* Dimensions of a physical quantity are the powers to which the base quantities must be raised to represent that quantity completely.

Eg: Density = $\frac{\text{Mass}}{\text{Volume}}$ &

Dimension of density

$$= \frac{[M]}{[L][L][L]} = \frac{[M]}{[L^3]}$$

$$= [M^1 L^{-3} T^0]$$

Hence the dimensions of density are '1' in mass, '-3' in length and '0' in time.

* Dimensional formulae and Dimensional equations

The expression which shows how and which of the fundamental quantities represent the dimensions of a physical quantity is called the dimensional formula.

Eg: The dimensional formula of acceleration is $[M^0 L^1 T^{-2}]$ and of force is $[M^1 L^1 T^{-2}]$

The equation obtained by equating a physical quantity with its dimensional formula is called dimensional equation of the physical quantity.

Eg: for Pressure; it is

$$[P] = [M L^{-1} T^{-2}]$$

and for velocity

$$[v] = [M^0 L^1 T^{-1}]$$

Applications of Dimensional Analysis.

(i) To check the dimensional correctness of an equation:

An equation can be checked for its correctness by applying the 'principle of homogeneity of dimensions'. According to this principle, a physical relation will be dimensionally correct, if the dimensions of all the terms on both sides of the equation are same. In other words, physical quantities having same dimension can be added, subtracted or compared.

Eg: To check the dimensional accuracy of the equation of motion:

$$S = ut + \frac{1}{2}at^2$$

Dimensions of different terms are:

$$[S] = [L]$$
$$[ut] = [LT^{-1}][T] = [L]$$
$$[at^2] = [LT^{-2}][T^2] = [L]$$

As all the terms on L.H.S & R.H.S have same dimension, the given equation is dimensionally correct.

(ii) Deducing relations among physical quantities:

The method of dimensions can be used to derive relation among different physical quantities. For this, the factors on which a physical quantity depends are written as their products and the dimensions on both L.H.S and R.H.S are compared.

Limitations of dimensional analysis.

(i) The method does not give any information about dimensionless constants.

(ii) It fails when a physical quantity depends on more than three physical quantities.

(iii) If an equation is dimensionally correct, it is not assured that it is an exact equation.