SHANTIBARTA FOUNDATION

Subject : Phy
Standard : 11
Total Mark : 180

Unit and Measurement (Solutions)

Paper Set : 1
Date : 18-11-2022
Time : 1H:0M

Physics - Section A - MCQ

[1] The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be ....

(A) $[ML^{-1}T^{-1}]$ (B) $[ML^{-1}T^{-2}]$ (C) $[ML^{2}T^{-1}]$ (D) $[M^{-1}L^{3}T^{0}]$

Solution:[Correct Answer : A]

Pascal second
$\frac{F}{A}t = \frac{MLT^{-2}}{L^2}T = ML^{-1}T^{-1}$

[2] If pressure P, velocity V and time T are taken as fundamental physical quantities, the dimensional formula of force is

(A) PV^2T^2 (B) $P^{-1}V^2T^{-2}$ (C) PVT^2 (D) $P^{-1}VT^2$

Solution:[Correct Answer : A]

$F = P^{\alpha}v^{\beta}T^{\gamma}$
$[M^1L^1T^{-2}] = [M^1L^{-1}T^2]^{\alpha}\,[LT^{-1}]^{\beta}[T]^{\gamma}$
$[M^1L^1R^{-2}] = [M^{\alpha}L^{-\alpha+\beta}T^{-2\alpha-\beta+\gamma}]$
$\alpha = 1;\ -\alpha + \beta = 1$
$\beta = 2,\ 2-2\alpha - \beta + \gamma = -2$
$\therefore\ -2 - 2 + \gamma = -2$
$\gamma = 2$
$\Rightarrow\ F = Pv^2T^2$

[3] Match List-I with List-II and select the correct answer by using the codes given below the lists

List - I	List - II
(A) Distance between earth and stars	(1) Microns
(B) Inter-atomic distance in a solid	(2) Angstroms
(C) Size of the nucleus	(3) Light years
(D) Wavelength of infrared laser	(4) Fermi
	(5) Kilometres

(A) $A-5, B-4, C-2, D-1$ (B) $A-3, B-2, C-4, D-1$ (C) $A-5, B-2, C-4, D-3$ (D) $A-3, B-4, C-1, D-2$

Solution:[Correct Answer : B]

(b)

[4] The Bernoulli's equation is given by $p + \frac{1}{2}\rho v^2 + h\rho g = k$
where $p =$ pressure, $\rho =$ density, $v =$ speed, $h =$ height of the liquid column, $g =$ acceleration due to gravity and k is constant. The dimensional formula for k is same as that for

(A) Velocity gradient (B) Pressure gradient (C) Modulus of elasticity (D) Thrust

Solution:[Correct Answer : C]

$[k] = [\rho]\,[v^2] = [ML^{-3}]\,[L^2T^{-2}] = ML^{-1}T^{-2}$
$= \frac{\text{Force}}{\text{Area}} =$ Modulus of elasticity

[5] According to Joule's law of heating, heat produced $H = I^2\,Rt$, where I is current, R is resistance and t is time. If the errors in the measurement of I, R and t are 3%, 4% and 6% respectively then error in the measurement of H is

(A) $\pm17\%$ (B) $\pm16\%$ (C) $\pm19\%$ (D) $\pm25\%$

Solution:[Correct Answer : B]

(b) $H = I^2Rt$
$\therefore\ \frac{\Delta H}{H} \times 100 = \left(\frac{2\Delta I}{I} + \frac{\Delta R}{R} + \frac{\Delta t}{t}\right) \times 100$
$= (2 \times 3 + 4 + 6)\% = 16\%$

[6] The dimensional formula for impulse is same as the dimensional formula for

(A) Momentum (B) Force (C) Angular momentum (D) Torque

Solution:[Correct Answer : A]

(a) Momentum = $mv = [MLT^{-1}]$
Impulse = Force $\times$ Time
= $[MLT^{-2}] \times [T] = [MLT^{-1}]$

[7] Dimensions of $\frac{1}{\mu_0 \varepsilon_0}$, where symbols have their usual meaning, are

(A) $[LT^{-1}]$ (B) $[L^{-1}T]$ (C) $[L^{-2}T^2]$ (D) $[L^2T^{-2}]$

Solution:[Correct Answer : D]

(d) $C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \Rightarrow \frac{1}{\mu_0 \varepsilon_0} = c^2 = [L^2T^{-2}]$

[8] If x and a stand for distance then for what value of n is given equation dimensionally correct the eq. is $\int \frac{dx}{\sqrt{a^2 - x^n}} = \sin^{-1} \frac{x}{a}$

(A) 0 (B) 2 (C) -2 (D) 1

Solution:[Correct Answer : B]

$\int \frac{dx}{\sqrt{a^2 - x^2}} = \sin^{-1} \frac{x}{a}$
terms in a equation or terms having arithematic operations of addition and subtraction should have same dimensions.
$\Rightarrow \ln a^2 - x^n$
$\dim(a^2) = \dim(x^n)$
$L^2 = L^n \Rightarrow [n = 2]$

[9] The pair(s) of physical quantities that have the same dimensions, is (are)

(A) Reynolds number and coefficient of friction (B) Latent heat and gravitational potential

(C) Curie and frequency of a light wave (D) All of these

Solution:[Correct Answer : D]

(d) Reynolds number and coefficient of friction are dimensionless.
Latent heat and gravitational potential both have dimension $[L^2T^{-2}]$.
Curie and frequency of a light wave both have dimension $[T^{-1}]$. But dimensions of Planck's constant is $[T^{-1}]$ and torque is $[ML^2T^{-2}]$.

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

(A) [F][A][T] (B) [F][A] $[T^2]$ (C) $[F]$[A] $[T^{-1}]$ (D) [F] $[A^{-1}]$ [T]

Solution:[Correct Answer : B]

$E \propto F_a A_b T^c$
$[M^1 L^2 T^2] \propto [M^1 L^1 T^{-2}]^a [LT^{-2}]^b [T]^c$
$a = 1$
$a + b = 2 \Rightarrow b = 1$
$-2a - 2b + c = -2$
$\Rightarrow c = 2$
$a = 1\ b = 1 c = 2$
$E \propto [F][A][T^2]$

[11] Measure of two quantities along with the precision of respective measuring instrument $A = 2.5\,ms^{-1} \pm 0.5\,ms^{-1}$, $B = 0.10\,s \pm 0.01\,s$ The value of AB will be

(A) $(0.25 \pm 0.08)\ m$ (B) $(0.25 \pm 0.5)\ m$ (C) $(0.25 \pm 0.05)\ m$ (D) $(0.25 \pm 0.135)\ m$

Solution:[Correct Answer : A]

Error in AB
$= \pm\left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right) AB = \pm\left[\frac{0.5}{2.5} + \frac{0.01}{0.10}\right][0.25]$
$= \pm 0.075 = \pm 0.08$
Therefore $AB = (0.25 \pm 0.08)m$

[12] The maximum percentage errors in the measurement of mass (M), radius (R) and angular velocity (ω) of a ring are 2%, 1% and 1% respectively, then find the maximum percenta? error in the measurement of its moment of inertia $\left(1 = \frac{1}{2}MR^2\right)$ about its geometric axis.

(A) 4 (B) 5 (C) 6 (D) 7

Solution:[Correct Answer : A]

જડત્વની ચાકમાત્રા (I) $= MR^2$
$\therefore \frac{\Delta I}{I} \times 100 = \frac{\Delta M}{M} \times 100 + 2\frac{\Delta R}{R} \times 100$
$= 2\% + (2 \times 1\%) = 4\%$
તેની જડત્વની ચાકમાત્રા ના માપનમાં મહત્તમ પ્રતિશત ક્ષતિ $= 4\%$

[13] Unit of self inductance is

(A) $\frac{Newton-second}{Coulomb \times Ampere}$ (B) $\frac{Joule/Coulomb \times Second}{Ampere}$ (C) $\frac{Volt \times metre}{Coulomb}$ (D) $\frac{Newton \times metre}{Ampere}$

Solution:[Correct Answer : B]

(b)

[14] The resistance $R = \frac{V}{I}$, where $V = (50 \pm 2)\ V$ and $I = (20 \pm 0.2)\ A$. The percentage error in R is $'x'\%$. The value of $'x'$ to the nearest integer is ....

(A) 3 (B) 6 (C) 7 (D) 5

Solution:[Correct Answer : D]

$\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$
% error in $R = \frac{2}{50} \times 100 + \frac{0.2}{20} \times 100$
% error in $R = 4 + 1$
% error in $R = 5\%$

[15] The dimensions of inter atomic force constant are

(A) MT^{-2} (B) MLT^{-1} (C) MLT^{-2} (D) $ML^{-1}T^{-1}$

Solution:[Correct Answer : A]

(a) $K = Y \times r_0$= $[ML^{-1}T^{-2}] \times [L]$= $[MT^{-2}]$
Y= Young's modulus and r_0 = Interatomic distance

[16] The least count of stop watch is $\frac{1}{5}$ $second$. The time of 20 oscillations of pendulum is measured to be 25 $seconds$. Then percentage error in the measurement of time will be......... %

(A) 8 (B) 1 (C) 0.8 (D) 16

Solution:[Correct Answer : C]

$\frac{\Delta t}{t} \times 100 = \frac{0.2}{25} \times 100 = 0.8\%$

[17] If force (F), length (L) and time (T) are assumed to be fundamental units, then the dimensional formula of the mass will be

(A) $FL^{-1}T^2$ (B) $FL^{-1}T^{-2}$ (C) $FL^{-1}T^{-1}$ (D) FL^2T^2

Solution:[Correct Answer : A]

(a) Let $m = KF^aL^bT^c$
Substituting the dimension of
$[F] = [MLT^{-2}]$, $[C] = [L]$ and $[T] = [T]$
and comparing both sides, we get
$m = FL^{-1}T^{-2}$

[18] Two full turns of the circular scale of screw gauge cover a distance of $1\,mm$ on scale. The total number of divisions on circular scale is 50. Further, it is found that screw gauge has a zero error of $+0.03\,mm$. While measuring the diameter of a thin wire a student notes the main scale reading of $3\,mm$ and the number of circular scale division in line, with the main scale is 35. The diameter of the wire is .... mm

(A) 3.32 (B) 3.73 (C) 3.67 (D) 3.38

Solution:[Correct Answer : A]

pitch $= \frac{1\text{mm}}{2} = 0.5$mm
LC $= \frac{0.5\text{mm}}{50} = 0.01$mm
observed diameter
$= 3$mm $+ (35 \times 0.01$mm$)$
$= 3.35$mm
Actual diameter
$= observed - error$
$= 3.35$mm $- (+0.03$mm$)$
$= 3.32$ mm

[19] Unit of Stefan's constant is

(A) $J\,s^{-1}$ (B) $J\,m^{-2}s^{-1}K^{-4}$ (C) $J\,m^{-2}$ (D) $J\,s$

Solution:[Correct Answer : B]

(b) $\frac{Q}{t}=\sigma AT^4$
$\Rightarrow \sigma = Jm^{-2}s^{-1}K^{-4}$

[20] $Pascal-Second$ has dimension of

(A) Force (B) Energy (C) Pressure (D) Coefficient of viscosity

Solution:[Correct Answer : D]

Pascal is unit of pressure, hence its dimensional formula is $\left[ML^{-1}T^{-2}\right]$
$\therefore$ Dimensional formula of Pascal-second is $\left[ML^{-1}T^{-1}\right]$
By the formula of coefficient of viscosity, we have
$\eta=\frac{F}{A(\Delta v/\Delta z)}$
where F is force, A is area and $\frac{\Delta v}{\Delta z}$ is velocity gradient.
$\therefore$ Dimensions of $\eta=\frac{\left[MLT^{-2}\right]}{\left[L^2\right]\left[LT^{-1}/L\right]}$
$=\left[ML^{-1}T^{-1}\right]$
Hence, Pascal-second has dimensions of coefficient of viscosity.

[21] The density of a material is CGS system of units is $4\,g/cm^3$. 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

(A) 400 (B) 0.04 (C) 0.4 (D) 40

Solution:[Correct Answer : D]

$4\text{gcm}^{-3}=\frac{?}{n_2}\text{M}_2\text{L}_2^{-3}$
$n_2=4\left[\frac{g}{M_2}\right]\left[\frac{cm}{L_2}\right]^{-3}$
$=4\left[\frac{g}{100g}\right]\left[\frac{cm}{10cm}\right]^{-3}$
$=40$

[22] If the unit of length and force be increased four times, then the unit of energy is

(A) Increased 4 times (B) Increased 8 times (C) Increased 16 times (D) Decreased 16 times

Solution:[Correct Answer : C]

(c) Energy = force $\times$ distance, so if both are increased by 4 times then energy will increase by 16 times.

[23] E, m, l and G denote energy, mass, angular momentum and gravitational constant respectively, then the dimension of $\frac{El^2}{m^5G^2}$ are

(A) Angle (B) Length (C) Mass (D) Time

Solution:[Correct Answer : A]

(a) $[E]=[ML^2T^{-2}]$, $[m]=[M]$, $[l]=[ML^2T^{-1}]$and $[G]=[M^{-1}L^3T^{-2}]$ Substituting the dimension of above quantities in the given formula :
$\frac{El^2}{m^5G^2}\frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M^5][M^{-1}L^3T^{-2}]^2}=\frac{M^3L^6T^{-4}}{M^3L^6T^{-4}}=[M^0L^0T^0]$

[24] The dimensional formula $M^0L^2T^{-2}$ stands for

(A) Torque (B) Angular momentum

(C) Latent heat (D) Coefficient of thermal conductivity

Solution:[Correct Answer : C]

Latent Heat $L=\frac{Q}{m}=\frac{\text{Energy}}{\text{mass}}=\frac{[ML^2T^{-2}]}{[M]}=[L^2T^{-2}]$

[25] A physical quantity z depends on four observables a, b, c and d, as $z=\frac{a^2b^{\frac{2}{3}}}{\sqrt{c}d^3}$. The percentage of error in the measurement of a, b, c and d are 2%, 1.5%, 4% and 2.5% respectively. The percentage of error in z is......%

(A) 12.5 (B) 14.5 (C) 16.5 (D) 13.5

Solution:[Correct Answer : B]

$\frac{\Delta Z}{Z}=\frac{2\Delta a}{a}+\frac{2}{3}\frac{\Delta b}{b}+\frac{1}{2}\frac{\Delta c}{c}+\frac{3\Delta d}{d}=14.5\%$

[26] The force F on a sphere of radius $'a'$ moving in a medium with velocity $'v'$ is given by $F=6\pi\eta av$. The dimensions of η are

(A) $ML^{-1}T^{-1}$ (B) MT^{-1} (C) MLT^{-2} (D) ML^{-3}

Solution:[Correct Answer : A]

(a) $\eta = \frac{F}{av} = \frac{[MLT^{-2}]}{[L]\,[LT^{-1}]} = [ML^{-1}T^{-1}]$

[27] Dimensional formula for thermal conductivity is (here K denotes the temperature)

(A) $MLT^{-3}K$ (B) $MLT^{-2}K$ (C) $MLT^{-2}K^{-2}$ (D) $MLT^{-3}K^{-1}$

Solution:[Correct Answer : D]

$\because \frac{dQ}{dt} = kA\frac{dT}{dx}$

$k = \frac{\left(\frac{dQ}{dt}\right)}{A\left(\frac{dT}{dx}\right)}$

$[k] = \frac{[ML^2T^{-3}]}{[L^2][KL^{-1}]} = [MLT^{-3}K^{-1}]$

[28] The dimension of $\frac{1}{\sqrt{\varepsilon_0\mu_0}}$ is that of

(A) Velocity (B) Time (C) Capacitance (D) Distance

Solution:[Correct Answer : A]

(a) $\frac{1}{\sqrt{\varepsilon_0\mu_0}} = C =$ velocity of light

[29] The quantity $X = \frac{\varepsilon_0 LV}{t}$: ε_0 is the permittivity of free space, L is length, V is potential difference and t is time. The dimensions of X are same as that of

(A) Resistance (B) Charge (C) Voltage (D) Current

Solution:[Correct Answer : D]

(d) $[\varepsilon_0 L] = [C]$

$\Rightarrow X = \frac{\varepsilon_0 LV}{t} = \frac{C\times V}{t} = \frac{Q}{t}$ = current

[30] The foundations of dimensional analysis were laid down by

(A) Gallileo (B) Newton (C) Fourier (D) Joule

Solution:[Correct Answer : C]

(c)

[31] The frequency of vibration of string is given by $\nu = \frac{p}{2l}\left[\frac{F}{m}\right]^{1/2}$. Here p is number of segments in the string and l is the length. The dimensional formula for m will be

(A) $[M^0LT^{-1}]$ (B) $[ML^0T^{-1}]$ (C) $[ML^{-1}T^0]$ (D) $[M^0L^0T^0]$

Solution:[Correct Answer : C]

(c) $\nu = \frac{P}{2l}\left[\frac{F}{m}\right]^{1/2}$

$\Rightarrow \nu^2 = \frac{P^2}{4l^2}\left[\frac{F}{m}\right]$

$\therefore m \propto \frac{F}{l^2\nu^2}$

$\Rightarrow [m] = \left[\frac{MLT^{-2}}{L^2T^{-2}}\right] = [ML^{-1}T^0]$

[32] The dimensions of couple are

(A) ML^2T^{-2} (B) MLT^{-2} (C) $ML^{-1}T^{-3}$ (D) $ML^{-2}T^{-2}$

Solution:[Correct Answer : A]

(a) Couple = Force $\times$ Arm length = $[MLT^{-2}]\,[L] = [ML^2T^{-2}]$

[33] If the acceleration due to gravity is $10\,ms^{-2}$ and the units of length and time are changed in kilometer and hour respectively, the numerical value of the acceleration is

(A) 360000 (B) 72000 (C) 36000 (D) 129600

Solution:[Correct Answer : D]

(d) $n_2 = n_1\left[\frac{L_1}{L_2}\right]^1\left[\frac{T_1}{T_2}\right]^{-2} = 10\left[\frac{meter}{km}\right]^1\left[\frac{\text{sec}}{hr}\right]^{-2}$

$n_2 = 10\left[\frac{m}{10^3 m}\right]^1\left[\frac{\text{sec}}{3600\text{ sec}}\right]^{-2} = 129600$

[34] 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

(A) $e_1 + 2e_2$ (B) $e_1 + e_2$ (C) $e_1 - 2e_2$ (D) $e_2 - e_1$

Solution:[Correct Answer : A]

h $= \frac{1}{2}$gt$^2 \Rightarrow$ g $= \frac{2h}{t^2}$
then $\frac{\Delta g}{g} \times 100 = \left(\frac{\Delta h}{h} + 2\frac{\Delta t}{t}\right) \times 100$
$= e_1 + 2e_2$

[35] If L and R are respectively the inductance and resistance, then the dimensions of $\frac{R}{L}$ will be

(A) T^2 (B) T (C) T^{-1} (D) T^{-2}

Solution:[Correct Answer : C]

(c) L/R is a time constant so $(R/L) = T^{-1}$

Physics - Section B - MCQ(Attemp any 10)

[36] The vernier constant of Vernier callipers is $0.1\,mm$ and it has zero error of $(-0.05)\,cm$. While measuring diameter of a sphere, the main scale reading is $1.7\,cm$ and coinciding vernier division is 5. The corrected diameter will be_______ $\times 10^{-2}\,cm$

(A) 160 (B) 150 (C) 189 (D) 180

Solution:[Correct Answer : D]

Measured diameter $= MSR + VSR \times VC$
$= 1.7 + 0.01 \times 5$
$= 1.75$
Corrected = Measured - Error
$= 1.75 - (-0.05)$
$= 1.80\,cm$
$= 180 \times 10^{-2}\,cm$
180

[37] The dimension of the ratio of angular to linear momentum is

(A) $M^0L^1T^0$ (B) $M^1L^1T^{-1}$ (C) $M^1L^2T^{-1}$ (D) $M^{-1}L^{-1}T^{-1}$

Solution:[Correct Answer : A]

(a) $\frac{\text{Angular momentum}}{\text{Linear momentum}} = \frac{mvr}{mv} = r = [M^0L^1T^0]$

[38] Dimensional formula for latent heat is

(A) $M^0L^2T^{-2}$ (B) MLT^{-2} (C) ML^2T^{-2} (D) ML^2T^{-1}

Solution:[Correct Answer : A]

a) $Q = mL \Rightarrow L = \frac{Q}{m}$ (Heat is a form of energy)
= $\frac{ML^2T^{-2}}{M} = [M^0L^2T^{-2}]$

[39] The radius of a sphere is measured to be $(7.50 \pm 0.85)\,cm$. Suppose the percentage error in its volume is x. The value of x, to the nearest x, is .....%

(A) 38 (B) 34 (C) 42 (D) 28

Solution:[Correct Answer : B]

$\because v = \frac{4}{3}\pi r^3$
taking log and then differentiate
$\frac{dV}{V} = 3\frac{dr}{r}$
$= \frac{3\times 0.85}{7.5} \times 100\,\% = 34\,\%$

[40] The force F is given in terms of time t and displacement x by the equation $F = A\cos Bx + C\sin Dt$. The dimensional formulae of D/B is

(A) $M^0L^0T^0$ (B) $M^0L^0T^{-1}$ (C) $M^0L^{-1}T^0$ (D) $M^0L^1T^{-1}$

Solution:[Correct Answer : D]

$F = A\cos Bx + C\sin Dt$
the argument, θ of cos or sin should be dimensionless.
therefore,
dimension of Bx $= [MLT]$
$[B]\,[L'] = [MLT]$
$[B] = [ML^0T]$
Similarly $[D]\,[T'] = [MLT]$
$[D] = [MLT^0$
dimension of $D/B = \frac{[MLT^0]}{[ML^0T]}$
$= [L^1T^{-1}]$

[41] In an experiment, the values of refractive indices of glass were found to be $1.54, 1.53$,$1.44, 1.54, 1.56$ and 1.45 in successive measurements, then Mean absolute error is

(A) 0.004
(B) 0.04
(C) 0.4
(D) 4

Solution:[Correct Answer : B]

Mean $\bar{n} = \frac{1.54+1.53+1.44+1.54+1.56+1.45}{6}$
$\therefore\ \bar{n} = 1.51$
$\Delta n_1 = 1.51 - 1.54 = -0.03,$
$\Delta n_2 = 1.51 - 1.53 = -0.02,$
$\Delta n_3 = 1.51 - 1.44 = +0.07$
$\Delta n_4 = 1.51 - 1.54 = -0.03,$
$\Delta n_5 = 1.51 - 1.56 = -0.05,$
$\Delta n_6 = 1.51 - 1.45 = +0.06$
$\Delta\bar{n} = \frac{|\Delta n_1| + |\Delta n_2| + \ldots + |\Delta n_6|}{6}$
$= \frac{|-0.03| + |-0.02| + |0.07| + |-0.03| + |-0.05| + |0.06|}{6}$
$= \frac{0.26}{6} = 0.043 \approx 0.04 \ \therefore\ \Delta\bar{n} = 0.04$

[42] In a screw gauge, 5 complete rotations of the screw cause it to move a linear distance of $0.25\,cm$. There are 100 circular scale divisions. The thickness of a wire measured by this screw gauge gives a reading of 4 main scale divisions and 30 circular scale divisions . Assuming negligible zero error, the thickness of the wire is

(A) $0.0430\,cm$
(B) $0.3150\,cm$
(C) $0.4300\,cm$
(D) $0.2150\,cm$

Solution:[Correct Answer : D]

In one rotation scale moves $\frac{0.25}{5} = 0.05cm$
Least count $= 0.05 \times 10^{-2}cm$
For 4 main scale division $= 4 \times 0.05 = 0.2cm$
For circular scale divosion $= 30 \times 0.05 \times 10^{-2} = 1.5 \times 10^{-2}cm$
Thickness of wire $= 0.2 + 0.015 = 0.2150cm$

[43] 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

(A) $M^1L^2T^{-2}$
(B) $M^1L^2T^{-1}I^{-1}$
(C) $M^1L^2T^{-3}I^{-2}$
(D) $M^1L^2T^{-3}I^{-1}$

Solution:[Correct Answer : C]

$$According\,to\,Ohm's\,law,$$
$$V = RI \ or\ R = \frac{V}{I}$$
$$Dimensions\,of\,V = \frac{W}{q} = \frac{[ML^2T^{-2}]}{[IT]}$$
$$R = \frac{[ML^2T^{-2}/IT]}{[I]} = [ML^2T^{-3}I^{-2}]$$

[44] Which of the following is unitless quantity ?

(A) Velocity gradient
(B) Pressure gradient
(C) Displacement gradient
(D) Force gradient

Solution:[Correct Answer : C]

Gradient of a quantity Q is given as $\frac{\Delta Q}{\Delta x}$
Thus, a gradient will be unitless if its numerator has same dimensions as denominator, i.e. x (which has the dimension L).
Thus, out of the options, Displacement has the dimension L and hence its gradient will be dimensionless.

[45] The length, breath and thickness of a metal sheet are $4.234\ m, 1.005\ m,$ and $2.01\ cm$ respectively then the volume of the sheet is

(A) $8.72m^2, 0.0855m^3$
(B) $8.12m^2, 0.0755m^3$
(C) $7.82m^2, 1.0855m^3$
(D) $7.12m^2, 0.3855m^3$

Solution:[Correct Answer : A]

$A = 2 \times (L \times B + B \times T + T \times L)$
$\therefore A = 2 \times (4.234 \times 1.005 + 1.005 \times 0.0201 + 0.0201 \times 4.234)$
$\therefore A = 2 \times (4.2552 + 0.0202 + 0.0851)$
$\therefore A = 8.721 m^2$
$\therefore A = 8.721 m^2$ to correct significant digits
$V = L \times B \times T$
$\therefore V = 4.234 \times 1.005 \times 0.0201$
$\therefore V = 0.0855 m^3$ to correct significant digits

[46] The velocity v (in $cm/$ sec) of a particle is given in terms of time t (in sec) by the relation $v = at + \frac{b}{t+c}$; the dimensions of a, b and c are

(A) $a = L^2,\ b = T,\ c = LT^2$ (B) $a = LT^2,\ b = LT,\ c = L$ (C) $a = LT^{-2}, b = L,\ c = T$ (D) $a = L,\ b = LT,\ c = T^2$

Solution:[Correct Answer : C]

(c) From the principle of dimensional homogenity $[v] = [at] \Rightarrow [a] = [LT^{-2}]$.
Similarly $[b] = [L]$and $[c] = [T]$

[47] Two full turns of the circular scale of a screw gauge cover a distance of $1\ mm$ on its main scale. The total number of divisions on the circular scale is 50. Further, it is found that the screw gauge has a zero error of $-0.03\ mm$. While measuring the diameter of a thin wire, a student notes the main scale reading of $3\ mm$ and the number of circular scale divisions in line with the main scale as 35. The diameter of the wire is ...... mm

(A) 3.38 (B) 3.32 (C) 3.73 (D) 3.67

Solution:[Correct Answer : A]

$$Least\ count\ of\ screw\ gauge = \frac{0.5}{50} mm = 0.01 mm$$
$$\therefore \text{Reading} = [Main\ scale\ reading + circular\ scale\ reading \times L.C] - (zero\ error)$$
$$= [3 + 35 \times 0.01] - (-0.03) = 3.38\ mm$$

[48] The dimensions of K in the equation $W = \frac{1}{2}\ Kx^2$ is

(A) $M^1L^0T^{-2}$ (B) $M^0L^1T^{-1}$ (C) $M^1L^1T^{-2}$ (D) $M^1L^0T^{-1}$

Solution:[Correct Answer : A]

(a) $W = \frac{1}{2}kx^2 \Rightarrow [k] = \frac{[W]}{[x^2]} = \left[\frac{ML^2T^{-2}}{L^2}\right] = [MT^{-2}]$

[49] If C and R represent capacitance and resistance respectively, then the dimensions of RC are

(A) $M^0L^0T^2$ (B) M^0L^0T (C) ML^{-1} (D) None of the above

Solution:[Correct Answer : B]

(b) $RC = T$
$\because [R] = [ML^2T^{-3}I^{-2}]$ and
$[C] = [M^{-1}L^{-2}T^4I^2]$

[50] In a particular system the units of length, mass and time are chosen to be $10\ cm$, $10\ g$, and $0.1\ s$ respectively. The units of force in this system will be equal to?

(A) 0.1 (B) 1 (C) 10 (D) 100

Solution:[Correct Answer : A]

$1 newton = 1 kgm/s^2$
$1 kg = 10^3$ and $1m = 10^2 cm$
$1N = \frac{(10^3 g)(10^2 cm)}{s^2}$
$1N = \frac{100 \times (10g) \times 10(10cm)}{100 \times (0.1s)^2}$
$= 10 \times \frac{(10g)(10cm)}{(0.1s)^2}$
$1N = 10\times$ New unit of force Thus, New unit $= 1/10 = 0.1N$