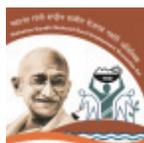


# Simple Mathematics and Measurement Guide

A Resource Booklet for MGNREGS Functionaries



Developed as part of MoRD-GIZ Project

“Environmental benefits of the Mahatma Gandhi National Rural Employment Guarantee Act  
(MGNREGA-EB)”

*This booklet is a handy reference for use by cutting edge MGNREGA functionaries. It is intended to help and support them to apply the knowledge/ tools/ instruments for the creation of technically sound assets and helps in following all the steps of the process/procedure in their proper sequence, with the recommended precautions.*

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November, 2015

# Foreword

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# Content

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1.	Introduction	5
2.	Different shapes	6
3.	Most useful measuring devices	8
4.	How do we measure the distance? What are the units? What is appropriate	9
5.	How do we measure perimeter?	10
6.	How do we measure the Area?	11
7.	How do we measure the Volume?	14
8.	Summary	16

# 1 Introduction

In our daily life we do lot of measurements in terms of weight, length, area, volume and temperature etc. We take or observe measurements generally for following purposes/circumstances;

- When we cook - we use so many ingredients. They should be mixed in a meaningful ratio and quantity. For that, we need to properly measure the quantities.
- When we purchase a piece of cloth or readymade dress, we should know the required size to fit to our body
- When we go to the Doctor, first they check the height and weight, to make a preliminary assessment on our health.
- While transportation, we need to know the carrying capacity of the vehicle we use, whether it may be a cycle or bullock cart or a tractor. You can't load heavily.
- If you are playing cricket, you should properly lay the pitch and draw the inner circle and boundary..
- If you are constructing a house, you have to measure the area to construct relevant size of rooms. Have you ever measured your house/rooms? What are the length, breadth and area of each of the room in your house?
- Have you ever measured your field? How many hectares your field is? What are the local measurements? Acre or Kani or Kunta or Kanal or Bigha?
- If you are digging a trench to reduce the speed of rain water flowing down in your field, what is the depth, length and breadth of the trench?

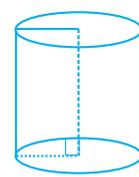
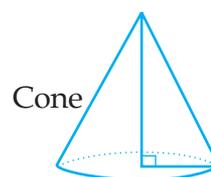
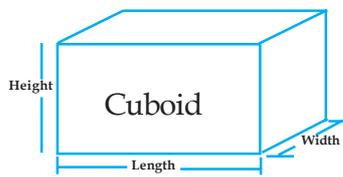
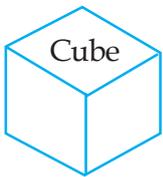
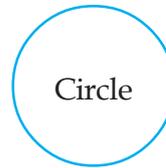
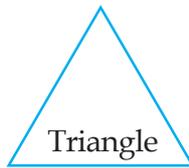
**There may be many examples like this ..... What else you think?**

For all the above, we need to understand the basic concepts of measurements, different shapes, measurements for different works under MGNREGS.

# 2

## Different shapes

We see different kinds of shapes; Square, rectangle, triangle, circle, semi-circle, cube, cuboid, cylinder, etc.



Cylinder

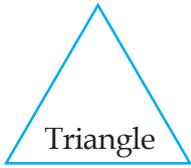
Where do you find these shapes in our daily life/ MGNREGS works?



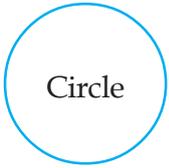
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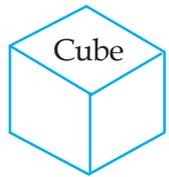
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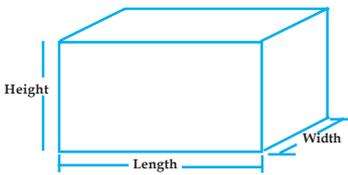
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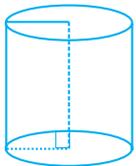
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# 3

## Most useful Measuring Devices



- **15 cm and 30 cm scales:** These scales are used to measure the distance between 2 points on the small map. We use them while preparing drawings for estimates



- **Tailor tape:** Normally its length is 1.5 mtr or 5 feet or 60 inches and is used to measure cloth or a small length. We use this in preparing hydro-marker to measure the slope.



- **3 m or 5 m Measuring tape:** This is steel tape used to measure the wood work: We use this to measure shorter distances during concrete works, carpentry, brick work, etc



- **30 m or 50 m tape:** This type of tape is used to measure longer distances.

During work execution, plumb bob to check vertical alignment and leveling equipment like dumpy level, A-frame, tube level, spirit level, etc for surface leveling are used

### Precautions

- ❖ Measuring tape should be in good condition without torn, stitched or overlapping of the scaling units, etc.

# 4 How do we Measure the Distance

In olden days measurements used to be taken using fingers, arms and foot etc. But as these body parts are not uniform among the people, there used to be deviations in measurements. Therefore, a standard measurement system is required.

Traditional system	Standard system	Measuring devices
<ul style="list-style-type: none"> <li>◆ Inch</li> <li>◆ Foot</li> <li>◆ Yard</li> </ul>	<ul style="list-style-type: none"> <li>◆ Centi meter</li> <li>◆ Meter</li> <li>◆ Kilo meter</li> </ul>	<ul style="list-style-type: none"> <li>◆ Scale</li> <li>◆ Tailor tape</li> <li>◆ Steel tape</li> <li>◆ Long tape</li> </ul>

You all know how to measure the distance between two points; it could be length, width, depth or height. These distances are measured in different units such as centi meters, meters, inches, feet, etc. It is important to know the units. Tables given below gives some understanding on different measuring units.

10 millimeter = 1 centimeter	<p><b>Average</b></p> <p>If the measurements are uneven, you need to take the average of them.</p> <p>Eg: breadth or depth in pits/ trenches.</p> <p>Average= <math>\frac{\text{Sum of all numbers}}{\text{Total number of items}}</math></p>
100 Centi meter = 1 meter	
1000 meter = 1 kilometer	
1 mtr = 3 feet 3 inches or 39.37 inches	
1 feet = 12 inches or 30.48 cm	
0.225 meter = 9 inches	

## Exercises

Measure the following and note down along with the units

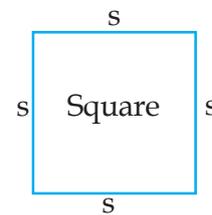
- ❖ The distance between each plant
- ❖ The length, width and depth of the trench
- ❖ The length of the loose boulder structure
- ❖ Depth, width of the gully

# 5

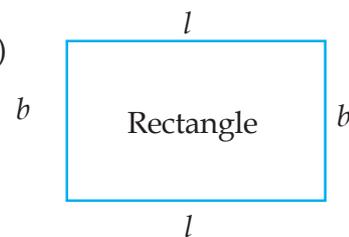
## How do we Measure Perimeter?

Perimeter is the sum of all sides in a shape. To know the perimeter you need to measure the distance of all sides. But, there are few easy formulas. The unit of measurement is cm or m or km or inch or feet

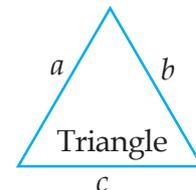
- a) Perimeter of square:  $4 \times S$  ( $s = \text{side}$ )



- b) Perimeter of rectangle :  $(2 \text{ length} + 2 \text{ breadth})$   
or  $2(l+b)$



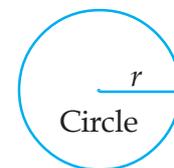
- c) Perimeter of triangle:  $a+b+c$ , if the 3 sides are equal then  $3 \times S$  ( $s = \text{side}$ )



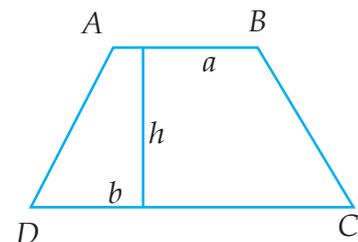
- d) Perimeter of circle or Circumference :

$$C = 2\pi r \quad (\pi = \frac{22}{7}, r = \text{radius})$$

$$\pi = \frac{22}{7} = 3.14$$



- e) Trapezium: Sum of all sides



# 6

## How do we measure the Area?

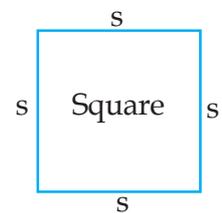
Suppose you want to take up plantation work in a specified area, you need to measure that area. This will help in understanding the number of plants to be planted and the quantum of work done once the work is over. But how do you do this? You need to understand the shape of the area to quantify the work done. Unit for the area is Square Units.

Example: Square Meter, i.e. Sqm or  $m^2$

### a) Area of Square

**Formula:**  $s^2$

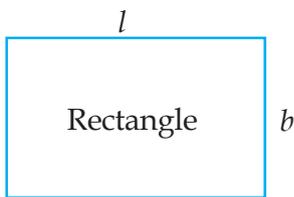
**Description:** (Vertical distance)  $\times$  (horizontal distance). Since all the sides are equal, area is Side  $\times$  Side. Side is identified as 'a', therefore, area of square is  $a^2$ .



### Where do we use in MGNREGS works?

- Area of a land to clear the weed
- Area of a land to take up plantation
- Area of the silt trap to dig





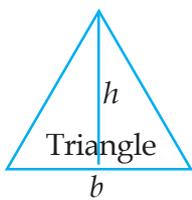
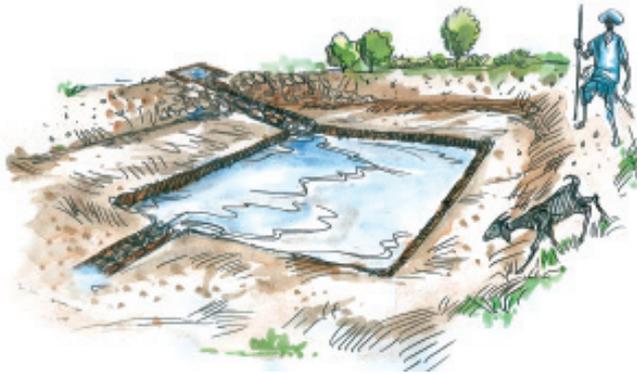
### b) Area of Rectangle

**Formula:**  $l \times b$

**Description:** (vertical distance) x (horizontal distance). Two lengths are equal and two widths are equal therefore, area is Length x Breadth, i.e. ( $l \times b$ )

#### Where do we use in MGNREGS works?

- Area of a land to clear the weed
- Area of a land to take up plantation
- Area of the pit or pond



### c) Area of Triangle

**Formula:**  $\frac{1}{2} bh$

**Description:** 'b' is base of the triangle and 'h' is height of the triangle.

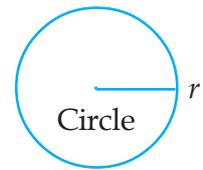
#### Where do we use in MGNREGS works?

- This shape is rare in MGNREGS works.

#### d) Area of Circle

**Formula:**  $A = \pi r^2$

**Description:** This is the area of a circular shape surface.



#### Where do we use in MGNREGS works?

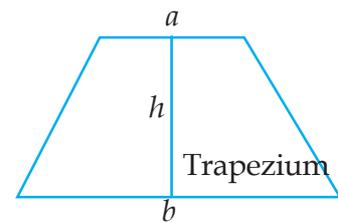
- The cross section area of a pipe/vent etc.
- Area of open well



#### e) Area of Trapezium

**Formula:**  $\frac{a+b}{2} \times h$

**Description:** Area of rectangle is  $l \times b$ , but, in trapezium there are two breadths, i.e. top width and bottom width. Hence, take the average width to multiply width height.



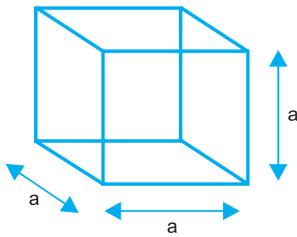
#### Where do we use in MGNREGS works?

- Cross section area of earthen bund or waste weirs, trenches, ponds, LBC, Gabion / RFD, Check Dam, Percolation Tank, etc.
- Side slope of farm pond to do stone revetment.



# 7

## How do we measure the Volume?



How do you know the work done by group of workers in digging the trench or pond; stone work done to fill the foundation of a dam? You should calculate the volume. Unit for the volume is cube Units. Example, Cubic Meter, i.e. Cum or Cmt or  $m^3$ . The most common volume calculations are explained in detail.

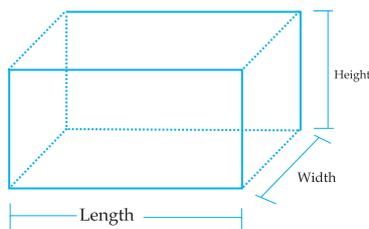
### a) Volume of cube

**Formula:**  $a^3$

**Description:** length x breadth x height or depth. In cube all sides are equal. Therefore, volume is side x side x side. Side is identified as 'a'. Thus, the Volume of cube is  $a^3$ .

**Where do we use in MGNREGS works?**

- Volume of silt trap
- Volume of plantation pits



### b) Volume of Cuboid

**Formula:**  $l \times b \times h$

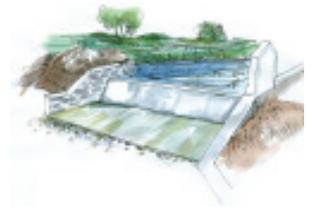
**Description:** Lengths are equal, widths are equal and height is same in a Cuboid. Therefore, its volume is length x breadth x depth/height, i.e.  $l \times b \times h$  or  $l \times b \times d$

**Where do we use in MGNREGS works?**

- This is the most common shape in many works
- Volume of a borrow pit, trench, bund, pond in Earthen bunds, trenches, farm pond, etc.



- Volume of earth work for foundation in drainage line treatment works such as LBC, Gabion / RFD, check dam, percolation tank, etc
- Volume of earth work for scrapping, desilting, digging the canals, etc
- Volume of stone work done for different parts in Loose Boulder Check, Gabion/ RFD, check dam, Percolation Tank, etc.
- Volume of cement concrete in Check dam, etc.



### c) Volume of Trapezoid:

**Formula:**  $\frac{1}{2}(a + b)lh$ .

**Description:** Volume of cuboid is  $l \times b \times h$ . But, in Trapezium there are two breadths. Therefore average of breadth should be taken. Thus instead of breadth, average breadth, i.e.,  $\frac{a+b}{2}$ , wherein 'a' is top width and 'b' is bottom width.

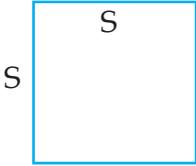
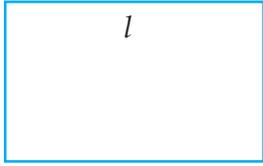
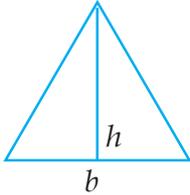
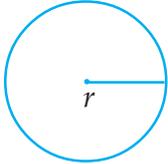
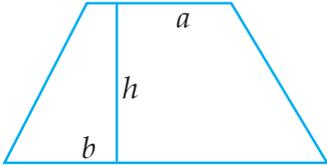


### Where do we use in MGNREGS works?

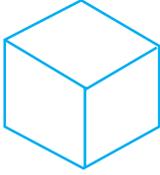
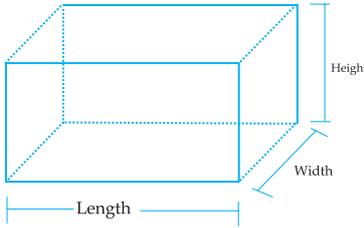
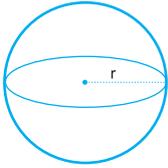
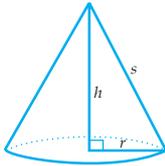
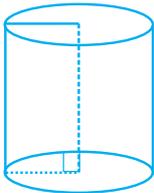
- Trapezoid shapes are there in works like; stone work for the main dam in Loose Boulder Check, Gabion/ RFD, Check Dam, etc.

# 8 Summary

## a) 2 D Shapes

Sl No	Shape	Formula
1	Square 	Area: $S \times S$ Perimeter: $4 \times S$
2.	Rectangle 	Area: $l \times b$ Perimeter: $2(l+b)$
3.	Triangle 	Area: $\frac{1}{2}bh$ Perimeter: $a+b+c$
4.	Circle 	Area: $\pi r^2$ Perimeter: $2\pi r$
5.	Trapezium 	Area: $\frac{1}{2}(a+b)h$ Perimeter: Sum of 4 sides

## b) 3 D Shapes

Sl No	Shape	Formula
1	Cube 	Volume: $a^3$ LSA: $4a^2$ TSA: $6a^2$
2.	Cuboid 	Volume: $l \times b \times h$ LSA: $2h(l+b)$ TSA: $2(l.b+bh+hl)$
3.	Sphere 	Volume: $\frac{4}{3} \pi r^3$ LSA: $4\pi r^2$ TSA: $4 \pi r^2$
4.	Hemisphere 	Volume: $\frac{2}{3} \pi r^3$ LSA: $2 \pi r^2$ TSA: $3 \pi r^2$
5.	Cone 	Volume: $\frac{1}{3} \pi r^2 h$ LSA: $\pi r l$ TSA: $\pi r (l+r)$
6.	Cylinder 	Volume: $\pi r^2 h$ LSA: $2 \pi r h$ TSA: $2 \pi r (r+h)$

Note: LSA - Lateral Surface Area, TSA - Total Surface Area