UNIT & DIMENSION

1. The dimension of $\frac{B^2}{2\mu_0}$, where B is magnetic field and μ_0 is the magnetic permeability of vacuum, is :

(1) $ML^{-1}T^{-2}$ (2) ML^2T^{-1}

(3) MLT^{-2} (4) ML^2T^{-2}

2. The dimension of stopping potential V_0 in photoelectric effect in units of Planck's constant 'h', speed of light 'c' and Gravitational constant 'G' and ampere A is :

(1) $h^2G^{3/2}c^{1/3}A^{-1}$ (2) $h^{-2/3}c^{-1/3}G^{4/3}A^{-1}$

(3) $h^{1/3}G^{2/3}c^{1/3}A^{-1}$ (4) $h^{2/3}c^{5/3}G^{1/3}A^{-1}$

3. A quantity f is given by $f=\sqrt{\frac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and h is the Planck's constant. Dimension of f is that of :

(1) Momentum (2) Area

(3) Energy (4) Volume

4. If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be :

(1) $FA^{-1}V^0$ (2) FA^2V^{-1}

(3) FA^2V^{-3} (4) FA^2V^{-2}

5. If momentum (P), area (A) and time (T) are taken to be the fundamental quantities then the dimensional formula for energy is :

(1) $[PA^{-1}T^{-2}]$ (2) $[PA^{1/2}T^{-1}]$

(3) $[P^2AT^{-2}]$ (4) $[P^{1/2}AT^{-1}]$

6. Amount of solar energy received on the earth's surface per unit area per unit time is defined a solar constant. Dimension of solar constant is:

(1) ML^2T^{-2} (2) MLT^{-2}

(3) $M^2L^0T^{-1}$ (4) ML^0T^{-3}

7. A quantity x is given by (IFv^2/WL^4) in terms of moment of inertia I, force F, velocity v, work W and Length L. The dimensional formula for x is same as that of :

(1) Planck's constant

(2) Force constant

(3) Energy density

(4) Coefficient of viscosity

8. The quantities $x=\frac{1}{\sqrt{\mu_0 \in_0}}$, $y=\frac{E}{B}$ and $z=\frac{1}{CR}$ are defined where C-capacitance, R-Resistance, *l*-length, E-Electric field, B-magnetic field and $\in_0$, μ_0,-free space permittivity and permeability respectively. Then :

(1) Only x and y have the same dimension

(2) x, y and z have the same dimension

(3) Only x and z have the same dimension

(4) Only y and z have the same dimension

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SOLUTION

1. NTA Ans. (1)

Sol. Magnetic energy stored per unit volume is

$\frac{B^2}{2\mu_0}$ $\Rightarrow$ Dimension is $ML^{-1}T^{-2}$

2. NTA Ans. (BONUS)

Sol. $v_0 = h^x c^y G^z A^w$

$$\frac{ML^2T^{-2}}{AT} = (ML^2T^{-1})^x (LT^{-1})^y (M^{-1}L^3T^{-2})^z A^w$$

$\Rightarrow w = -1$

$(x - z = 1)$

$2x + y + 3x = 2$

$- x - y - 2z = -3$

$2x = 0$

$x = 0$

$z = -1$

$2 \times 0 + y + 3x - 1 = 2$

$y = 5 \quad \Rightarrow v_0 = h^0 c^5 G^{-1} A^{-1}$

So Bonus

3. NTA Ans. (3)

Sol. $[h] = M^1L^2T^{-1}$

$[C] = L^1T^{-1}$

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

$$[f] = \sqrt{\frac{M^1L^2T^{-1} \times L^5T^{-5}}{M^{-1}L^3T^{-2}}} = M^1L^2T^{-2}$$

4. Official Ans. by NTA (1)

Sol. $Y = F^x A^y V^z$

$M^1L^{-1}T^{-2} = [MLT^{-2}]^x [L^2]^y [LT^{-1}]^z$

$M^1L^1T^{-2} = [M]^x [L]^{x+2y+z} [T]^{-2x-z}$

comparing power of ML and T

$x = 1 ...(1)$

$x + 2y + z = -1 ....(2)$

$-2x - z = -2 ...(3)$

after solving

$x = 1$

$y = -1$

$z = 0$

$Y = FA^{-1}V^0$

5. Official Ans. by NTA (2)

Sol. Let $[E] = [P]^x [A]^y [T]^z$

$ML^2T^{-2} = [MLT^{-1}]^x [L^2]^y [T]^z$

$ML^2T^{-2} = M^x L^{x+2y} T^{-x+z}$

$\rightarrow x = 1$

$\rightarrow x + 2y = 2$

$1 + 2y = 2$

$$y = \frac{1}{2}$$

$\rightarrow -x + z = -2$

$-1 + z = -2$

$z = -1$

$[E] = [PA^{1/2} T^{-1}]$

6. Official Ans. by NTA (4)

Sol. $S = \frac{P}{A} = \frac{ML^2T^{-3}}{L^2} = MT^{-3}$

7. Official Ans. by NTA (3)

Sol. $x = \frac{IFV^2}{WL^4}$

$$[x] = \frac{[ML^2][MLT^{-2}][LT^{-1}]^2}{[ML^2T^{-2}][L]^4}$$

$[x] = [ML^{-1}T^{-2}]$

$$[\text{Energy density}] = \left[\frac{E}{V}\right]$$

$$= \left[\frac{ML^2T^{-2}}{L^3}\right]$$

$= [ML^{-1}T^{-2}]$

Same as x

8. Official Ans. by NTA (2)

Sol. $x = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = \text{speed} \Rightarrow [x] = [L^1T^{-1}]$

$y = \frac{E}{B} = \text{speed} \Rightarrow [y] = [L^1T^{-1}]$

$z = \frac{\ell}{RC} = \frac{\ell}{\tau} \Rightarrow [z] = [L^1T^{-1}]$

So, x, y, z all have the same dimensions.

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