Dimensions of physical quantities,

XI- SCIENCE

SUBJECT : PHYSICS
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Dimensions of physical quantities,

Dimension

Dimension of a physical quantity represents the fundamental quantities, which are present in that quantity.

The dimension of length is L .

The dimension of mass is M .

The dimension of time is T .

The dimension of electric current is I **or A**

The dimension of thermodynamic temperature is Θ **or K**

The dimension of amount of substance is N .

The dimension of luminous intensity is J .

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Dimensions of physical quantities,

Dimension of some physical quantities

Area

Area A of a rectangle = length $\times$ breadth

So the dimension or dimensional formula of area is L^2 . Symbolically we will write this

$$[A] = \mathrm{L}^2$$

Volume

Volume V of a rectangular block = area $\times$ height

So,

$$[V] = \mathrm{L}^3$$

Speed and velocity

$$\text{Speed } u = \frac{\text{distance}}{\text{time}}$$

Dimensions of physical quantities,

Velocity $v = \dfrac{\text{displacement}}{\text{time}}$

So,

$[u] = \mathrm{LT}^{-1}$

$[v] = \mathrm{LT}^{-1}$

PROBLEM Find the dimension of force, power, volume density of mass

Ans MLT^{-2}, $\mathrm{ML}^{2}\mathrm{T}^{-3}$, ML^{-3}

Note for students :

Must remember the dimensions of the quantities ;

speed , acceleration , force , linear momentum, angular momentum , area , volume , density , pressure , work or energy , power, frequeny , angular displacement , angular velocity , charge , electric potential .

Dimensions of physical quantities,

Q. Find the dimensional formula for G (Universal gravitational constant) from the formula; $F = \frac{Gm_1m_2}{r^2}$

Where symbols carry their usual meanings .

Solution:

$$F = \frac{Gm_1m_2}{r^2}$$

$$\Rightarrow G = \frac{Fr^2}{m_1m_2}$$

$$\Rightarrow [G] = \left[\frac{Fr^2}{m_1m_2}\right] = \frac{MLT^{-2}.L^2}{M.M} = M^{-1}L^3T^{-2}$$

Dimensions of physical quantities,

Q. Find the dimensional formula for h (Planck's constant) from the formula; $E = h\upsilon$

Where symbols carry their usual meanings .

Solution:

$$E = h\upsilon$$

$$\Rightarrow h = \frac{E}{\upsilon}$$

$$\Rightarrow [h] = \left[\frac{E}{\upsilon}\right] = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$$

So dimensionally Planck's constant is same as angular momentum .

Dimensions of physical quantities,

Q. Find the dimensional formula for coefficient of viscosity (η) from the formula; $F = 6\pi r v$

Where symbols carry their usual meanings .

Solution:

$$F = 6\pi\eta r\upsilon$$

$$\Rightarrow \eta = \frac{F}{6\pi r\upsilon}$$

$$\Rightarrow [\eta] = \left[\frac{F}{6\pi r\upsilon}\right] = \frac{MLT^{-2}}{L.LT^{-1}} = ML^{-1}T^{-1}$$

Dimensions of physical quantities,

Q. Find the dimensional formula for coefficient of thermal conductivity (K) from the formula; $\frac{\Delta Q}{\Delta t} = \frac{KA\Delta\theta}{\Delta x}$

Where ; .ΔQ = heat energy flowing in time Δt through a conductor of length Δx , area of cross – section A with temperature difference ΔK .

Solution:

$$\frac{\Delta Q}{\Delta t} = \frac{KA\Delta\theta}{\Delta x}$$

$$\Rightarrow K = \frac{\Delta Q}{\Delta t}\frac{\Delta x}{A\Delta\theta}$$

$$\Rightarrow [K] = \left[\frac{\Delta Q}{\Delta t}\frac{\Delta x}{A\Delta\theta}\right] = \frac{ML^2T^{-2}.L}{T.L^2.K} = ML^1T^{-3}K^{-1}$$

HOME WORK :

1. Find the dimensions of
   (a) Linear momentum (b) Frequency and
   (c) Pressure.
2. Find the dimensions of
   (a) angular speed (ω) (b) angular acceleration (α)
   (c) torque (τ) and (d) moment of inertia(I).
   some of the equations involving these quantities are

$$\omega = \frac{\theta_2 - \theta_1}{t_2 - t_1}, \alpha = \frac{\omega_2 - \omega_1}{t_2 - t_1}, \Gamma = F.r \text{ and } I = mr^2$$

   The symbols have standard meanings.
3. Find the dimensions of
   (a) Electric field E, (b) magnetic field B and
   (c) magnetic permeability .
   The relevant equations are;

$$F = qE, F = qvB, \text{ and } B = \frac{\mu_0 I}{2\pi a}$$

   where F is force, q is charge, v is speed, I is current, and a is distance.

Home work :

4. Find the dimensions of
   (a) electric dipole moment p and
   (b) magnetic dipole moment M.
   The defining equations are p = q.d and M =I A :
   where d is distance, A is area, q is charge and I is current.
5. Find the dimensions of Planck's constant h from the equation E = hv where E is the energy and v is the frequency.
6. Find the dimensions of
   (a) the specific heat capacity c,
   (b) the coefficient of linear expansion and
   (c) the gas constant R.
   Some of the equations involving these quantities are

$$Q = mc(T_2 - T_1), \ell_t = \ell_0[1 + \alpha(T_2 - T_1)]$$ and PV = nRT.

THANKING YOU

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