dam} = 1 \text{ hm (hectometre)}$$

$$10 \text{ hm} = 1 \text{ km}$$

$$1 \text{ hectare} = 10000 \text{ m}^2$$

$$12 \text{ inch} = 1 \text{ foot}$$

$$3 \text{ feet} = 1 \text{ yard}$$

$$220 \text{ yds} = 1 \text{ furlong}$$

$$8 \text{ furlong} = 1 \text{ mile}$$

$$10 \text{ chains} = 1 \text{ furlong}$$

$$201.2 \text{ mtr} = 1 \text{ furlong}$$

## 4. Scale of Construction

(a) Plain Scale

(a) Diagonal Scale

(c) Vernier Scale

(d) Comparative Scale

(e) Scale of Chords



4a. Plain Scale  $\longrightarrow$  UNIT - SUBUNIT ,  $km \rightarrow m$  ,  $m \rightarrow cm$  ,  $cm \rightarrow mm$

Example: Construct a scale of 1:4 to show centimeters and long enough to measure upto 5 decimeters 0.1 unit

$RF = 1:4$

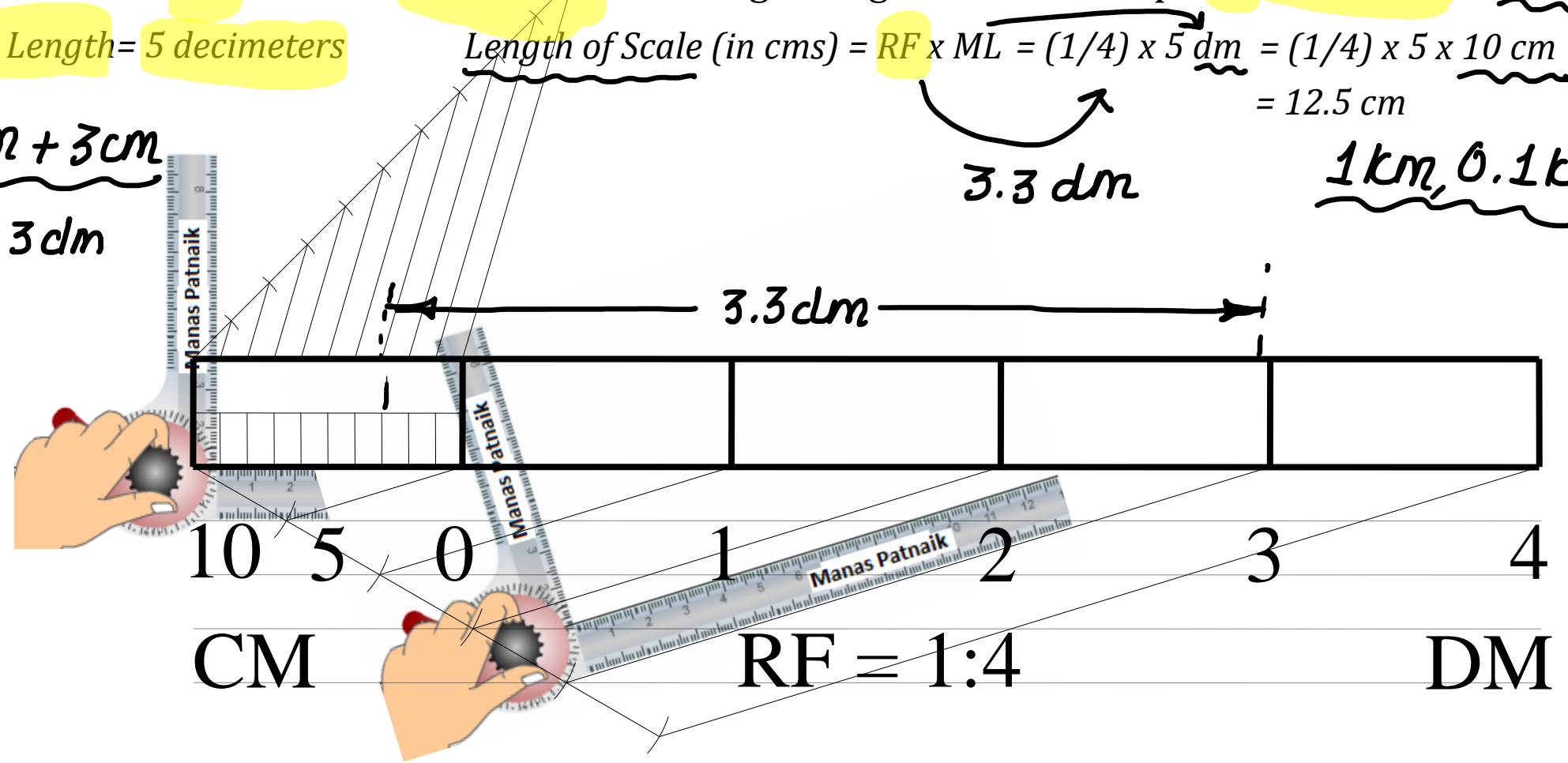
Max Length = 5 decimeters

Length of Scale (in cms) =  $RF \times ML = (1/4) \times 5 \text{ dm} = (1/4) \times 5 \times 10 \text{ cm} = 12.5 \text{ cm}$

$3 \text{ dm} + 3 \text{ cm}$   
 $= 3.3 \text{ dm}$

3.3 dm

1 km, 0.1 km





# 4b. Diagonal Scale UNIT - (SUB-U) - (SUB-SUB-UN) , km - m - cm

Example: Construct a diagonal scale of  $RF=1/32$  showing yards, feet and inches and to measure upto 4 yards.

$RF = 1:32$

Max Length = 4 yards

Length of Scale Calculation:

$LOS = RF \times ML$

$AB \rightarrow 2y, 2f, 7$

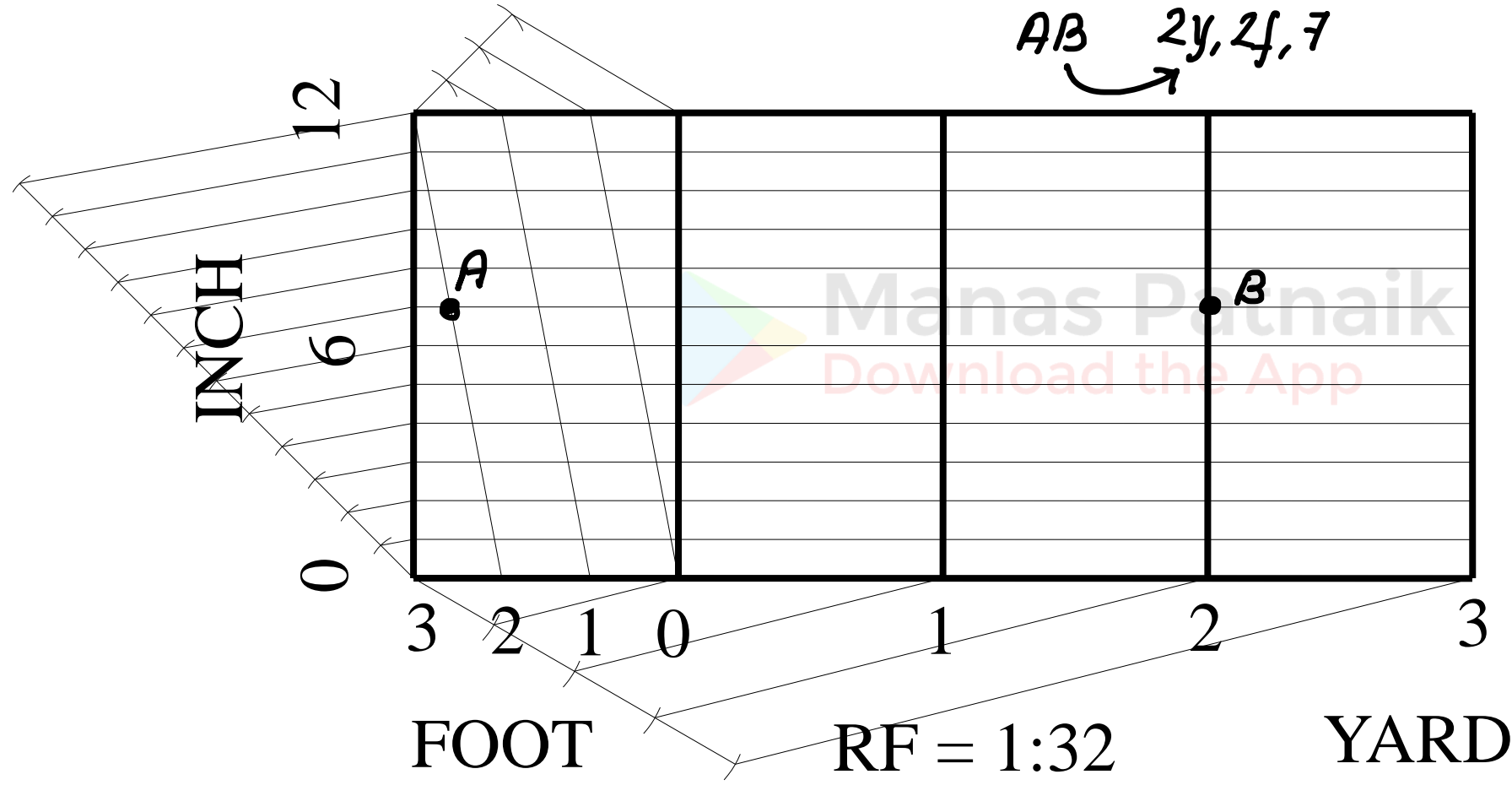
$= \frac{1}{32} \times 4 \text{ yds}$

$= \frac{1}{32} \times 4 \times 3 \text{ ft}$

$= \frac{1}{32} \times 4 \times 3 \times 12 \text{ inch}$

$= \frac{1}{32} \times 4 \times 3 \times 12 \times 2.54 \text{ cm}$

$= 11.4 \text{ cms approximately}$

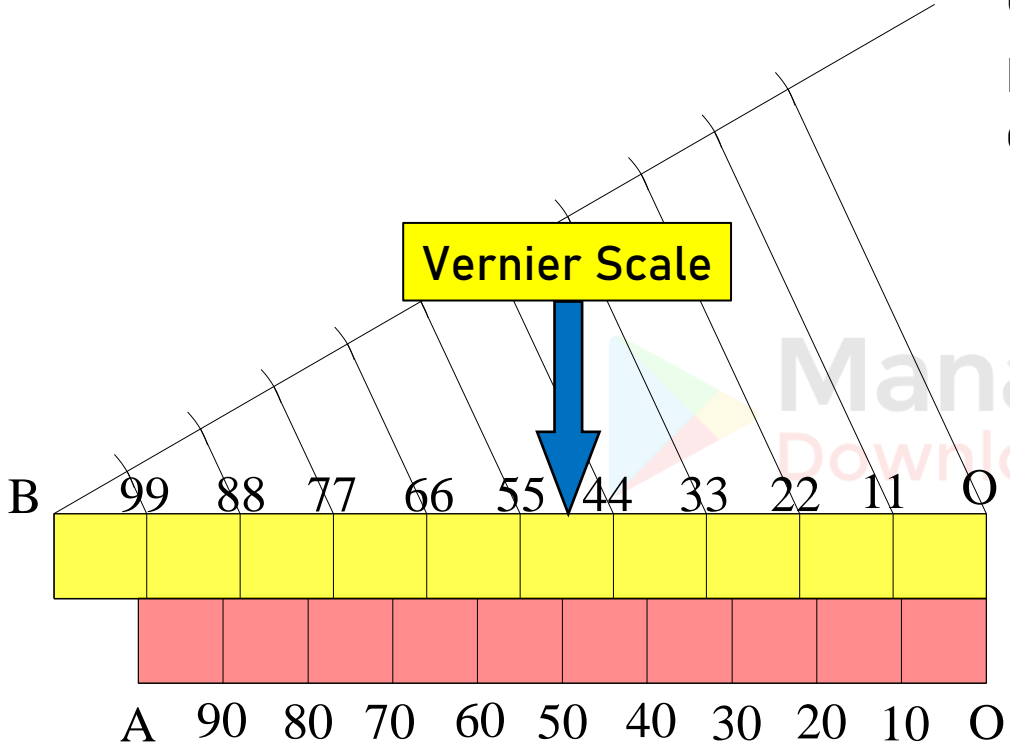


4c. Vernier Scale  $\rightarrow$  3 UNIT  $\rightarrow$  km - m - cm, (U - SU - SSU)

One Division of Red Scale will represent a distance = 10 mm

One Division of Yellow Scale will represent a distance = 11 mm

Difference of One Division of Yellow Scale & one division of Red scale = 11 - 10 = 1 mm



100 mm

$$\frac{110}{10} = 11$$

# 4c. Vernier Scale

Example: Draw a Vernier scale of  $RF = 1 / 25$  to read centimeters up to 4 meters and on it, show lengths  $2.39\text{ m}$  and  $0.91\text{ m}$ .

Given:

$$RF = 1 / 25$$

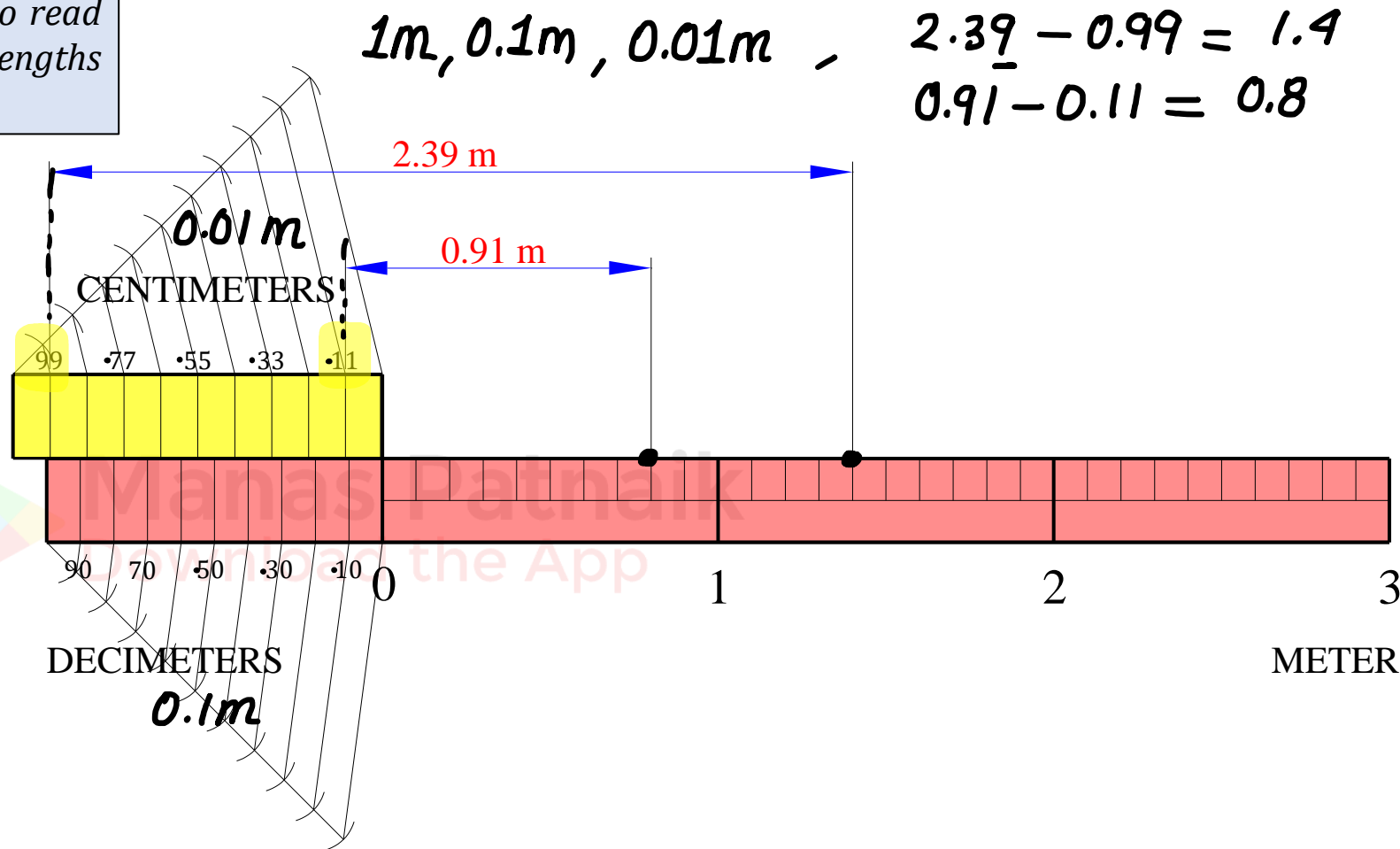
Max Length = 4 mts

Length of Scale =  $RF \times ML$

$$= \left(\frac{1}{25} \times 4\right) \text{ mts}$$

$$= \left(\frac{1}{25} \times 4 \times 100\right) \text{ cms}$$

$$= 16 \text{ cms}$$



# 4d. Comparative Scale

1. These are the Scales having same R.F. but graduated to read different units.
2. These scales may be Plain scales or Diagonal scales and may be constructed separately or one above the other

*Example: A distance of 40 miles is represented by a line 8 cm long. Construct a plain scale to read 80 miles. Also construct a comparative scale to read kilometers upto 120 km ( 1 mile = 1.609 km )*

### SOLUTION STEPS:

#### Scale of Miles:

40 miles are represented = 8 cm  
: 80 miles = 16 cm (LOS)  
R.F. =  $8 / 40 \times 1.609 \times 1000 \times 100$   
= 1 / 8,04,500

#### CONSTRUCTION:

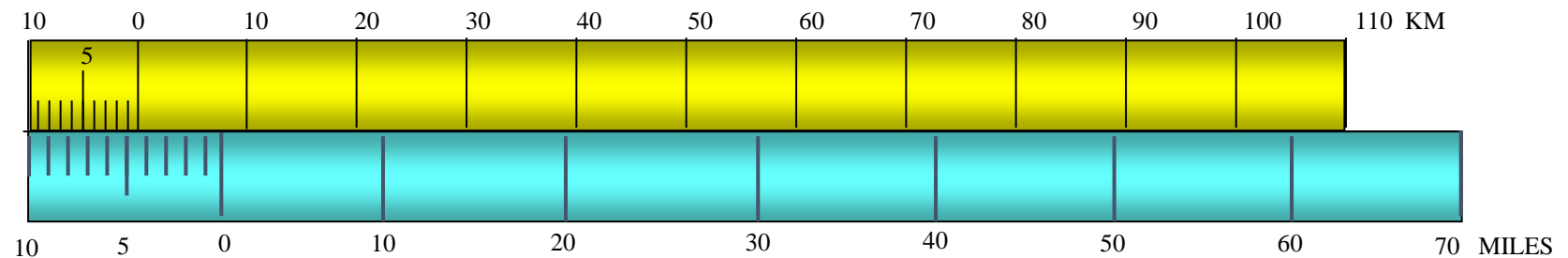
Take a line 16 cm long and divide it into 8 parts. Each will represent 10 miles. Subdivide the first part and each sub-division will measure single mile.

#### Scale of Km:

Length of scale  
=  $1 / 8,04,500 \times 120 \times 1000 \times 100$   
= 14.90 cm

#### CONSTRUCTION:

On the top line of the scale of miles cut off a distance of 14.90 cm and divide it into 12 equal parts. Each part will represent 10 km. Subdivide the first part into 10 equal parts. Each subdivision will show single km.



R.F. = 1 / 804500

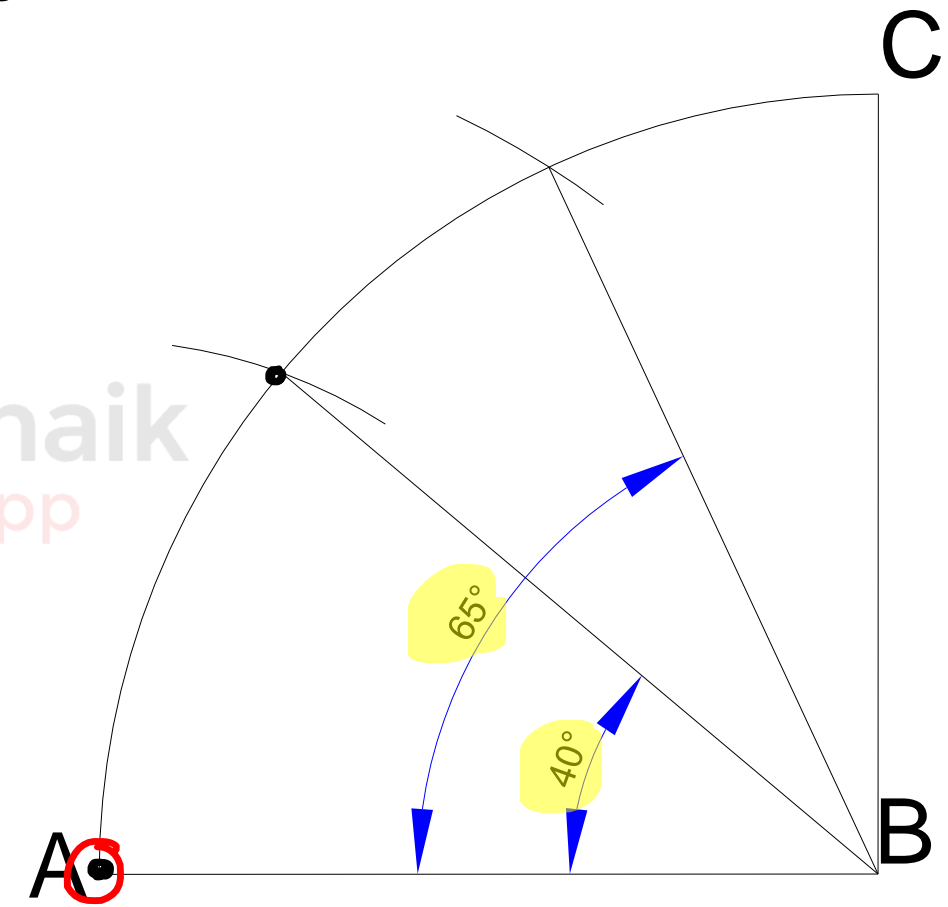
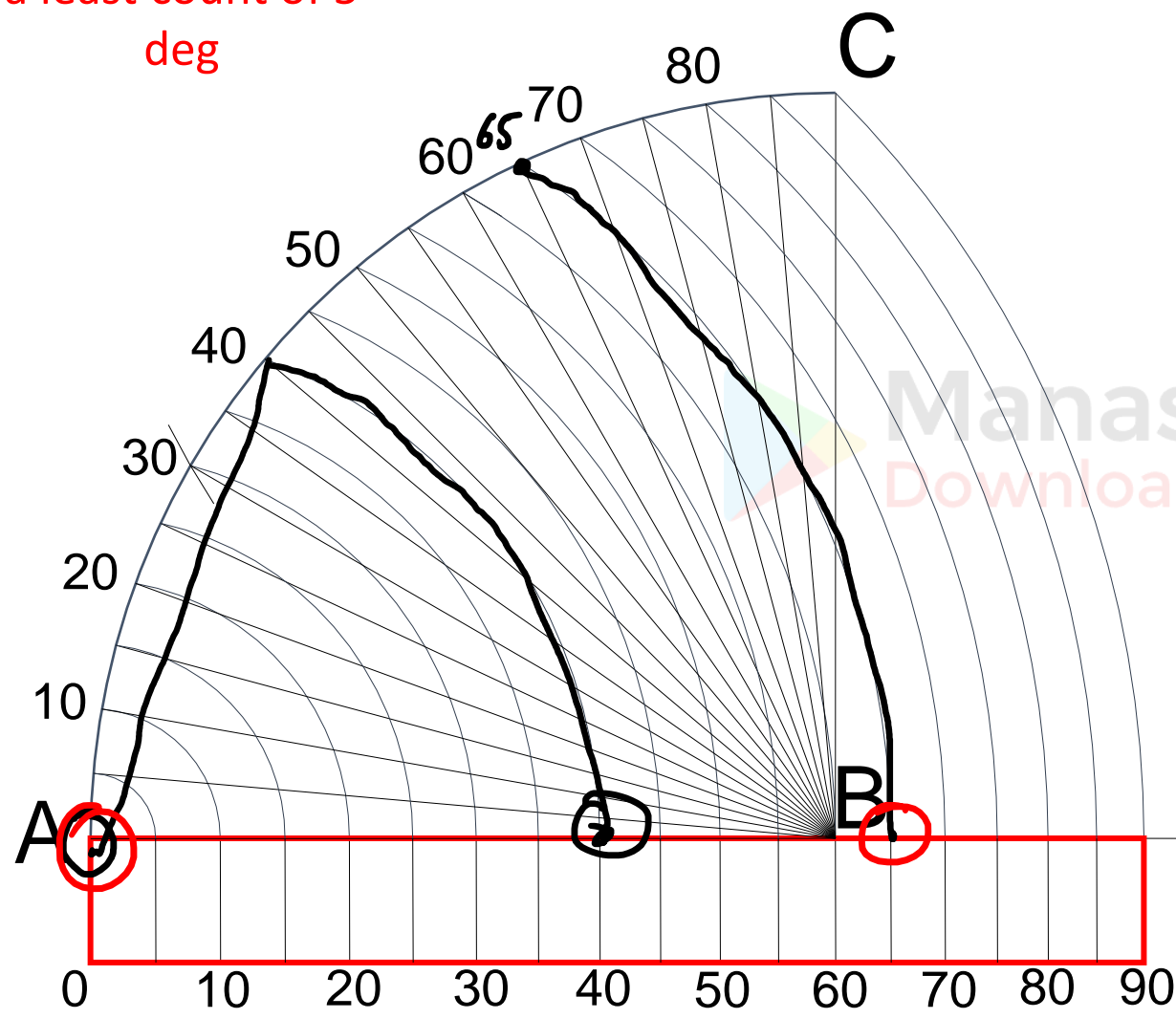
**COMPARATIVE SCALE SHOWING MILES AND KILOMETERS**

# 4e. Scale of Chords

As cord lengths are used to measure & construct different angles it is called scale of cords.

$40^\circ, 65^\circ$

Scale of chord with  
a least count of 5  
deg



Chapter 5

# Scales – MCQ Type Problems

1. Representative fraction is the \_\_\_\_\_
- a) ratio of the length in drawing to the actual length
  - b) ratio of the actual length to the length in drawing
  - c) reciprocal of actual length
  - d) square of the length in drawing

$$RF = \frac{LOD}{AL}$$



2. The scale of a drawing is given as 15:1. What is the representative fraction?

- a) ~~15~~
- b) 0.15
- c) 1.5
- d) 1/15

$$RF = \frac{15}{1} = \underline{15}$$





3. The length of the drawing is 50 mm, the scale is given as 1:5. Find the actual length.

- a) 50 cm
- b) 10 cm
- c) 25 cm
- d) 10 mm

$$LOD = 50 \text{ mm}, \quad RF = \frac{1}{5}$$

$$RF = \frac{LOD}{AL} \Rightarrow \frac{1}{5} = \frac{50 \text{ mm}}{AL}$$

$$\begin{aligned} \Rightarrow AL &= 250 \text{ mm} \\ &= 25 \times 10 \text{ mm} \\ &= 25 \times 1 \text{ cm} \\ &= 25 \text{ cm} \end{aligned}$$



4. The actual length is 1m. The length of the drawing is 5cm. Find the representative factor.

- a) 1/5
- b) 20
- c) 1/20
- d) 5

UNITLESS

$$AL = 1m, \quad LOD = 5cm$$

$$RF = \frac{LOD}{AL} = \frac{5cm}{1m} = \frac{5cm}{100cm}$$

$$= \frac{1}{20}$$



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5. The representative factor is 4. The actual length is 20 mm. Find the length of the drawing.

- a) 5 cm
- b) 5 mm
- c) 0.2 mm
- d) ~~8 cm~~

$$RF = 4, AL = 20 \text{ mm}$$

$$RF = \frac{LOD}{AL} \Rightarrow 4 = \frac{LOD}{20 \text{ mm}}$$

$$\Rightarrow LOD = 80 \text{ mm} \\ = 8 \text{ cm}$$



6. A machine part is drawn two times with different scales. The ratio of 1st drawing's R.F. to 2nd drawing R.F. with respect to the actual object is found to be 2. The length of the second drawing is 10 mm. Find the 1st drawing length.

- a) 5 mm
- b) 200 mm
- c) 5 cm
- d) 2 cm

$$\frac{RF_1}{RF_2} = 2 \Rightarrow \frac{(LOD_1 / AL)}{(LOD_2 / AL)} = 2$$

$$\Rightarrow \frac{LOD_1}{10 \text{ mm}} = 2$$

$$\Rightarrow LOD_1 = 20 \text{ mm} \\ = 2 \text{ cm}$$



7. What is the representative factor of a line, whose length is 24cm on the drawing sheet, representing an actual length of 6m?

- a) 1:50
- b) 1:25
- c) 1:24
- d) 1:60

$$LOD = 24 \text{ cm} , AL = 6 \text{ m}$$

$$RF = \frac{24 \text{ cm}}{6 \text{ m}} = \frac{24 \text{ cm}}{6 \times 100 \text{ cm}}$$
$$= \frac{1}{25}$$



8. A line of 10cm is drawn on a drawing sheet. It represents an actual length of 25mm. What is the representative factor?

- a) 1:4
- b) 1:40
- c) 4:1
- d) 40:1

$$\begin{aligned} LOD &= 10 \text{ cm} , \quad AL = 25 \text{ mm} \\ RF &= \frac{LOD}{AL} = \frac{10 \text{ cm}}{25 \text{ mm}} = \frac{10 \times 10 \text{ mm}}{25 \text{ mm}} \\ &= 4 \end{aligned}$$



9. Which of the following representative factor will have an enlarging scale?

- a) 1:24 ✗
- b) 1:5 ✗
- c) 1:3 ✗
- d) 1:0.5

$$\underline{RF > 1}$$

$$\frac{1}{0.5} = \frac{1}{\frac{1}{2}} = 2 > 1$$



10. Which of the following representative factors depict that the actual length of the object is greater than the length of the drawing?

- a)  2:5
- b)  4:1
- c)  3:2
- d)  5:3

$$RF = \frac{LOD}{AL}$$

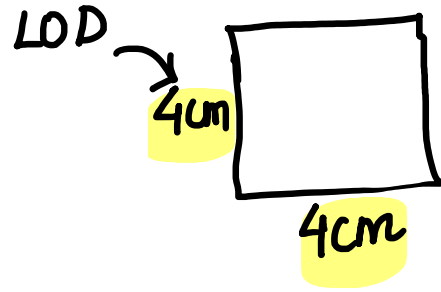
Handwritten notes: A checkmark is next to the formula. A bracket is drawn under 'LOD' and 'AL'. A circled '5' is written next to the formula. To the right, four ratios are listed:  $\frac{4}{1}$ ,  $\frac{3}{2}$ , and  $\frac{5}{3}$ .





11. What is the representative factor if sides of a square measuring 4cm in the drawing sheet while the actual length of the side of the square is 3m?

- a) 1:0.75
- b) 4:3
- c) 1:75
- d) 3:4



$$LOD = 4\text{cm}, AL = 3\text{m}$$

$$RF = \frac{LOD}{AL} = \frac{4\text{cm}}{3\text{m}} = \frac{4\text{cm}}{3 \times 100\text{cm}} = \frac{1}{75}$$



12. What is the type of scale in which the representative fraction is 1:1?

- a) Enlarged scale
- b) Reduced scale
- c) Full size scale
- d) Graphical scale

$$RF = 1 \quad \{ \text{Full} \}$$

$$< 1 \quad \{ \text{Reducing} \}$$

$$> 1 \quad \{ \text{Enlarging} \}$$



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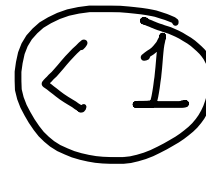
13. Which of the following scales is a reducing scale?

a)  $3:2 = 1.5 \rightarrow$

b)  $1:3 = 0.33 \leftarrow$

c)  $1:1 = 1 =$

d)  $1:0.4 = 2.5 \rightarrow$

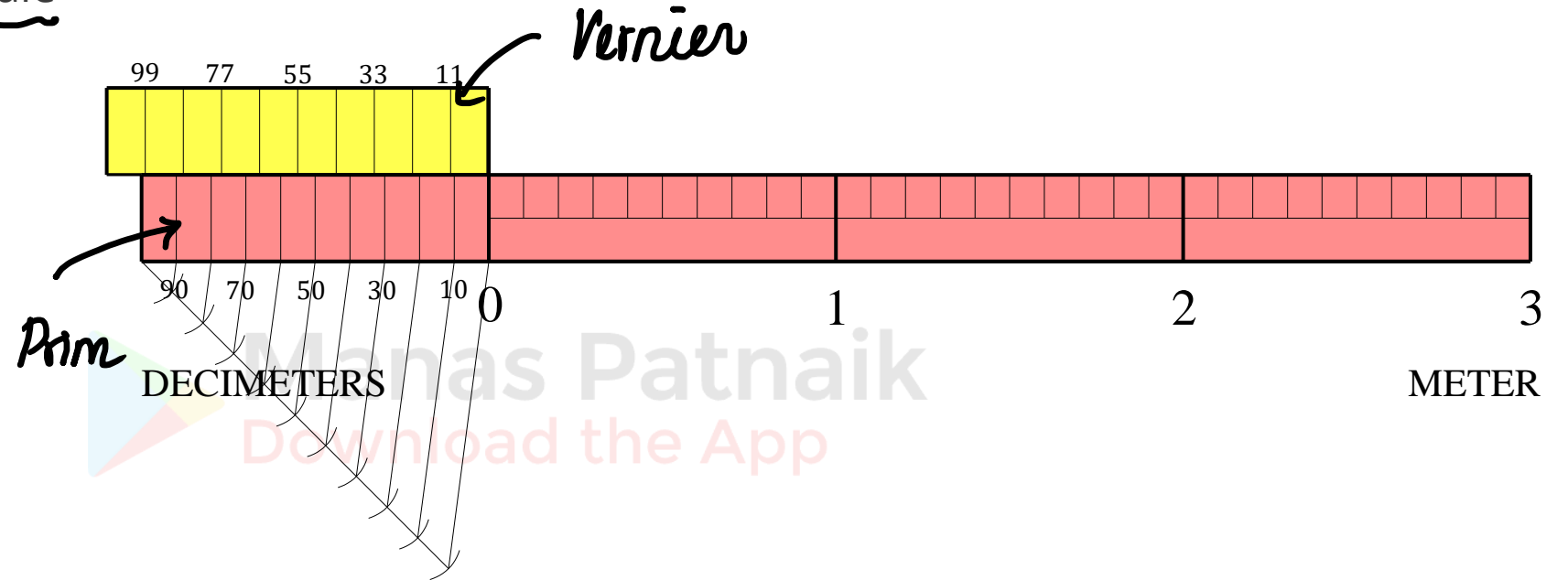


$$\frac{1}{0.4} = \frac{1}{\frac{4}{10}} = \frac{10}{4} = \frac{5}{2} = 2.5$$

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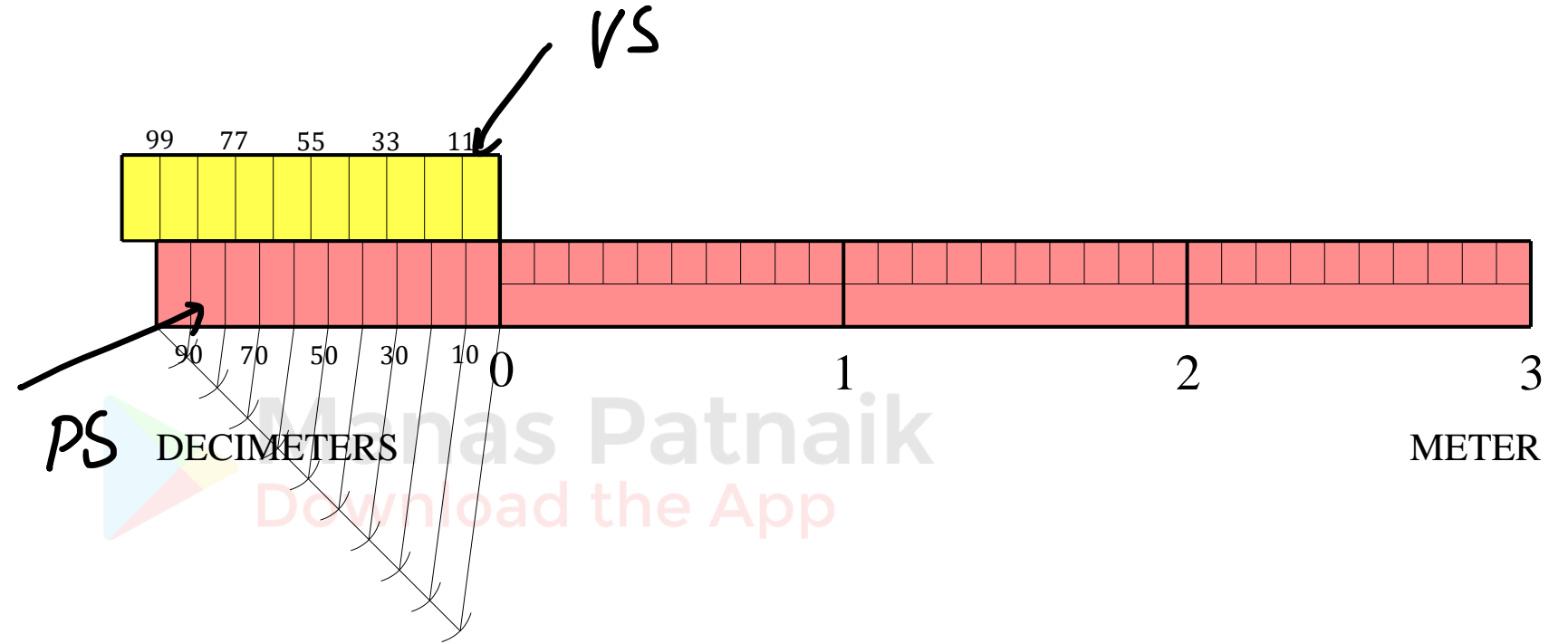
14. What are the two parts of the Vernier scale?

- a) Primary scale and secondary scale
- b) Plain scale and comparative scale
- c) Vernier scale and secondary scale
- d) Primary scale and Vernier scale



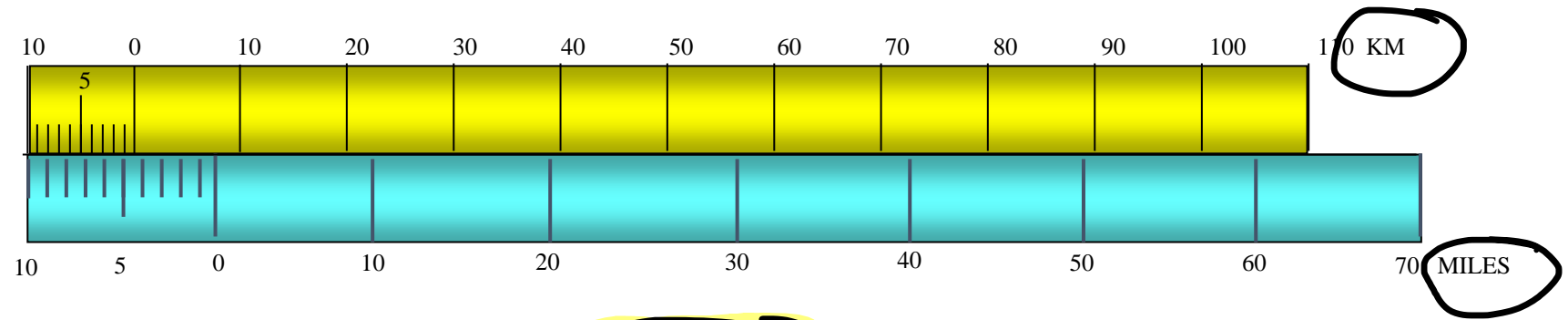
15. The graduations of which scale is derived from the primary scale?

- a) Comparative scale
- b) Vernier scale
- c) Plain scale
- d) Diagonal scale



16. Which of the following scales represent two different units having the same representative fraction?

- a) Plain scale
- b) Diagonal scale
- c) Comparative scale
- d) Vernier scale



R.F. = 1 / 804500

COMPARATIVE SCALE SHOWING MILES AND KILOMETERS



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17. In a particular drawing, 40 inches is represented by a 10 cm long line. A comparative scale is constructed that measures up to 180 inches and 2 m respectively. What are the lengths of scale for both the inches as well as the meter scales? (1 inch = 0.0254 meter)

- a) 7 cm and 8.3 cm
- b) 35 cm and 18.35
- c) 2.2 cm and 22.9 cm
- ✓ d) 45 cm and 19.7 cm

$$\text{SCALE 1 : } AL = 40 \text{ in, } LOD = 10 \text{ cm, } ML = 180 \text{ in}$$

$$RF = \frac{10 \text{ cm}}{40 \text{ in}} = \frac{10 \text{ cm}}{40 \times 2.54 \text{ cm}}$$

$$\therefore RF = 25/254$$

$$LOS = \frac{25}{254} \times 180 \text{ in}$$

$$= \frac{25}{254} \times 180 \times 2.54 \text{ cm}$$

$$= 45 \text{ cm}$$

$$\text{SCALE 2 : } RF = 25/254, ML = 2 \text{ m}$$

$$LOS = RF \times ML$$

$$= \frac{25}{254} \times 2 \text{ m}$$

$$= \frac{25}{254} \times 2 \times 100$$

$$= 19.7 \text{ cm}$$

18. Which of the following is used to set or measure angles when a protractor is not available?

- a) Plain scale
- b) Diagonal scale
- c) Scale of chords
- d) Comparative scale





19. The scale used in micrometer is \_\_\_\_\_

- a) Plain scale
- b) Comparative scale
- c) Diagonal scale
- d) ~~Circular vernier scale~~



20. Which scale you prefer if there is a need to measure most accurately.

- a) Plain scale
- b) Vernier scale
- c) Ordinary scale
- d) Comparative scale



21. Which scale is employed when we need to measure in three units?

- a) Plane scale
- b) Scale of chords
- c) Vernier Scale
- d)  Diagonal scale

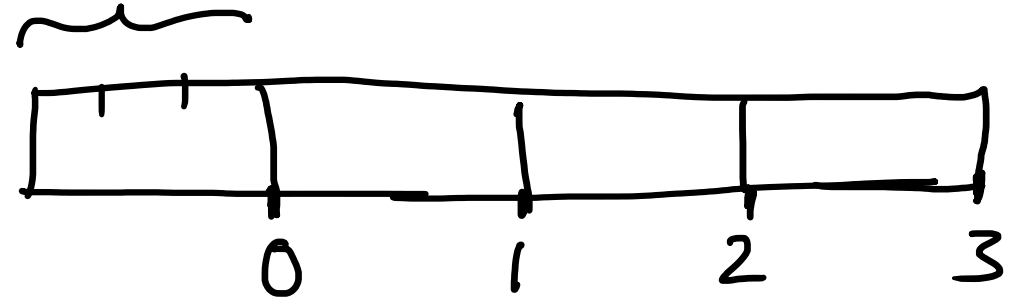
*km - m - cm*



22. In preparing a plain scale of feet and yards, the first division is to be divided into how many sub-divisions?

- a) 5
- b) 3
- c) 4
- d) 10

$$1Y = 3 \text{ Feet}$$

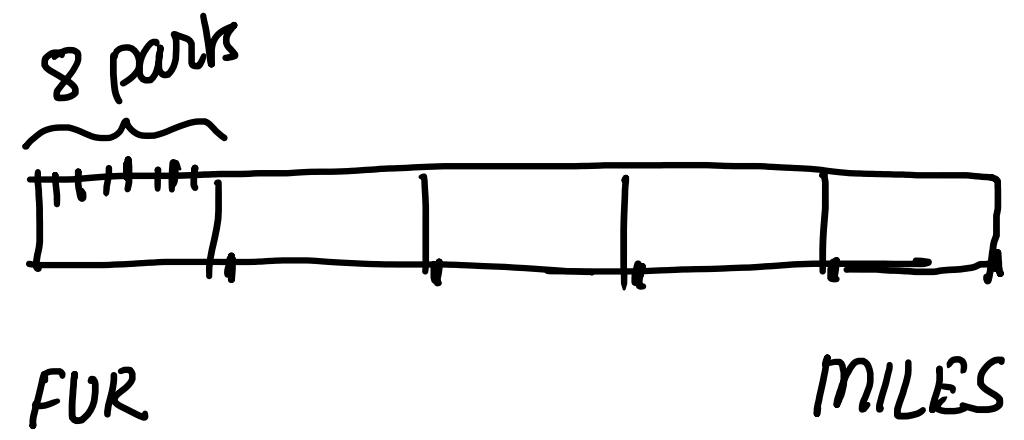


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23. In preparing a plain scale of miles and furlongs, how many divisions do the first part is to be made?

- a) 10
- b) 12
- ~~c) 8~~
- d) 6

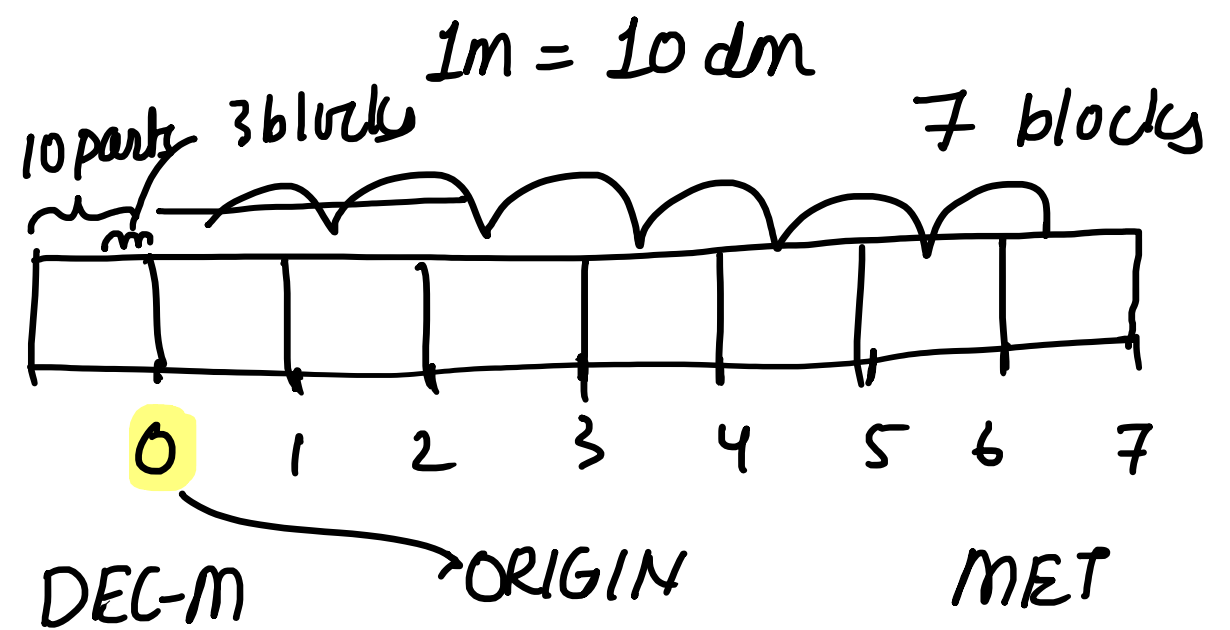
$$1m = 8F$$



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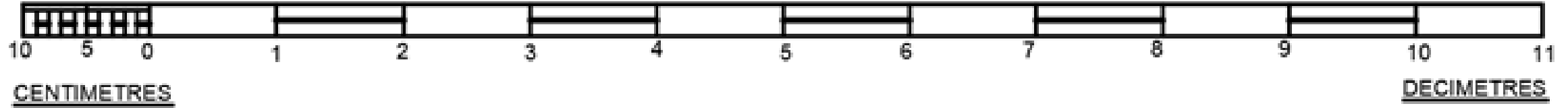
24. A plain scale is made to show 8 meters and sub division is decimeters. To measure 7 meters and 3 decimeters how many divisions is to take on the right side of origin and how many it is to take on the left side of origin?

- a) 7, 3
- b) 3, 7
- c) 6, 4
- d) 4, 6



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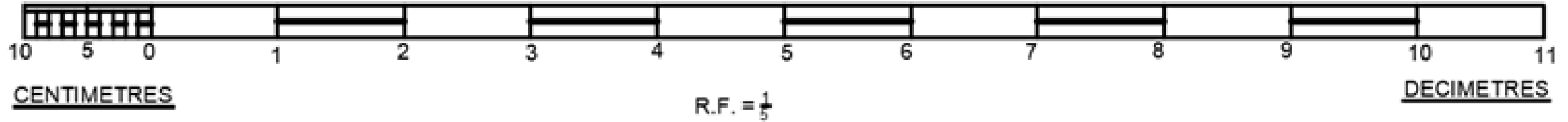
25. From the following figure what is the maximum length that can be measured?



- a) 11 dm
- b) 10 dm
- c) 13 dm
- d) 12 dm → mL.



26. What is the length of the scale? (R.F. = 1/5)



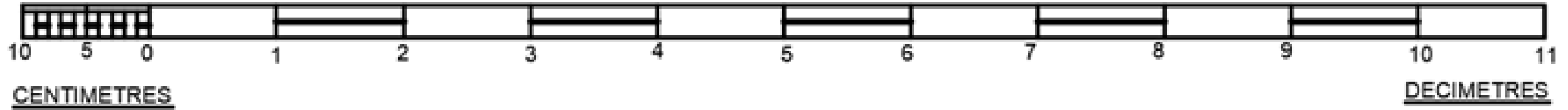
- a) 2.4 cm
- b) 24 cm
- c) 240cm
- d) 0.24cm

$$\begin{aligned}LOS &= RF \times ML \\ &= \frac{1}{5} \times 12 \text{ dm} \\ &= \frac{1}{5} \times 12 \times 10 \text{ cm} \\ &= 24 \text{ cm}\end{aligned}$$

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27. What is the least count of the given scale?



- a)  1 cm
- b) 0.1 cm
- c) 1 dm
- d) 10 cm



28. A plot of 35,000 sq m is drawn on map as plot of 14 cm and 5 cm. Find the R.F.

- a) 1/35000
- b) 1/50000
- c) 1/34930
- d)  1/2236

$$RF = \sqrt{\frac{DRG. AREA}{ACT. AREA}}$$

$$= \sqrt{\frac{(14 \times 5) \text{ cm}^2}{35000 \text{ m}^2}}$$

$$= \sqrt{\frac{70 \text{ cm}^2}{35000 \times (100 \text{ cm})^2}}$$

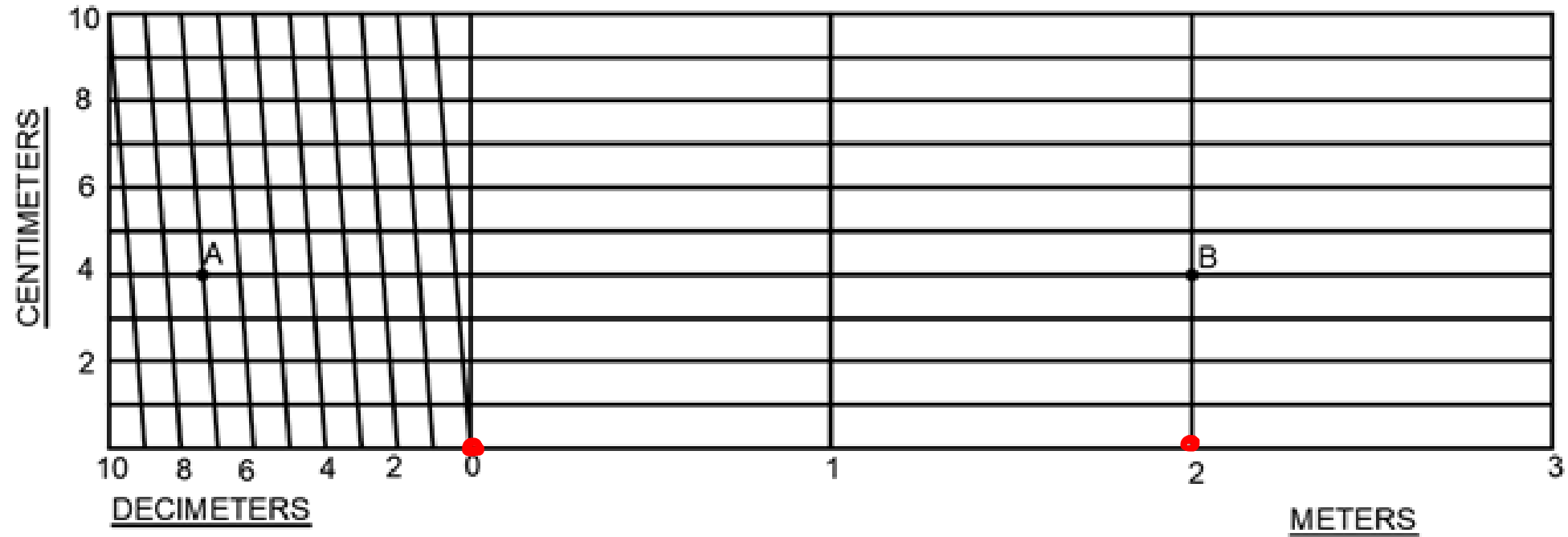
$$= \sqrt{\frac{70 \text{ cm}^2}{35 \times 10^7 \text{ cm}^2}}$$

$$= \frac{1}{2236} \text{ approx.}$$



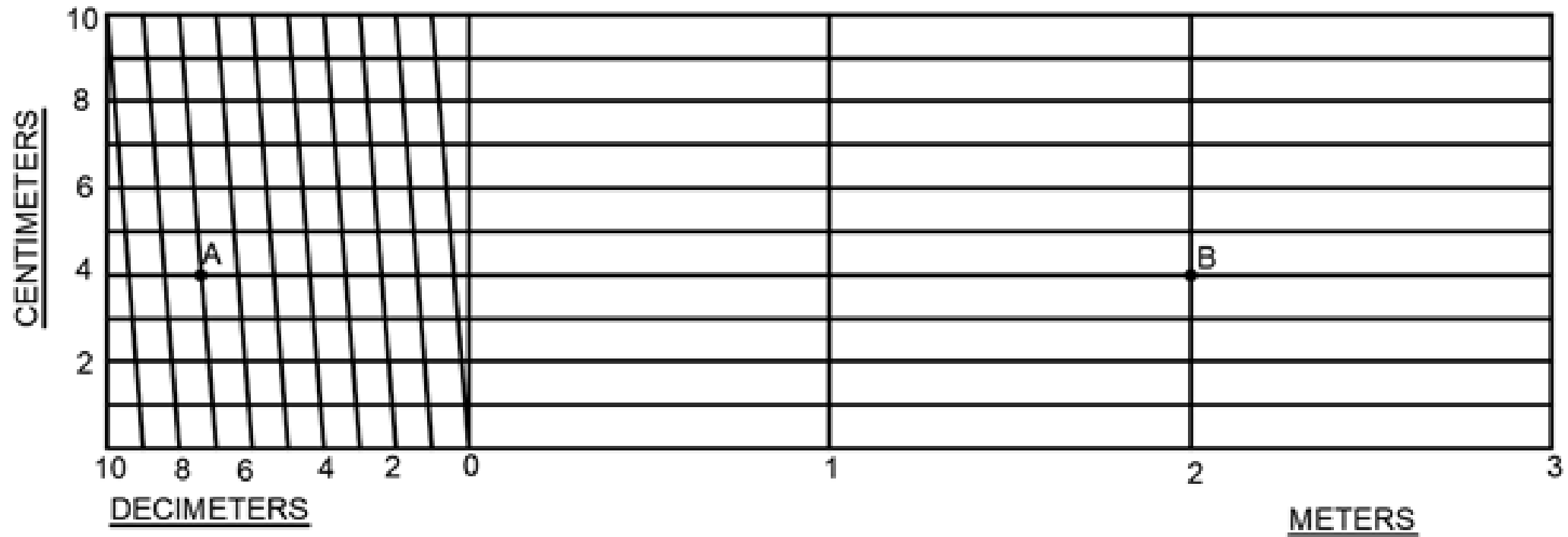
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29. What is the length of AB in the following scale?



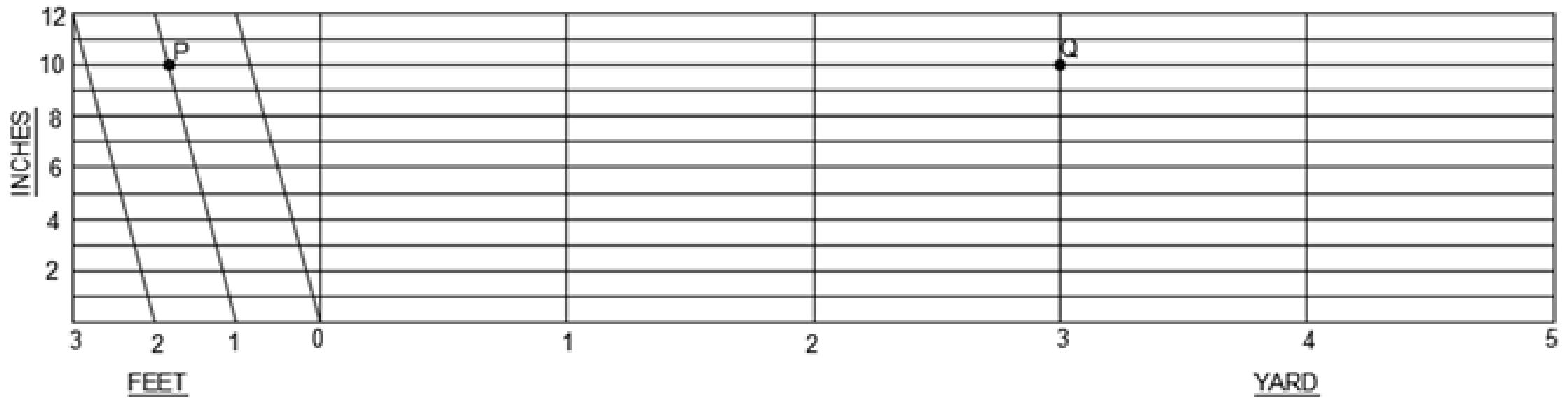
- a) 2.74 m
- b) 3.74 m
- c) 2.47 m
- d) 3.47 m

30. What is the maximum length of the given scale?



- a) 3 dm
- b) 4 dm
- c) 3 m
- ~~d) 4 m~~

31. From the given scale below, what is the length of PQ?



- a) 3 yd 2 ft 0"
- b) 3 yd 1 ft 10"
- c) 3 yd 0 ft 10"
- d) 4 yd 2 ft 0"

