AVIRAL CLASSES
IIT-JEE | NEET | FOUNDATIONS

PHYSICS CRASH COURSE

LECTURE - 02

TOPICS : Unit and Dimensions

1. If the energy, $E = G^p h^q c^r$, where G is the universal gravitational constant, h is the Planck's constant and c is the speed of light, then the values of p, q and r are, respectively.

(a) $\frac{-1}{2}, \frac{1}{2}$ and $\frac{5}{2}$

(b) $\frac{1}{2}, \frac{-1}{2}$ and $\frac{-5}{2}$

(c) $\frac{-1}{2}, \frac{1}{2}$ and $\frac{3}{2}$

(d) $\frac{1}{2}, \frac{-1}{2}$ and $\frac{-3}{2}$

2. The velocity of a body moving in viscous medium is given by $V = \frac{P}{Q}(1 - e^{Qt})$ where t is time; P and Q are constants. Then the dimensions of P are

(a) M^0LT^{-2} (b) $M^0L^2T^{-2}$

(c) $M^{-1}LT^{-2}$ (d) $M^0L^0T^{-2}$

3. In the relation, y = r sin (ωt + kx), the dimensional formula for kx or ωt is same as

(a) r/ω (b) r/y

(c) ωt/r (d) yr/ωt

4. The dimensional formula for acceleration, velocity and length are $\alpha\beta^{-2}$ and $\alpha\gamma$. What is the dimensional formula for the coefficient of friciton ?

(a) $\alpha\beta\gamma$ (b) $\alpha^{-1}\beta^0\gamma^0$

(c) $\alpha^0\beta^{-1}\gamma^0$ (d) $\alpha^0\beta^0\gamma^{-1}$

5. Turpentine oil is flowing through a tube of length l and radius r. The pressure difference between the two ends of the tube is P. The viscosity of oil is given by. $\eta \frac{P(r^2 - x^2)}{4\upsilon l}$, where υ is the velocity of oil at a distance x from the axis of the tube. The dimension of η is

(a) $[M^0L^0T^0]$ (b) $[MLT^{-1}]$

(c) $[ML^2T^{-2}]$ (d) $[ML^{-1}T^{-1}]$

6. The dimensions of mobility of charge carriers are

(a) $M^{-2} T^2 A$ (b) $M^{-1} T^2 A$

(c) $M^{-2} T^3 A$ (d) $M^{-1} T^3 A$

7. The relation between force F and density d is $F = \frac{x}{\sqrt{d}}$. The dimensions of x are

(a) $[L^{-1/2} M^{3/2} T^{-2}]$

(b) $[L^{-1/2} M^{1/2} T^{-2}]$

(c) $[L^{-1} M^{3/2} T^{-2}]$

(d) $[L^{-1} M^{1/2} T^{-2}]$

8. Which of the following is a dimensionless quantity?

(a) Magnetic flux density

(b) Electric flux density

(c) Lumen flux density

(d) Optical density

9. In a vernier callipers, N divisions of vernier scale coincide with (N – 1) divison of main scale (in which one division represents 1 mm). The vernier constant is (cm)

(a) N (b) N – 1

(c) $\frac{1}{N-1}$ (d) $\frac{1}{10\ N}$

10. In the formula, $X = 3YZ^2$; X has dimensions of capacitance and Z has dimensions of magnetic induction. The dimensions of Y are

(a) $[M^{-3}L^{-2}T^{-2}A^4]$

(b) $[ML^{-2}T^2A^2]$

(c) $[M^{-3}L^{-2}T^4A^4]$

(d) $[M^{-3}L^{-2}T^8A^4]$

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TOPICS : Unit and Dimensions (SOLUTION)

1. **(a)** : $E = G^p h^q c^r$ ...(i)

Equating dimensions on both sides of equation (i), we get

$[M^1L^2T^{-2}] = [M^{-1}L^3T^{-2}]^p[ML^2T^{-1}]^q[LT^{-1}]^r$

$= [M^{-p+q}L^{3p+2q+r}T^{-2p-q-r}]$

Applying principle of homogeneity of dimensions, we get

$-p + q = 1$ ...(ii)

$3p + 2q + r = 2$ ...(iii)

$-2p - q - r = -2$ ...(iv)

Adding (iii) and (iv), we get

$p + q = 0$ ...(v)

Adding (ii) and (v), we get

$2q = 1$ or $q = \frac{1}{2}$

From (ii), $p = q - 1 = \frac{1}{2} - 1 = -\frac{1}{2}$

Substituting the values of p and q in equation (iii), we get

$-\frac{3}{2} + 1 + r = 2$ or $r = \frac{5}{2}$

Hence, $p = -\frac{1}{2}, q = \frac{1}{2}, r = \frac{5}{2}$

2. **(a)** : $V = \frac{P}{Q}(1 - e^{Qt})$

As Qt = number, $\therefore$ $[Q] = \frac{1}{[t]} = T^{-1}$

Now, $\frac{P}{Q} = V$,

$\therefore$ $[P] = [Q \times V] = T^{-1} \times LT^{-1} = [M^0LT^{-2}]$

3. **(b)** : ωt and kx both are dimensionless. Out of the given options, only r/y is dimensionless.

4. **(d)** : Here, $[a] = LT^{-2} = \alpha\beta^{-2}$

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

$\therefore$ $\alpha = L, \beta = T$

$[L] = \alpha\gamma$

$\therefore$ $\gamma = \frac{[L]}{\alpha} = \frac{L}{L} = 1$

Coefficient of friction,

$\mu = \frac{F}{R} = M^0L^0T^0$ *i.e.* dimensionless

Now, $\alpha^0\beta^0\gamma^{-1} = L^0T^0(1)^{-1} = 1$, which is dimensionless.

5. **(d)** : Dimensions of $P = [ML^{-1}T^{-2}]$

Dimensions of $r = [L]$

Dimensions of $v = [LT^{-1}]$

Dimensions of $l = [L]$

$\therefore$ Dimensions of $\eta = \frac{[P][(r^2 - x)^2]}{[v][l]} = \frac{[ML^{-1}T^{-2}][L^2]}{[LT^{-1}][L]}$

$= [ML^{-1}T^{-1}]$

6. **(b)** : Mobility, $\mu = \frac{\text{Drift velocity } (v_d)}{\text{Electric field } (E)}$

$\therefore$ $[\mu] = \frac{[v_d]}{[E]} = \frac{[M^0LT^{-1}]}{[MLT^{-3}A^{-1}]} = [M^{-1}T^2A]$

7. **(a)** : Given : $F = \frac{x}{\sqrt{d}}$

$\therefore$ $x = F\sqrt{d}$

$[x] = [L^1 M^1 T^{-2}][L^{-3} M^1 T^0]^{1/2}$

$= [L^1 M^1 T^{-2}][L^{-3/2} M^{1/2} T^0] = [L^{-1/2} M^{3/2} T^{-2}]$

8. **(d) :** Optical density is the ratio of the speed of light in two media. As optical density is the ratio of two similar physical quantities, therefore it is the dimensionless quantity. All other given physical quantities have dimensions.

9. **(d) :** N VSD = (N – 1) MSD

$$1\ \text{VSD} = \frac{N-1}{N}\ \text{MSD}$$

V.C. = 1 MSD – 1 VSD

$$= 1\ \text{MSD} - \left(\frac{N-1}{N}\right)\text{MSD} = \frac{1}{N}\ \text{MSD}$$

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

10. **(d) :** As $q = CV$,

$$\Rightarrow\ C = \frac{q}{V} = \frac{q^2}{W}\quad \left[\text{as } V = \frac{W}{q}\right]$$

$$[X] \to [C] = \left[\frac{\text{A}^2\text{T}^2}{\text{ML}^2\text{T}^{-2}}\right] = [\text{M}^{-1}\text{L}^{-2}\text{T}^4\text{A}^2]$$

$$F = BIl\sin\theta,\ [B] = \left[\frac{F}{Il}\right]$$

$$[Z] \to [B] = \left[\frac{\text{MLT}^{-2}}{\text{AL}}\right] = [\text{ML}^0\text{T}^{-2}\text{A}^{-1}]$$

Given: $X = 3YZ^2 \Rightarrow Y = X/(3Z^2)$

$$\text{or}\quad [Y] = \frac{[X]}{[Z^2]} = \frac{[\text{M}^{-1}\text{L}^{-2}\text{T}^4\text{A}^2]}{[\text{ML}^0\text{T}^{-2}\text{A}^{-1}]^2} = [\text{M}^{-3}\text{L}^{-2}\text{T}^8\text{A}^4]$$