Physical World, Units and Measurements

Question1

In a vernier callipers, (N + 1) divisions of vernier scale coincide with N divisions of main scale. If 1 MSD represents 0.1mm, the vernier constant (in cm) is:

[NEET 2024]

Options:

A.

1/10N

B.

1/100(N + 1)

C.

100N

D.

10(N + 1)

Answer: B

Solution:

V.C = MSD - VSD ....(1)

given : $(N+1)$ VSD $= N$ MSD

$$\text{VSD} = \left(\frac{N}{N+1}\right)\text{MSD} \text{ ....(2)}$$

From (1) and (2)

$$V.C = (MSD) - \frac{N}{N+1}(MSD)$$

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

$$= \frac{0.01}{N+1} = \frac{1}{100(N+1)}$$

Question2

The quantities which have the same dimensions as those of solid angle are:

[NEET 2024]

Options:

A.

strain and angle

B.

stress and angle

C.

strain and arc

D.

angular speed and stress

Answer: A

Solution:

Solid angle $d\Omega = \frac{dA}{r^2}$ has dimensions $[M^0L^0T^0]$

Strain $= \frac{\Delta l}{l}$ has dimensions $[M^0L^0T^0]$

Angle measured in radians is also dimensionless $[M^0L^0T^0]$

$\theta = \frac{l}{r}$

Question3

A force defined by $F = \alpha t^2 + \beta t$ acts on a particle at a given time t. The factor which is dimensionless, if α and β are constants, is:

[NEET 2024]

Options:

A.

$\beta t/\alpha$

B.

$\alpha t/\beta$

C.

$\alpha\beta t$

D.

$\alpha\beta/t$

Answer: B

Solution:

From principle of homogeneity

$$[F] = [\alpha t^2] = [\beta t]$$

$$[\alpha] = \frac{[F]}{[t^2]} \text{ and } [\beta] = \frac{[F]}{[t]}$$

$$\therefore \quad [\alpha][t] = [\beta]$$

$$\therefore \quad \frac{\alpha t}{\beta} = \text{ dimensionless}$$

Question4

In an electrical circuit, the voltage is measured as V = (200 ± 4) volt and the current is measured as I = (20 ± 0.2) A. The value of the resistance is:

[NEET 2024 Re]

Options:

A.

(10 ± 4.2) Ω

B.

(10 ± 0.3) Ω

C.

(10 ± 0.1) Ω

D.

(10 ± 0.8) Ω

Answer: B

Solution:

$$R = \frac{V}{I} = \frac{200}{20} = 10\Omega$$

$$\frac{\Delta R}{R} = \frac{\Delta V}{V} + \frac{\Delta I}{I} = \frac{4}{200} + \frac{0.2}{20} = \frac{4+2}{200} = \frac{6}{200}$$

$$\Rightarrow \Delta R = \frac{6}{200} \times R = \frac{6}{20} = \frac{3}{10} = 0.3\Omega$$

$$\therefore \quad \text{Resistance} = R \pm \Delta R = (10 \pm 0.3)\Omega$$

Question5

The pitch of an error free screw gauge is 1mm and there are 100 divisions on the circular scale. While measuring the diameter of a thick wire, the pitch scale reads 1mm and 63rd division on the circular scale coincides with the reference line. The diameter of the wire is:

[NEET 2024 Re]

Options:

A.

1.63cm

B.

0.163cm

C.

0.163m

D.

1.63m

Answer: B

Solution:

$$\text{Least count of screw gauge} = \frac{\text{Pitch}}{\text{No. of divisions on circular scale}}$$

$$\Rightarrow \text{Least count} = \frac{1}{100} = 0.01\ \text{mm}$$

$$\text{Final reading} = \text{MSR} + \text{CSR} \times \text{L.C.}$$

$$= 1\ \text{mm} + (63)(0.01)\ \text{mm}$$

$$= 1.63\ \text{mm}$$

$$= 0.163\ \text{cm}$$

Question6

The potential energy of a particle moving along x-direction varies as $V = \frac{Ax^2}{\sqrt{x}+B}$. The dimensions of A^2/B are:

[NEET 2024 Re]

Options:

A.

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

B.

$[M^{1/2}LT^{-3}]$

C.

$[M^2L^{1/2}T^{-4}]$

D.

$[ML^2T^{-4}]$

Answer: C

Solution:

$V = \frac{Ax^2}{\sqrt{x}+B}$ As per homogeneous rule $B = \sqrt{L}$

$ML^2T^{-2} = \frac{AL^2}{L^{1/2}}$

$A = ML^{1/2}T^{-2}$

$\frac{A^2}{B} = \frac{M^2LT^{-4}}{L^{1/2}} = M^2L^{1/2}T^{-4}$

Question7

The diameter of a spherical bob, when measured with vernier callipers yielded the following values : 3.33cm,3.32cm,3.34cm,3.33cm and 3.32cm. The mean diameter to appropriate significant figures is :

[NEET 2023 mpr]

Options:

A.

3.328cm

B.

3.3cm

C.

3.33cm

D.

3.32cm

Answer: D

Solution:

Mean diameter $= \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5}$

$= \frac{3.33 + 3.32 + 3.34 + 3.33 + 3.32}{5}$

$= 3.328 \approx 3.33$

Question8

The mechanical quantity, which has dimensions of reciprocal of mass (M^{-1}) is :
[NEET 2023 mpr]

Options:

A.

angular momentum

B.

coefficient of thermal conductivity

C.

torque

D.

gravitational constant

Answer: D

Solution:

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

Coeff of thermal conductivity $= [MLT^{-3}K^{-1}]$

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

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

So, gravitational constant has power of (-1) of M.

Question9

The errors in the measurement which arise due to unpredictable fluctuations in temperature and voltage supply are

[NEET 2023]

Options:

A.

Personal errors

B.

Least count errors

C.

Random errors

D.

Instrumental errors

Answer: C

Solution:

The errors which cannot be associated with any systematic or constant cause are called random errors. These errors can arise due to unpredictable fluctuations in experimental conditions. e.g., random change in pressure, temperature, voltage supply etc.

Question10

A metal wire has mass (0.4 ± 0.002)g, radius (0.3 ± 0.001)mm and length (5 ± 0.02)cm. The maximum possible percentage error in the measurement of density will nearly be

[NEET 2023]

Options:

A.

1.3%

B.

1.6%

C.

1.4%

D.

1.2%

Answer: B

Solution:

We know, $\rho = \frac{\text{Mass}}{\text{Volume}} = \frac{M}{\pi r^2 \ell}$

Using the concept of errors we know,

$$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + \frac{2\,\Delta r}{r} + \frac{\Delta\ell}{\ell}$$

$$= \left(\frac{0.002}{0.4} + \frac{2 \times 0.001}{0.3} + \frac{0.02}{5}\right)$$

$$\frac{\Delta\rho}{\rho} = 0.0156$$

$$\frac{\Delta\rho}{\rho}\% = 1.56\% \approx 1.6\%$$

Question11

Plane angle and solid angle have [NEET-2022]

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Options:

A. Units but no dimensions

B. Dimensions but no units

C. No units and no dimensions

D. Both units and dimensions

Answer: A

Solution:

$$\text{Plane angle} = \frac{\text{Arc}}{\text{Radius}} = \frac{[L]}{[L]} \longrightarrow \text{Unit} = \text{Radian}$$

$$= [M^0 L^0 T^0]$$

$$\text{Solid angle} = \frac{\text{Area}}{(\text{Radius})^2} \longrightarrow \text{Unit} = \text{Steradian}$$

$$= \frac{L^2}{L^2} = [M^0 L^0 T^0]$$

$\therefore$ Both have units but no dimensions

Question12

The area of a rectangular field (in m^2) of length 55.3m and breadth 25m after rounding off the value for correct significant digits is [NEET-2022]

Options:

A. 138×10^1

B. 1382

C. 1382.5

D. 14×10^2

Answer: D

Solution:

$$\text{Area} = \text{Length} \times \text{Breadth}$$

$$= 55.3 \times 25 m^2$$

$$= 1382.5 m^2$$

$$= 14 \times 10^2 m^2 \text{ (Rounding off of two significant figures)}$$

Question13

The physical quantity that has the same dimensional formula as pressure is:
[NEET Re-2022]

Options:

A. Coefficient of viscosity

B. Force

C. Momentum

D. Young's modulus of elasticity

Answer: D

Solution:

Solution:

Pressure $= \frac{F}{A}$

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

Young's modulus $Y = \frac{\text{Stess}}{\text{Strain}}$

$$[Y] = \frac{\frac{F}{A}}{\frac{\Delta L}{L}} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$$

Question14

The percentage error in the measurement of g is:
(Given that g = $\frac{4\pi^2 L}{T^2}$, L = (10 ± 0.1) cm, T = (100 ± 1)s)
[NEET Re-2022]

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Options:

A. 7%

B. 2%

C. 5%

D. 3%

Answer: D

Solution:

Solution:

$$g = \frac{4\pi^2 L}{T^2}$$

$$\frac{\Delta g}{g} \times 100 = \frac{\Delta L}{L} \times 100 + 2\frac{\Delta T}{T} \times 100$$

$$= \left(\frac{0.1}{10} \times 100\right) + 2\left[\frac{1}{100} \times 100\right]$$

$$\frac{\Delta g}{g} \times 100 = 1 + 2 = 3\%$$

Question15

If force [F], acceleration [A] and time [T] are chosen as the fundamental physical quantities. Find the dimensions of energy.
[NEET 2021]

Options:

A. $[F][A][T]$

B. $[F][A][T^2]$

C. $[F][A][T^{-1}]$

D. $[F][A^{-1}][T]$

Answer: B

Solution:

Energy, $E \propto F^a A^b T^c$
$[E] = [F^a][A^b][T^c]$
$\Rightarrow [ML^2T^{-2}] = [MLT^{-2}]^a[LT^{-2}]^b[T]^c$
$[ML^2T^{-2}] = [M^a L^{a+b} T^{-2a-2b+c}]$
Comparing dimensions on both sides.
$\Rightarrow a = 1$; $a + b = 2$ and $-2 = -2a - 2b + c$
$\Rightarrow b = 1 \quad \Rightarrow -2 = -2 - 2 + c$
$\Rightarrow c = 2$
$[E] = [FAT^2]$

Question16

A screw gauge gives the following readings when used to measure the diameter of a wire
Main scale reading : 0 mm
Circular scale reading : 52 divisions
Given that 1 mm on main scale corresponds to 100 divisions on the circular scale. The diameter of the wire from the above data is [NEET 2021]

Options:

A. 0.52 cm

B. 0.026 cm

C. 0.26 cm

D. 0.052 cm

Answer: D

Solution:

Solution:
Here, pitch of the screw gauge, P = 1 mm

Number of circular division, n = 100

Thus least count LC = $\frac{P}{n} = \frac{1}{100} = 0.01\text{mm}$

= 0.001 cm

So, diameter of the wire = MSR + (CSR × LC)

= 0 + (52 × 0.001 cm)

= 0.052 cm

Question17

If E and G respectively denote energy and gravitational constant, then $\frac{E}{G}$ has the dimensions of
[NEET 2021]

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Options:

A. $[M^2][L^{-1}][T^0]$

B. $[M][L^{-1}][T^{-1}]$

C. $[M][L^0][T^0]$

D. $[M^2][L^{-2}][T^{-1}]$

Answer: A

Solution:

Solution:

Dimensional formula of energy

$[E] = [M^1L^2T^{-2}]$ ....(I)

Dimensional formula of gravitational constant

$[G] = [M^{-1}L^3T^{-2}]$ ....(II)

From (I) & (II)

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

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

Hence, dimensions of $\left[\frac{E}{G}\right] = [M^2L^{-1}T^0]$

So, correct option is (1)

Question18

Dimensions of stress are :
(2020)

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Options:

A. $[ML^2T^{-2}]$

B. $[M L^0 T^{-2}]$

C. $[M L^{-1} T^{-2}]$

D. $[M L T^{-2}]$

Answer: C

Solution:

Solution:

Stress $= \frac{\text{Force}}{\text{Area}}$

Dimensions of force $= [M L T^{-2}]$

Dimensions of area $= [L^2]$

$\therefore$ Stress $= \frac{[M L T^{-2}]}{[L^2]} = [M L^{-1} T^{-2}]$

Question19

Taking into account of the significant figures, what is the value of 9.99m − 0.0099m? [2020]

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Options:

A. 9.98m

B. 9.980m

C. 9.9m

D. 9.9801m

Answer: A

Solution:

Solution:

(a) In subtraction the number of decimal places in the result should be equal to the number of decimal places of that term in the operation which contain lesser number of decimal places.

$9.99 - 0.0099 = 9.9801$

As the least number of decimal places is 3.

So, answer should be 9.98m.

Question20

A screw gauge has least count of 0.01 mathrm mm and there are 50 divisions in its circular scale. Thepitch of the screw gauge is : [2020]

Options:

A. 0.25mm

B. 0.5mm

C. 1.0mm

D. 0.01mm

Answer: B

Solution:

Solution:
(b) Least count of screw gauge $= 0.01 \mathrm{mm}$ Least count
$= \frac{\text{Pitch}}{\text{No. of divisions on circular scale}}$
$\Rightarrow 0.01 \mathrm{mm} = \frac{\text{Pitch}}{50}$
$\Rightarrow$ Pitch $= 0.5 \mathrm{mm}$

Question21

The unit of thermal conductivity is. (2019 NEET)

Options:

A. $\mathrm{W\,m^{-1}K^{-1}}$

B. $\mathrm{J\,mK^{-1}}$

C. $\mathrm{J\,m^{-1}K^{-1}}$

D. $\mathrm{W\,mK^{-1}}$

Answer: A

Solution:

Solution:
$K = \frac{Qx}{A(T_1 - T_2)t}$,
where Q is the amount of heat flow, x is the thickness of the slab, A is the area of cross-section, and t is the time taken.
$K = \frac{\mathrm{J\,m}}{\mathrm{m^2 K\,s}} = \mathrm{W}\,\frac{1}{\mathrm{m}}\,\frac{1}{\mathrm{K}} = \mathrm{W\,m^{-1}K^{-1}}$

Question22

In an experiment, the percentage of error occurred in the measurement

of physical quantities A, B, C and D are 1%, 2%, 3% and 4% respectively. Then the maximum percentage of error in the measurement X, where $X = \frac{A^2B^{1/2}}{C^{1/3}D^3}$ will be.
(NEET2019)

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Options:

A. 10%

B. (3/13) %

C. 16%

D. -10%

Answer: C

Solution:

Solution:
$X = \frac{A^2B^{1/2}}{C^{1/3}D^3}$
Maximum percentage error in X
$\left(\frac{dX}{X}\right) \times 100 = \left(2\frac{dA}{A} + \frac{1}{2}\frac{dB}{B} + \frac{1}{3}\frac{dC}{C} + 3\frac{dD}{D}\right) \times 100$
$= 2 \times 1 + \frac{1}{2} \times 2 + \frac{1}{3} \times 3 + 3 \times 4 = 16\%$

Question23

The main scale of a vernier callipers has n divisions/cm. n divisions of the vernier scale coincide with (n-1) divisions of main scale. The least count of the vernier callipers is,
(Odisha NEET 2019)

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Options:

A. $\frac{1}{(n+1)(n-1)}$cm

B. $\frac{1}{n}$cm

C. $\frac{1}{n^2}$cm

D. $\frac{1}{n(n+1)}$cm

Answer: C

Solution:

If n^{th} division of vernier scale coincides with $(n-1)$ divisions of main scale.
Therefore, $nVSD = (n-1)MSD$

$\Rightarrow 1VSD = \frac{(n-1)}{n}MSD$

$\therefore$ Least count $= 1MSD - 1VSD$

$= 1MSD - \frac{(n-1)}{n}MSD$

$= 1MSD - 1MSD + \frac{1}{n}MSD$

$= \frac{1}{n}MSD$

$= \frac{1}{n} \times \frac{1}{n} = \frac{1}{n^2}cm \left[\because 1MSD = \frac{1}{n}cm\right]$

Question24

A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of -0.004 cm, the correct diameter of the ball is.
(NEET 2018)

Options:

A. 0.521 cm

B. 0.525 cm

C. 0.053 cm

D. 0.529 cm

Answer: D

Solution:

Solution:
Diameter of the ball
$= MSR + CSR \times$ (Least count) $-$ Zero error
$= 5mm + 25 \times 0.001cm - (-0.004)cm$
$= 0.5cm + 25 \times 0.001cm - (-0.004)cm = 0.529cm$

Question25

A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi\varepsilon_0}$ is [c is velocity of light, G is the universal constant of gravitation and e is charge].
(NEET 2017)

Options:

A. $c^2\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

B. $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$

C. $\frac{1}{c}G\frac{e^2}{4\pi\varepsilon_0}$

D. $\frac{1}{c^2}\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

Answer: D

Solution:

Solution:
Dimensions of
$\frac{e^2}{4\pi\varepsilon_0} = [F \times d^2] = [M L^3 T^{-2}]$
Dimensions of G = $[M^{-1} L^3 T^{-2}]$
Dimensions of c = $[LT^{-1}]$
$l \propto \left(\frac{e^2}{4\pi\varepsilon_0}\right)^p G^q c^r$
$\therefore\ [L^1] = [M L^3 T^{-2}]^p [M^{-1} L^3 T^{-2}]^q [LT^{-1}]^r$
On comparing both sides and solving, we get
$p = \frac{1}{2}$, $q = \frac{1}{2}$ and $r = -2$
$\therefore l = \frac{1}{c^2}\left[\frac{Ge^2}{4\pi\varepsilon_0}\right]^{1/2}$

Question26

Planck’s constant (h), speed of light in vacuum (c) and Newton’s gravitational constant (G) are three fundamental constants. Which of the following combinations of these has the dimension of length ? (NEET-II 2016)

Options:

A. $\frac{\sqrt{hG}}{c^{3/2}}$

B. $\frac{\sqrt{hG}}{c^{5/2}}$

C. $\sqrt{\frac{hc}{G}}$

D. $\sqrt{\frac{Gc}{h^{3/2}}}$

Answer: A

Solution:

Solution:
According to question,
$l \propto h^p c^q G^r$
$l = kh^p c^q G^r$ .....(i)
Writing dimensions of physical quantities on both sides,
$[M^0 L T^0] = [M L^2 T^{-1}]^p [L T^{-1}]^q [M^{-1} L^3 T^{-2}]^r$
Applying the principle of homogeneity of dimensions, we get
$p - r = 0$ ......(ii)
$2p + q + 3r = 1$ ....(iii)
$-p - q - 2r = 0$ ....(iv)
Solving eqns. (ii), (iii) and (iv), we get
$p = r = \frac{1}{2}, q = -\frac{3}{2}$
From eqn. (i), we get $l = \frac{\sqrt{hG}}{c^{3/2}}$

Question27

If dimensions of critical velocity v_c of a liquid flowing through a tube are expressed as $[\eta^x \rho^y \gamma^z]$ where η, ρ and γ are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by. (2015)

Options:

A. -1,-1,-1

B. 1,1,1

C. 1,-1,-1

D. -1,-1,1

Answer: C

Solution:

Solution:
$[v_c] = [\eta^x \rho^y \gamma^z]$ (given) ....(i)
Writing the dimensions of various quantities in eqn. (i), we get
$[M^0 L T^{-1}] = [M L^{-1} T^{-1}]^x [M L^{-3} T^0]^y [M^0 L T^0]^z$
$= [M^{x+y} L^{-x-3y+z} T^{-x}]$
Applying the principle of homogeneity of dimensions, we get
$x + y = 0; -x - 3y + z = 1; -x = -1$
On solving, we get $x = 1, y = -1, z = -1$

Question28

If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of mass are
(2014)

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Options:

A. $[F V T^{-1}]$

B. $[F V T^{-2}]$

C. $[F V^{-1} T^{-1}]$

D. $[F V^{-1} T]$

Answer: D

Solution:

Solution:
Let mass $m \propto F^a V^b T^c$ or $m = kF^a V^b T^c$.............(i)
where k is a dimensionless constant and a, b and c are the exponents.
Writing dimensions on both sides, we get
$[M L^0 T^0] = [M L T^{-2}]^a [L T - 1]^b [T]^c$
$[M L^0 T^0] = [m^a L^{a+b} T^{-21-b+c}]$
Applying the principle of homogeneity of dimensions, we get
$a = 1$...(ii)
$a + b = 0$.....(iii)
$-2aa - b + c = 0$....(iv)
Solving eqns. (ii), (iii) and (iv), we get
$a = 1, b = -1, c = 1$
From eqn. (i),$[m] = [F V^{-1} T]$

Question29

In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculated as follows
$P = \frac{a^3 b^2}{cd}$ %error in P is
(2013 NEET)

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Options:

A. 7%

B. 4%

C. 14%

D. 10%

Answer: C

Solution:

$P = \frac{a^3 b^2}{cd}$

%error in P is

$\frac{\Delta P}{P} \times 100 = \left[3\left(\frac{\Delta a}{a}\right) + 2\left(\frac{\Delta b}{b}\right) + \frac{\Delta c}{c} + \frac{\Delta c}{d}\right] \times 100$

$= [3 \times 2\% + 2 \times 2\% + 3\% + 4\%] = 14\%$

Question30

The pair of quantities having same dimensions is. (Karnataka NEET 2013)

Options:

A. Impulse and Surface Tension

B. Angular momentum and Work

C. Work and Torque

D. Young’s modulus and Energy

Answer: C

Solution:

Impulse = Force × time

$= [M\,LT^{-2}][T\,] = [M\,LT^{-1}]$

Surface tension $= \frac{\text{Force}}{\text{length}} = \frac{[M\,LT^{-2}]}{[L]} = [M\,L^0T^{-2}]$

Angular momentum = Moment of inertia × angular velocity

$= [M\,L^2][T^{-1}] = [M\,L^2T^{-1}]$

Work = Force × distance $= [M\,LT^{-2}][L]$

$= [M\,L^2T^{-2}]$

Energy = $[M\,L^2T^{-2}]$

Torque = Force × distance $= [M\,LT^{-2}][L]$

$= [M\,L^2T^{-2}]$

Young's modulus $= \frac{\text{Force / Area}}{\text{Change in length / original length}}$

$= \frac{[M\,LT^{-2}] / [L^2]}{[L] / [L]} = [M\,L^{-1}T^{-2}]$

Hence, among the given pair of physical quantities work and torque have the same dimensions $[M\,L^2T^{-2}]$

Question31

The damping force on an oscillator is directly proportional to the velocity. The units of the constant of proportionality are (2012)

Options:

A. $kgms^{-1}$

B. $kgms^{-2}$

C. kgs^{-1}

D. kg s

Answer: C

Solution:

Damping force,F ∝ v or F = kv

$\therefore k = \frac{F}{v} = \frac{N}{ms^{-1}} = \frac{kgms^{-2}}{ms^{-1}} = kgs^{-1}$

Question32

The dimensions of $(\mu_0\varepsilon_0)^{-\frac{1}{2}}$ are
(2012 Mains, 2011)

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Options:

A. $\left[L^{-\frac{1}{2}}T^{-\frac{1}{2}}\right]$

B. $[L^{-1}T]$

C. $[LT^{-1}]$

D. $\left[L^{\frac{1}{2}}T^{\frac{1}{2}}\right]$

Answer: C

Solution:

The speed of the light in vacuum is

$c = \frac{1}{\sqrt{\mu_0\varepsilon_0}} = (\mu_0\varepsilon_0)^{-\frac{1}{2}} \quad \therefore \left[(\mu_0\varepsilon_0)^{-\frac{1}{2}}\right] = [c] = [LT^{-1}]$

Question33

The density of a material in CGS system of units is $4g / cm^3$ In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be

(2011 Mains)

Options:

A. 0.04

B. 0.4

C. 40

D. 400

Answer: C

Solution:

Solution:
In CGS, $d = 4\ g / cm^3$
If unit of mass is 100g, 4g mass in new units is $\frac{4}{100}$ units
and unit of distance is 10cm, 1cm in new units is $\frac{1}{10}$ units
So, density $= \frac{4\left(\frac{g}{100}\right)}{\left(\frac{1}{10}cm\right)^3} = \frac{\left(\frac{4}{100}\right)}{\left(\frac{1}{10}\right)^3} = 40$ units

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Question34

The dimension of $\frac{1}{2}\varepsilon_0 E^2$, where ε_0 is permittivity of free space and E is electric field, is
(2010)

Options:

A. $[M L^2 T^{-2}]$

B. $[M L^{-1} T^{-2}]$

C. $[M L^2 T^{-1}]$

D. $[M L T^{-1}]$

Answer: B

Solution:

Solution:
Energy destiny of an electric field E is $\mu_E = \frac{1}{2}\varepsilon_0 E^2$
where ε_0 is permittivity of free space
$\mu_E = \frac{Energy}{Volume} = \frac{[M L^2 T^{-2}]}{[L^3]} = [M L^{-1} T^{-2}]$

Question35

A student measures the distance traversed in free fall of a body, initially at rest, in a given time. He uses this data to estimate g, the acceleration due to gravity. If the maximum percentage errors in measurement of the distance and the time are e_1 and e_2 respectively, the percentage error in the estimation of g is
(2010 Mains)

Options:

A. $e_2 - e_1$

B. $e_1 + 2e_2$

C. $e_1 + e_2$

D. $e_1 - 2e_2$

Answer: B

Solution:

Solution:
From the relation
$h = ut + \frac{1}{2}gt^2$, $h = \frac{1}{2}gt^2 \Rightarrow g = \frac{2h}{t^2}$
(∵ body initially at rest)

Taking natural logarithm on both sides,we get
$\ln g = \ln 2 + \ln h - 2\ln t$
Differentiating, $\frac{\Delta g}{g} = \frac{\Delta h}{h} - 2\frac{\Delta t}{t}$
For maximum permissible error,
or
$\left(\frac{\Delta g}{g} \times 100\right)_{max} = \left(\frac{\Delta h}{h} \times 100\right) + 2 \times \left(\frac{\Delta t}{t} \times 100\right)$

According to problem
$\frac{\Delta h}{h} \times 100 = e_1$ and $\frac{\Delta t}{t} \times 100 = e_2$
Therefore, $\left(\frac{\Delta g}{g} \times 100\right)_{max} = e_1 + 2e_2$

Question36

If the dimensions of a physical quantity are given by $M^aL^bT^c$, then the physical quantity will be
(2009)

Options:

A. velocity if a = 1, b = 0, c = - 1

B. acceleration if a = 1, b = 1, c = -2

C. force if a = 0, b = - 1, c = -2

D. pressure if a = 1, b = -1, c = -2

Answer: D

Solution:

Solution:

Pressure, $p = \frac{\text{force}}{\text{area}} = \frac{\text{mass} \times \text{acceleration}}{\text{area}}$

$\therefore [P] = \frac{[M^1 L T^{-2}]}{[L^2]} = [M^1 L^{-1} T^{-2}]$

$= M^a L^b T^c$

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

Question37

If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be (2008)

Options:

A. 8%

B. 2%

C. 4%

D. 6%

Answer: D

Solution:

$V = \frac{4}{3}\pi r^3$

$\ln V = \ln\left(\frac{4}{3}\pi\right) + \ln R^3$

Differentiating, $\frac{dV}{V} = 3\frac{dR}{R}$

Error in the determination of the volume = 3×2% = 6%

Question38

Which two of the following five physical parameters have the same dimensions ?
1. energy density 2. refractive index
3. dielectric constant 4. Young's modulus
5. magnetic field
(2008)

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Options:

A. 1 and 4

B. 1 and 5

C. 2 and 4

D. 3 and 5

Answer: A

Solution:

[Energy density] = [Work done / Volume]

$$= \frac{M LT^{-2} \cdot L}{L^3} = [M L^{-1} T^{-2}]$$

[Young's modulus] = $[Y] = \left[\frac{\text{Force}}{\text{Area}} \right] \times \frac{[l]}{[\Delta l]}$

$$= \frac{M LT^{-2}}{L^2} \cdot \frac{L}{L} = [M L^{-1} T^{-2}]$$

The dimensions of 1 and 4 are the same.

Question39

Dimensions of resistance in an electrical circuit, in terms of dimension of mass M , of length L, of time T and of current I, would be
(2007)

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Options:

A. $[M L^2 T^{-2}]$

B. $[M L^2 T^{-1} I^{-1}]$

C. $[M L^2 T^{-3} I^{-2}]$

D. $[M L^2 T^{-3} I^{-1}]$.

Answer: C

Solution:

According to Ohm's law,

$V = RI \quad$ or $\quad R = \frac{V}{I}$

Dimensions of $V = \frac{W}{q} = \frac{[ML^2T^{-2}]}{[IT]}$

$\therefore R = \frac{[ML^2T^{-2}/IT]}{[I]} = [ML^2T^{-3}I^{-2}]$

Question40

The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a, b and c are constants. The dimensions of a, b and c are (2006)

Options:

A. [L], [LT] and $[LT^{-2}]$

B. $[LT^{-2}]$, [L] and [T]

C. $[L^2]$, [T], and $[LT^{-2}]$

D. $[LT^{-2}]$, [LT], and [L]

Answer: B

Solution:

Solution:

$v = at + \frac{b}{t+c}$

As c is added to t, $\therefore$ [c] = [T]

$[at] = [LT^{-1}]$ or, $[a] = \frac{[LT^{-1}]}{[T]} = [LT^{-2}]$

$\frac{[b]}{[T]} = [LT^{-1}] \quad \therefore [b] = [L]$

Question41

The ratio of the dimensions of Planck's constant and that of moment of inertia is the dimensions of (2005)

Options:

A. time

B. frequency

C. angular momentum

D. velocity.

Answer: B

Solution:

$$\frac{h}{I} = \frac{E\lambda}{c \times I} = \frac{[ML^2T^{-2}][L]}{[LT^{-1}] \times [ML^2]}$$

$$\frac{h}{I} = [T^{-1}] = \text{ frequency.}$$

Question42

The dimensions of universal gravitational constant are (2004,1992)

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Options:

A. $[M^{-1}L^3T^{-2}]$

B. $[ML^2T^{-1}]$

C. $[M^{-2}L^3T^{-2}]$

D. $[M^{-2}L^2T^{-1}]$

Answer: A

Solution:

Solution:

Gravitational constant G $= \frac{\text{force} \times (\text{distance})^2}{\text{mass} \times \text{mass}}$

$\therefore$ Dimensions of G $= \frac{[MLT^{-2}][L^2]}{[M][M]} = [M^{-1}L^3T^{-2}]$

Question43

The unit of permittivity of free space, ε_0, is (2004)

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Options:

A. coulomb/newton-metre

B. newton-metre ^{2}/ coulomb ^{2}

C. coulomb ^{2}/ newton-metre ^{2}

D. coulomb ^{2}/ (newton-metre) ^{2}

Answer: C

Solution:

Solution:

Force between two charges $F = \frac{1}{4\pi\varepsilon_0}\frac{q^2}{r^2} \Rightarrow \varepsilon_0 = \frac{1}{4\pi}\frac{q^2}{F\,r^2} = C^2 / N - m^2$

Question44

The dimensions of Planck's constant equals to that of (2001)

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Options:

A. energy

B. momentum

C. angular momentum

D. power.

Answer: C

Solution:

Solution:

Dimensions of Planck's constant $h = \frac{\text{Energy}}{\text{Frequency}} = [ML^2T^{-2}][T^{-1}] = [ML^2T^{-1}]$

Dimensions of angular momentum L= Moment of inertia(I) × Angular velocity (ω) $= [ML^2][T^{-1}] = [ML^2T^{-1}]$

Question45

Which pair do not have equal dimensions? (2000)

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Options:

A. Energy and torque

B. Force and impulse

C. Angular momentum and Planck's constant

D. Elastic modulus and pressure.

Answer: B

Solution:

Solution:
Dimensions of force $= [MLT^{-2}]$
Dimensions of impulse $= [MLT^{-1}]$

Question46

The dimensional formula of magnetic flux is (1999)

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Options:

A. $[M^0L^{-2}T^{-2}A^{-2}]$

B. $[ML^0T^{-2}A^{-2}]$

C. $[ML^2T^{-2}A^{-1}]$

D. $[ML^2T^{-1}A^3]$

Answer: C

Solution:

Solution:
Magnetic flux, $\phi = BA = \left(\frac{F}{I\,l}\right)A = \frac{[MLT^{-2}][L^2]}{[A][L]} = [ML^2T^{-2}A^{-1}]$

Question47

An equation is given here $\left(P + \frac{a}{V^2}\right) = b\frac{\theta}{V}$ where P = Pressure, V = Volume and θ = Absolute temperature. If a and b are constants, the dimensions of a will be (1996)

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Options:

A. $[ML^{-5}T^{-1}]$

B. $[ML^5T^1]$

C. $[ML^5T^{-2}]$

D. $[M^{-1}L^5T^2]$

Answer: C

Solution:

Equation $\left(P + \frac{a}{V^2}\right) = b\frac{\theta}{V}$. since $\frac{a}{V^2}$ is added to the pressure, therefore dimensions of $\frac{a}{V^2}$ and pressure (P) will be the same. And dimensions of $\frac{a}{V^2} = \frac{a}{[L^3]^2}$ $= [ML^{-1}T^{-2}]$ ora $= [ML^5T^{-2}]$

Question48

The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and lengths are 3% and 2% respectively, the maximum error in the measurement of density would be (1996)

Options:

A. 12%

B. 14%

C. 7%

D. 9%.

Answer: D

Solution:

Solution:

Maximum error in mass $\left(\frac{\Delta m}{m}\right) = 3\% = \frac{3}{100}$ and maximum error in length $\left(\frac{\Delta l}{l}\right) = 2\% = \frac{2}{100}$

Maximum error inn the measurement of density $\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + \left(3 \times \frac{\Delta l}{l}\right) = \frac{3}{100} + \left(3 \times \frac{2}{100}\right) = \frac{3}{100} + \frac{6}{100} = \frac{9}{100} = 9\%$

Question49

The dimensions of impulse are equal to that of (1996)

Options:

A. pressure

B. linear momentum

C. force

D. angular momentum

Answer: B

Solution:

Solution:
Impulse = Force × Time.
Therefore dimensional formula of impulse = Dimensional formula of force × Dimensional formula of time
$= [MLT^{-2}][T] = [MLT^{-1}]$
and dimensional formula of linear momentum $[p] = MLT^{-1}$

Question50

Which of the following dimensions will be the same as that of time? (1996)

Options:

A. $\frac{L}{R}$

B. $\frac{C}{L}$

C. LC

D. $\frac{R}{L}$

Answer: A

Solution:

Solution:
We know that $[V] = [iR] = \left[L\frac{di}{dt}\right]$
or, $[i][R] = \frac{[L][i]}{[t]}$
Thus, $\left[\frac{L}{R}\right] = [t] = T$

Question51

Which of the following is a dimensional constant? (1995)

Options:

A. Relative density

B. Gravitational constant

C. Refractive index

D. Poisson's ratio.

Answer: B

Solution:

Solution:
Relative density, refractive index and Poisson's ratio all the three are ratios, therefore they are dimensionless constants.

Question52

The dimensions of RC is
(1995)

Options:

A. square of time

B. square of inverse time

C. time

D. inverse time.

Answer: C

Solution:

Solution:
Units of RC = $\mathrm{ohm} \times \mathrm{ohm}^{-1} \times$ second = second.
Therefore dimensions of RC = time.

Question53

Percentage errors in the measurement of mass and speed are 2% and 3% respectively. The error in the estimate of kinetic energy obtained by measuring mass and speed will be
(1995)

Options:

A. 8%

B. 2%

C. 12%

D. 10%

Answer: A

Solution:

Solution:

Percentage error in mass $= 2\% = \frac{2}{100}$ and percentage error in speed $= 3\% = \frac{3}{100}$

$K.E. = \frac{1}{2}mv^2$

Therefore the error in measurement of kinetic energy

$\frac{\Delta K.E.}{K.E.} = \frac{\Delta m}{m} + 2 \times \frac{\Delta v}{v} = \frac{2}{100} + 2 \times \frac{3}{100} = \frac{8}{100} = 8\%$

Question54

Which of the following has the dimensions of pressure?
(1994, 1990)

Options:

A. $[MLT^{-2}]$

B. $[ML^{-1}T^{-2}]$

C. $[ML^{-2}T^{-2}]$

D. $[M^{-1}L^{-1}]$

Answer: B

Solution:

$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$

Therefore dimensions of pressure $= \frac{\text{Force}}{\text{Area}} = [ML^{-1}T^{-2}]$

Question55

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 $\eta = \frac{P(r^2 - x^2)}{4vl}$ where v is the velocity of oil ata distance x from the axis of the tube. The dimensions of η are
(1993)

Options:

A. $[M^0L^0T^0]$

B. $[MLT^{-1}]$

C. $[ML^2T^{-2}]$

D. $[ML^{-1}T^{-1}]$

Answer: D

Solution:

Dimensions of P = $[ML^{-1}T^{-2}]$
Dimensions of r = [L]
Dimensions of v = $[LT^{-1}]$
Dimensions of l = [L]

$\therefore$ Dimensions of $\eta = \frac{[P][r^2 - x^2]}{[4vl]}$

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

Question56

The time dependence of a physical quantity p is given by $p = p_0 \exp(-\alpha t^2)$, where α is a constant and t is the time. The constant α (1993)

Options:

A. is dimensionless

B. has dimensions $[T^{-2}]$

C. has dimensions $[T^2]$

D. has dimensions of p

Answer: B

Solution:

Solution:
Given : $p = p_0 e^{-\alpha t^2}$
αt^2 is a dimensionless
$\therefore \alpha = \frac{1}{t^2} \frac{1}{[T^2]} = [T^{-2}]$

Question57

P represents radiation pressure, c represents speed of light and S represents radiation energy striking per unit area per sec. The non zero integers x, y, z such that $P^xS^yc^z$ is dimensionless are
(1992)

Options:

A. x = 1, y = 1, z = 1

B. x = −1, y = 1, z = 1

C. x = 1, y = −1, z = 1

D. x = 1, y = 1, z = −1

Answer: C

Solution:

Solution:
Let $k = P^xS^yc^z$...(i)
k is a dimensionless
Dimensions of $k = [M^0L^0T^0]$
$\therefore$ Dimensions of $P = \frac{\text{Force}}{\text{Area}} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$
Dimensions of $S = \frac{\text{Energy}}{\text{Area} \times \text{time}} = \frac{[ML^2T^{-2}]}{[L^2][T]} = [ML^{-3}]$
Dimensions of $c = [LT^{-1}]$
Substituting these dimensions in eqn (i), we get
$[M^0L^0T^0] = [ML^{-1}T^{-2}]^x[MT^{-3}]^y[LT^{-1}]^z$
Applying the principle of homogeneity of dimensions, we get
$x + y = 0$...(ii)
$-x + z = 0$...(iii)
$-2x - 3y - z = 0$...(iv)
Solving (ii), (iii) and (iv), we get
$x = 1, y = -1, z = 1$

Question58

A certain body weighs 22.42g and has a measured volume of 4.7cc. The possible error in the measurement of mass and volume are 0.01g and 0.1cc. Then maximum error in the densiy will be
(1991)

Options:

A. 22%

B. 2%

C. 0.2%

D. 0.02%

Answer: B

Solution:

Solution:
Density = $\frac{\text{mass}}{\text{Volume}}$ ...(i)
Take logarithm to take base e on the both sides of eqn (i), we get
$\ln\rho = \ln m - \ln V$ ....(ii)
Differentiate eqn (ii), on both sides, we get
$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} - \frac{\Delta V}{V}$
Errors are always added.
Error in the density ρ will be
$= \left[\frac{\Delta m}{m} + \frac{\Delta V}{V}\right] \times 100\%$
$= \left[\frac{0.01}{22.42} + \frac{0.1}{4.7}\right] \times 100\% = 2\%$

Question59

The dimensional formula of permeability of free space μ_0 is (1991)

Options:

A. $[MLT^{-2}A^{-2}]$

B. $[M^0L^1T]$

C. $[M^0L^2T^{-1}A^2]$

D. none of these.

Answer: A

Solution:

Solution:
Permeability of free space
$\mu_0 = \frac{2\pi \times \text{force} \times \text{distance}}{\text{current} \times \text{current} \times \text{length}}$
Dimensional formula of $\mu_0 = \frac{[MLT^{-2}][L]}{[A][A][L]} = [MLT^{-2}A^{-2}]$

Question60

The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by a relation $f = am^xk^y$, where a is a dimensionless constant. The values of x and y are

(1991)

Options:

A. $x = \frac{1}{2}, y = \frac{1}{2}$

B. $x = -\frac{1}{2}, y = -\frac{1}{2}$

C. $x = \frac{1}{2}, y = -\frac{1}{2}$

D. $x = -\frac{1}{2}, y = \frac{1}{2}$

Answer: D

Solution:

Solution:
$f = am^x k^y$ ....(i)
Dimensions of frequency $v = [M^0 L^0 T^{-1}]$
Dimensions of constant $a = [M^0 L^0 T^0]$
Dimensions of mass $m = [M]$
Dimensions of spring constant $k = [M T^{-2}]$
Putting these value in equation (i), we get
$[M^0 L^0 T^{-1}] = [M]^x [M T^{-2}]^y$
Applying principle of homogeneity of dimensions, we get
$x + y = 0$
$-2y = -1$
or $x = -\frac{1}{2}, y = \frac{1}{2}$

Question61

According to Newton, the viscous force acting between liquid layers of area A and velocity gradient $\Delta v / \Delta Z$ is given by $F = -\eta A \frac{\Delta v}{\Delta Z}$, where η is constant called coefficient of viscosity. The dimensional formula of η is (1990)

Options:

A. $[ML^{-2}T^{-2}]$

B. $[M^0L^0T^0]$

C. $[ML^2T^{-2}]$

D. $[ML^{-1}T^{-1}]$

Answer: D

Solution:

Dimensions of force $F = [MLT^{-2}]$

Dimensions of velocity gradient $\frac{\Delta v}{\Delta Z} = \frac{[LT^{-1}]}{[L]} = [T^{-1}]$

Dimensions of area $A = [L^2]$

Given $F = -\eta A \frac{\Delta v}{\Delta Z}$

Dimensional formula for coefficient of viscocity

$$\eta = \frac{F}{(A)\left(\frac{\Delta v}{\Delta Z}\right)} = \frac{[MLT^{-2}]}{[L^2][T^{-1}]} = [ML^{-1}T^{-1}]$$

Question62

If $x = at + bt^2$, where x is the distance travelled by the body in kilometers while t is the time in seconds, then the units of b is (1989)

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Options:

A. km/s

B. km s

C. km/s^2

D. $km\ s^2$

Answer: C

Solution:

Solution:

Units of $b = \frac{x}{t^2} = \frac{km}{s^2}$

Question63

Of the following quantities, which one has dimensions different from the remaining three? (1989)

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Options:

A. Energy per unit volume

B. Force per unit area

C. Product of voltage and charge per unit volume

D. Angular momentum.

Answer: D

Solution:

Solution:
Dimensions of energy $E = [ML^2T^{-2}]$
Dimensions of volume $v = [L^3]$
Dimensions of force $F = [MLT^{-2}]$
Dimensions of area $A = [L^2]$
Dimensions of voltage $V = [ML^2T^{-3}A^{-1}]$
Dimensions of charge $q = [AT]$
Dimensions of angular momentum $L = [ML^2T^{-1}]$
∴ Dimensions of $\frac{E}{v} = [ML^2T^{-2}][L^3] = [ML^{-1}T^{-2}]$
Dimensions of $\frac{F}{A} = \frac{[MLT^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$
Dimensions of $\frac{Vq}{v} = \frac{[ML^2T^{-3}A^{-1}][AT]}{[L^3]} = [ML^{-1}T^{-2}]$
Dimensions of angular momentum is $[ML^2T^{-1}]$ while other three has dimensions $[ML^{-1}T^{-2}]$

Question64

Dimensional formula of self inductance is (1989)

Options:

A. $[MLT^{-2}A^{-2}]$

B. $[ML^2T^{-1}A^{-2}]$

C. $[ML^2T^{-2}A^{-2}]$

D. $[ML^2T^{-2}A^{-1}]$

Answer: C

Solution:

Solution:
Induced emf $|\varepsilon| = L\frac{dI}{dt}$
where L is the self inductance and $\frac{dI}{dt}$ is the rate of change of current.
∴ Dimensional formula of $L = \frac{|\varepsilon|}{\frac{dI}{dt}} = \frac{[ML^2T^{-3}A^{-1}]}{[AT^{-1}]} = [ML^2T^{-2}A^{-2}]$

Question65

The dimensional formula of torque is (1989)

Options:

A. $[ML^2T^{-2}]$

B. $[MLT^{-2}]$

C. $[ML^{-1}T^{-2}]$

D. $[ML^{-2}T^{-2}]$

Answer: A

Solution:

Solution:
Torque (τ) = Force × distance
Dimensional formula for (τ) = $[MLT^{-2}][L] = [ML^2T^{-2}]$

Question66

If C and R denote capacitance and resistance, the dimensional formula of CR is
(1988)

Options:

A. $[M^0L^0T^1]$

B. $[M^0L^0T^0]$

C. $[M^0L^0T^{-1}]$

D. not expressible in terms of MLT.

Answer: A

Solution:

Solution:
Capacitance C = $\frac{\text{Charge}}{\text{Potential difference}}$
Dimensions of C = $\frac{[AT]}{[ML^2T^{-3}A^{-1}]} = [M^{-1}L^{-2}T^4A^2]$
Resistance R = $\frac{\text{Potential difference}}{\text{Current}} = \frac{[ML^2T^{-3}A^{-1}]}{[A]} = [ML^2T^{-3}A^{-2}]$
Dimensional formula of CR = $[M^{-1}L^{-2}T^4A^2][ML^2T^{-3}A^{-2}] = [T]$
As the (CR) has dimensions of time and so is called time constant of CR circuit.

Question67

The dimensional formula of angular momentum is (1988)

Options:

A. $[ML^2T^{-2}]$

B. $[ML^{-2}T^{-1}]$

C. $[MLT^{-1}]$

D. $[ML^2T^{-1}]$

Answer: D

Solution:

Angular momentum L = Moment of inertia $I \times$ Angular velocity ω.
∴ Dimensional formula $L = [ML^2][T^{-1}] = [ML^2T^{-1}]$
