## UNIT \& DIMENSION

1. The workdone by a gas molecule in an isolated system is given by, $W=\alpha \beta^{2} e^{-\frac{x^{2}}{\alpha k T}}$, where $x$ is the displacement, k is the Boltzmann constant and T is the temperature, $\alpha$ and $\beta$ are constants. Then the dimension of $\beta$ will be :
(1) $\left[\mathrm{M} \mathrm{L}^{2} \mathrm{~T}^{-2}\right]$
(2) $\left[\mathrm{M} \mathrm{L} \mathrm{T}^{-2}\right]$
(3) $\left[\mathrm{M}^{2} \mathrm{~L} \mathrm{~T}^{2}\right]$
(4) $\left[\mathrm{M}^{0} \mathrm{~L} \mathrm{~T}^{0}\right]$
2. Match List-I with List-II :

## List-I

(a) h (Planck's constant)

## List-II

(i) $\left[\mathrm{M} \mathrm{L} \mathrm{T}^{-1}\right]$
(b) E (kinetic energy)
(ii) $\left[\mathrm{M} \mathrm{L}^{2} \mathrm{~T}^{-1}\right]$
(c) V (electric potential)
(iii) $\left[\mathrm{M} \mathrm{L}^{2} \mathrm{~T}^{-2}\right]$
(d) P (linear momentum) (iv) $\left[\mathrm{M}^{2} \mathrm{I}^{-1} \mathrm{~T}^{-3}\right]$

Choose the correct answer from the options given below :
(1) (a) $\rightarrow$ (iii), (b) $\rightarrow$ (iv), (c) $\rightarrow$ (ii), (d) $\rightarrow$ (i)
(2) (a) $\rightarrow$ (ii), (b) $\rightarrow$ (iii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)
(3) (a) $\rightarrow$ (i), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (iii)
(4) (a) $\rightarrow$ (iii), (b) $\rightarrow$ (ii), (c) $\rightarrow$ (iv), (d) $\rightarrow$ (i)
3. If e is the electronic charge, c is the speed of light in free space and $h$ is Planck's constant, the quantity $\frac{1}{4 \pi \varepsilon_{0}} \frac{|\mathrm{e}|^{2}}{h c}$ has dimensions of :
(1) $\left[\mathrm{M}^{0} \mathrm{~L}^{0} \mathrm{~T}^{0}\right]$
(2) $\left[\mathrm{L} \mathrm{C}^{-1}\right]$
(3) $\left[\mathrm{M} \mathrm{L} \mathrm{T}^{-1}\right]$
(4) $\left[\mathrm{M} \mathrm{L} \mathrm{T}{ }^{0}\right]$
4. In a typical combustion engine the work done by a gas molecule is given $\mathrm{W}=\alpha^{2} \beta \mathrm{e}^{\frac{-\beta \mathrm{x}^{2}}{\mathrm{kT}}}$, where x is the displacement, k is the Boltzmann constant and T is the temperature. If $\alpha$ and $\beta$ are constants, dimensions of $\alpha$ will be :
(1) $\left[\mathrm{MLT}^{-2}\right]$
(2) $\left[\mathrm{M}^{0} \mathrm{LT}^{0}\right]$
(3) $\left[\mathrm{M}^{2} \mathrm{LT}^{-2}\right]$
(4) $\left[\mathrm{MLT}^{-1}\right]$
5. If ' C ' and ' $V$ ' represent capacity and voltage respectively then what are the dimensions of $\lambda$, where $\frac{\mathrm{C}}{\mathrm{V}}=\lambda$ ?
(1) $\left[\mathrm{M}^{-2} \mathrm{~L}^{-3} \mathrm{I}^{2} \mathrm{~T}^{6}\right]$
(2) $\left[\mathrm{M}^{-3} \mathrm{~L}^{-4} \mathrm{H}^{3} \mathrm{~T}^{7}\right]$
(3) $\left[\mathrm{M}^{-1} \mathrm{~L}^{-3} \mathrm{I}^{-2} \mathrm{~T}^{-7}\right]$
(4) $\left[\mathrm{M}^{-2} \mathrm{~L}^{-4} \mathrm{I}^{3} \mathrm{~T}^{7}\right]$
6. If time $(t)$, velocity $(v)$, and angular momentum $(l)$ are taken as the fundamental units. Then the dimension of mass (m) in terms of $t, v$ and $l$ is:
(1) $\left[t^{-1} v^{1} l^{-2}\right]$
(2) $\left[t^{1} v^{2} l^{-1}\right]$
(3) $\left[t^{-2} v^{-1} l^{1}\right]$
(4) $\left[t^{-1} v^{-2} l^{1}\right]$
7. The force is given in terms of time $t$ and displacement x by the equation
$\mathrm{F}=\mathrm{A} \cos \mathrm{Bx}+\mathrm{C} \sin \mathrm{Dt}$
The dimensional formula of $\frac{A D}{B}$ is :
(1) $\left[\mathrm{M}^{0} \mathrm{~L} \mathrm{~T}^{-1}\right]$
(2) $\left[\mathrm{M} \mathrm{L}^{2} \mathrm{~T}^{-3}\right]$
(3) $\left[\mathrm{M}^{1} \mathrm{~L}^{1} \mathrm{~T}^{-2}\right]$
(4) $\left[\mathrm{M}^{2} \mathrm{~L}^{2} \mathrm{~T}^{-3}\right]$
8. If $\mathrm{E}, \mathrm{L}, \mathrm{M}$ and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $\mathrm{P}=\mathrm{EL}^{2} \mathrm{M}^{-5} \mathrm{G}^{-2}$ are :-
(1) $\left[\mathrm{M}^{0} \mathrm{~L}^{1} \mathrm{~T}^{0}\right]$
(2) $\left[\mathrm{M}^{-1} \mathrm{~L}^{-1} \mathrm{~T}^{2}\right]$
(3) $\left[\mathrm{M}^{1} \mathrm{~L}^{1} \mathrm{~T}^{-2}\right]$
(4) $\left[\mathrm{M}^{0} \mathrm{~L}^{0} \mathrm{~T}^{0}\right]$
9. Match List-I with List-II.

| List-I |  | List-II |  |
| :--- | :--- | :--- | :--- |
| (a) | Magnetic Induction | (i) | $\mathrm{ML}^{2} \mathrm{~T}^{-2} \mathrm{~A}^{-1}$ |
| (b) | Magnetic Flux | (ii) | $\mathrm{M}^{0} \mathrm{~L}^{-1} \mathrm{~A}$ |
| (c) | Magnetic <br> Permeability | (iii) | $\mathrm{MT}^{-2} \mathrm{~A}^{-1}$ |
| (d) | Magnetization | (iv) | $\mathrm{MLT}^{-2} \mathrm{~A}^{-2}$ |

Choose the most appropriate answer from the options given below :
(1) (a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)
(2) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)
(3) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
(4) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
10. Which of the following is not a dimensionless quantity?
(1) Relative magnetic permeability $\left(\mu_{\mathrm{r}}\right)$
(2) Power factor
(3) Permeability of free space $\left(\mu_{0}\right)$
(4) Quality factor
11. If E and H represents the intensity of electric field and magnetising field respectively, then the unit of $\mathrm{E} / \mathrm{H}$ will be :
(1) ohm
(2) mho
(3) joule
(4) newton
12. Match List-I with List-II.

## List-I List-II

(a) $\mathrm{R}_{\mathrm{H}}$ (Rydberg constant)
(i) $\mathrm{kg} \mathrm{m}^{-1} \mathrm{~s}^{-1}$
(b) $h$ (Planck's constant)
(ii) $\mathrm{kg} \mathrm{m}^{2} \mathrm{~s}^{-1}$
(c) $\mu_{\mathrm{B}}$ (Magnetic field
(iii) $\mathrm{m}^{-1}$ energy density)
(d) $\eta$ (coefficient of viscocity) (iv) $\mathrm{kg} \mathrm{m}^{-1} \mathrm{~s}^{-2}$

Choose the most appropriate answer from the options given below :
(1) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)
(2) (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)
(3) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)
(4) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)
13. If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density :
(1) $\left[\mathrm{FL}^{-4} \mathrm{~T}^{2}\right]$
(2) $\left[\mathrm{FL}^{-3} \mathrm{~T}^{2}\right]$
(3) $\left[\mathrm{FL}^{-5} \mathrm{~T}^{2}\right]$
(4) $\left[\mathrm{FL}^{-3} \mathrm{~T}^{3}\right]$
14. Match List-I with List-II.

## List-I

(a) Torque
(b) Impulse
(c) Tension
(d) Surface Tension

## List-II

(i) $\mathrm{MLT}^{-1}$
(ii) $\mathrm{MT}^{-2}$
(iii) $\mathrm{ML}^{2} \mathrm{~T}^{-2}$
(iv) $\mathrm{MLT}^{-2}$

Choose the most appropriate answer from the option given below :
(1) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
(2) (a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)
(3) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)
(4) (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)
15. Which of the following equations is dimensionally incorrect?
Where $\mathrm{t}=$ time, $\mathrm{h}=$ height, $\mathrm{s}=$ surface tension, $\theta=$ angle, $\rho=$ density, $\mathrm{a}, \mathrm{r}=$ radius, $\mathrm{g}=$ acceleration due to gravity, $\mathrm{v}=$ volume , $\mathrm{p}=$ pressure, $\mathrm{W}=$ work done, $\Gamma=$ torque, $\in=$ permittivity, $\mathrm{E}=$ electric field, $\mathrm{J}=$ current density, L = length.
(1) $v=\frac{\pi p a^{4}}{8 \eta L}$
(2) $\mathrm{h}=\frac{2 \mathrm{~s} \cos \theta}{\rho r g}$
(3) $J=\epsilon \frac{\partial \mathrm{E}}{\partial \mathrm{t}}$
(4) $\mathrm{W}=\Gamma \theta$
16. If velocity [V], time $[\mathrm{T}]$ and force $[\mathrm{F}]$ are chosen as the base quantities, the dimensions of the mass will be :
(1) $\left[\mathrm{FT}^{-1} \mathrm{~V}^{-1}\right]$
(2) $\left[\mathrm{FTV}^{-1}\right]$
(3) $\left[\mathrm{FT}^{2} \mathrm{~V}\right]$
(4) $\left[\mathrm{FVT}^{-1}\right]$

## SOLUTION

1. Official Ans. by NTA (2)

Sol. $\frac{\mathrm{x}^{2}}{\alpha \mathrm{kT}} \rightarrow$ dimensionless
$\Rightarrow[\alpha]=\frac{\left[\mathrm{x}^{2}\right]}{[\mathrm{kT}]}=\frac{\mathrm{L}^{2}}{\mathrm{ML}^{2} \mathrm{~T}^{-2}}=\mathrm{M}^{-1} \mathrm{~T}^{2}$
Now $[\mathrm{W}]=[\alpha][\beta]^{2}$
$[\beta]=\sqrt{\frac{\mathrm{ML}^{2} \mathrm{~T}^{-2}}{\mathrm{M}^{-1} \mathrm{~T}^{2}}}=\mathrm{M}^{1} \mathrm{~L}^{1} \mathrm{~T}^{-2}$
2. Official Ans. by NTA (2)

Sol. By dimensional analysis.
3. Official Ans. by NTA (1)

Sol. $\mathrm{F}=\frac{1}{4 \pi \epsilon_{0} \mathrm{e}^{2}} ; \quad \mathrm{E}=\frac{\mathrm{hc}}{\lambda}$
$\left[\frac{\mathrm{e}^{2}}{4 \pi \varepsilon_{0}} \times \frac{1}{\mathrm{hc}}\right]=\frac{\mathrm{Fr}^{2}}{\mathrm{E} \mathrm{\lambda}}=\left(\mathrm{M}^{0} \mathrm{~L}^{0} \mathrm{~T}^{0}\right)$
4. Official Ans. by NTA (2)

Sol. kT has dimension of energy
$\frac{\beta \mathrm{x}^{2}}{\mathrm{kT}}$ is dimensionless
$[\beta]\left[\mathrm{L}^{2}\right]=\left[\mathrm{ML}^{2} \mathrm{~T}^{-2}\right]$
$[\beta]=\left[\mathrm{MT}^{-2}\right]$
$\alpha^{2} \beta$ has dimensions of work
$\left[\alpha^{2}\right]\left[\mathrm{MT}^{-2}\right]=\left[\mathrm{ML}^{2} \mathrm{~T}^{-2}\right]$
$[\alpha]=\left[\mathrm{M}^{0} \mathrm{LT}^{0}\right]$
Ans. 2
5. Official Ans. by NTA (4)

Sol. $\lambda=\frac{\mathrm{C}}{\mathrm{V}}=\frac{\mathrm{Q} / \mathrm{V}}{\mathrm{V}}=\frac{\mathrm{Q}}{\mathrm{V}^{2}}$
$\mathrm{V}=\frac{\text { work }}{\mathrm{Q}}$
$\lambda=\frac{\mathrm{Q}^{3}}{(\text { work })^{2}}=\frac{(\mathrm{It})^{3}}{\left(\mathrm{~F} . \mathrm{s}^{2}\right.}$
$=\frac{\left[\mathrm{I}^{3} \mathrm{~T}^{3}\right]}{\left[\mathrm{ML}^{2} \mathrm{~T}^{-2}\right]^{2}}=\left[\mathrm{M}^{-2} \mathrm{~L}^{-4} \mathrm{I}^{3} \mathrm{~T}^{7}\right]$
6. Official Ans. by NTA (4)

Sol. $m \propto t^{a} v^{b} \ell^{c}$
$m \propto[T]^{a}\left[\mathrm{LT}^{-1}\right]^{b}\left[\mathrm{ML}^{2} \mathrm{~T}^{-1}\right]^{c}$
$\mathrm{M}^{1} \mathrm{~L}^{0} \mathrm{~T}^{0}=\mathrm{M}^{\mathrm{c}} \mathrm{L}^{\mathrm{b}+2 \mathrm{c}} \mathrm{T}^{\mathrm{ab}-\mathrm{c}}$
comparing powers
$\mathrm{c}=1, \mathrm{~b}=-2, \mathrm{a}=-1$
$\mathrm{m} \propto \mathrm{t}^{-1} \mathrm{v}^{-2} \ell^{1}$
7. Official Ans. by NTA (2)

Sol. $[\mathrm{A}]=\left[\mathrm{MLT}^{-2}\right]$
$[\mathrm{B}]=\left[\mathrm{L}^{-1}\right]$
[D] $=\left[\mathrm{T}^{-1}\right]$
$\left[\frac{\mathrm{AD}}{\mathrm{B}}\right]=\frac{\left[\mathrm{MLT}^{-2}\right]\left[\mathrm{T}^{-1}\right]}{\left[\mathrm{L}^{-1}\right]}$
$\left[\frac{\mathrm{AD}}{\mathrm{B}}\right]=\left[\mathrm{ML}^{2} \mathrm{~T}^{-3}\right]$
8. Official Ans. by NTA (4)

Sol. $\mathrm{E}=\mathrm{ML}^{2} \mathrm{~T}^{-2}$
$\mathrm{L}=\mathrm{ML}^{2} \mathrm{~T}^{-1}$
$\mathrm{m}=\mathrm{M}$
$\mathrm{G}=\mathrm{M}^{-1} \mathrm{~L}^{+3} \mathrm{~T}^{-2}$
$\mathrm{P}=\frac{\mathrm{EL}^{2}}{\mathrm{M}^{5} \mathrm{G}^{2}}$
$[P]=\frac{\left(\mathrm{ML}^{2} \mathrm{~T}^{-2}\right)\left(\mathrm{M}^{2} \mathrm{~L}^{4} \mathrm{~T}^{-2}\right)}{\mathrm{M}^{5}\left(\mathrm{M}^{-2} \mathrm{~L}^{6} \mathrm{~T}^{-4}\right)}=\mathrm{M}^{0} \mathrm{~L}^{0} \mathrm{~T}^{0}$
Option (4)
9. Official Ans. by NTA (4)

Sol. (a) Magnetic Induction $=\mathrm{MT}^{-2} \mathrm{~A}^{-1}$
(b) Magnetic Flux $=\mathrm{ML}^{2} \mathrm{~T}^{-2} \mathrm{~A}^{-1}$
(c) Magnetic Permeability $=\mathrm{MLT}^{-2} \mathrm{~A}^{-2}$
(d) Magnetization $=\mathrm{M}^{0} \mathrm{~L}^{-1} \mathrm{~A}$

Ans. 4
10. Official Ans. by NTA (3)

Sol. $\left[\mu_{\mathrm{r}}\right]=1$ as $\mu_{\mathrm{r}}=\frac{\mu}{\mu_{\mathrm{m}}}$
$[$ power factor $(\cos \phi)]=1$
$\mu_{0}=\frac{\mathrm{B}_{0}}{\mathrm{H}}\left(\right.$ unit $\left.=\mathrm{NA}^{-2}\right):$ Not dimensionless
$\left[\mu_{0}\right]=\left[\mathrm{MLT}^{-2} \mathrm{~A}^{-2}\right]$
quality factor $(\mathrm{Q})=\frac{\text { Energy stored }}{\text { Energy dissipated per cycle }}$
So Q is unitless \& dimensionless.
11. Official Ans. by NTA (1)

Sol. Unit of $\frac{\mathrm{E}}{\mathrm{H}}$ is $\frac{\text { volt / metre }}{\text { Ampere / metre }}$
$=\frac{\text { volt }}{\text { Ampere }}=$ ohm
12. Official Ans. by NTA (2)

Sol. SI unit of Rydberg const. $=\mathrm{m}^{-1}$
SI unit of Plank's const. $=\mathrm{kg} \mathrm{m}^{2} \mathrm{~s}^{-1}$
SI unit of Magnetic field energy density $=\mathrm{kg} \mathrm{m}^{-}$ ${ }^{1} \mathrm{~S}^{-2}$
SI unit of coeff. of viscosity $=\mathrm{kg} \mathrm{m}^{-1} \mathrm{~s}^{-1}$
13. Official Ans. by NTA (1)

Sol. Density $=\left[F^{a} L^{b} T^{c}\right]$
$\left[\mathrm{ML}^{-3}\right]=\left[\mathrm{M}^{\mathrm{a}} \mathrm{L}^{\mathrm{a}} \mathrm{T}^{-2 \mathrm{a}} \mathrm{L}^{\mathrm{b}} \mathrm{T}^{\mathrm{c}}\right]$
$\left[\mathrm{M}^{1} \mathrm{~L}^{-3}\right]=\left[\mathrm{M}^{\mathrm{a}} \mathrm{L}^{\mathrm{a+b}} \mathrm{~T}^{-2 \mathrm{a}+\mathrm{c}}\right]$
$\mathrm{a}=1 ; \mathrm{a}+\mathrm{b}=-3 ;-2 \mathrm{a}+\mathrm{c}=0$
$1+\mathrm{b}=-3 \quad \mathrm{c}=2 \mathrm{a}$
$\mathrm{b}=-4 \quad \mathrm{c}=2$
So, density $=\left[\mathrm{F}^{1} \mathrm{~L}^{-4} \mathrm{~T}^{2}\right]$
14. Official Ans. by NTA (1)

Sol. torque $\tau \rightarrow \mathrm{ML}^{2} \mathrm{~T}^{-2}$ (III)
Impulse $\mathrm{I} \Rightarrow \mathrm{MLT}^{-1}$ (I)
Tension force $\Rightarrow \mathrm{MLT}^{-2}$ (IV)
Surface tension $\Rightarrow \mathrm{MT}^{-2}$ (II)
Option (1)
15. Official Ans. by NTA (1)

Sol. (i) $\frac{\pi \mathrm{pa}^{4}}{8 \eta \mathrm{~L}}=\frac{\mathrm{dv}}{\mathrm{dt}}=$ Volumetric flow rate (poiseuille's law)
(ii) $\mathrm{h} \rho \mathrm{g}=\frac{2 \mathrm{~s}}{\mathrm{r}} \cos \theta$
(iii) $\mathrm{RHS} \Rightarrow \varepsilon \times \frac{1}{4 \pi \varepsilon_{0}} \frac{\mathrm{a}}{\mathrm{r}^{2}} \times \frac{1}{\varepsilon}=\frac{\mathrm{q}}{\mathrm{t}} \times \frac{1}{\mathrm{r}^{2}}$
$=\frac{\mathrm{I}}{\mathrm{L}^{2}}=\mathrm{IL}^{-2}$
LHS
$\mathrm{T}=\frac{\mathrm{I}}{\mathrm{A}}=\mathrm{IL}^{-2}$
(iv) $\mathrm{W}=\tau \theta$

Option (1)
16. Official Ans. by NTA (2)

Sol. $[\mathrm{M}]=\mathrm{K}[\mathrm{F}]^{\mathrm{a}}[\mathrm{T}]^{\mathrm{b}}[\mathrm{V}]^{\mathrm{c}}$
$\left[\mathrm{M}^{1}\right]=\left[\mathrm{M}^{1} \mathrm{~L}^{1} \mathrm{~T}^{-2}\right]^{\mathrm{a}}\left[\mathrm{T}^{1}\right]^{\mathrm{b}}\left[\mathrm{L}^{1} \mathrm{~T}^{-1}\right]^{\mathrm{c}}$
$\mathrm{a}=1, \mathrm{~b}=1, \mathrm{c}=-1$
$\therefore[\mathrm{M}]=\left[\mathrm{FTV}^{-1}\right]$

