***Use 4:***

***To find the dimension of constants in a given relation.***

***Using dimensional analysis, we can find the unknown dimension from a given (or established) relation.***

***Question:***

1. *Find the dimensional formula of gravitational constant.*
2. *Find the dimension of specific heat capacity.*
3. *In the relation $F = 6\pi\eta r v$, find the dimension of $\eta$.*

***Arbitrary basic quantities:***

According to SI system, the basic fundamental quantities chosen for dimensional analysis are *mass, length, and time*. However, we can choose other quantities as basic quantity in arbitrary manner so the dimensional formula of a quantity can be expressed in a new system. Those arbitrarily chosen basic quantities are called as arbitrary basic quantities.

***Question****: Considering force (F), mass (M), and velocity (V) as basic quantities, find the dimension of length.*

*Solution:*

*Let us consider the dimensional EQUATION of length be:*

$$[L] = [F^a M^b V^c] \text{.. ... .... .... .... ... (1)}$$

*Equation (1) can be written in terms of original dimensional form (fundamental basic quantities) as:*

$$[L] = [[M^1 L^1 T^{-2}]^a \quad M^b \quad [M^0 L^1 T^{-1}]^c]$$

*Or* $$[L] = [\,[M^a L^a T^{-2a}] \quad M^b \quad [M^0 L^c T^{-c}]]$$

*Or* $$[\boldsymbol{L^1}] = [M^{a+b} \quad L^{a+c} \quad T^{-2a-c}]$$

On comparing the dimensions on both sides, we get

On comparing M: $\mathrm{a} + \mathrm{b} = 0$ … ……(i)

On comparing L: $\mathrm{a} + \mathrm{c} = 1$ … …….. (ii)

On comparing T: $-2\mathrm{a} - \mathrm{c} = 0$ … … (iii)

Solving equations (i), (ii), and (iii), we get

$$a = -1, \qquad b = 1, \qquad c = 2$$

*Finally, using these values in equation (1), we get*

$$[L] = [F^{-1} M^1 V^2]$$

*Hence, the dimension of length is: -1 in force, 1 in mass and 2 in velocity.*

***Questions:***

a. *Considering force, mass and time as fundamental quantities, find the dimensional formula of velocity.*
b. *Obtain a dimensional formula of displacement considering mass M, energy E and acceleration A as basic quantity.*