Unit And Measurements

1. If the units of length and force are increased four times, then the unit of energy will:

   (A) Increase 8 times (B) Increase 16 times
   (C) Decreases 16 times (D) Increase 4 times

Answer: [B]

Dimensionally,

$E = ML^2T^{-2}$

$E(MLT^{-2})(L)$

$= (4)(MLT^{-2})(4L) = 16(ML^2T^{-2})$

2. If velocity, force and time are taken to be fundamental quantities find dimensions formula for (a) mass:

   (A) $KV^{-1}FT^{-1}$ (B) $KV^{-1}FT$ (C) $KVF^{-1}T^{-1}$ (D) $KV^{-1}F^{-1}T$

Answer: [B]

Let the mass in represented by M then

M = f (V,F,T)

Assuming that a function is product of power functions of V, F and T

$M=KV^xF^yT^z$

Where k is a dimension less constant of proportionality. The above equation dimensionally becomes.

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

i.e. $[M]=[M^y][L^{x+y}Y^{-x-2y+z}]$

So equation becomes

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

For dimensionally correct expression,

y=1,x+y=0and −x−2y+z=0

⇒x=−1,y=1andz=1

Therefore M=KV−1FT.

Hence correct answer is (B).

3. A rectangular plate has length (2±0.02)cmand width (1±0.01)cm.The maximum percentage error in the measurement of its area is:

(A) 1% (B) 2% (C) 3% (D) 5%

Answer: [B]

$A = \ell b$

$$\frac{\Delta A}{A} \times 100 = \frac{\Delta \ell}{\ell} \times 100 + \frac{\Delta b}{b} \times 100$$

4. In a resonance tube with tuning fork of frequency 512 Hz, first resonance occurs at water level equal to 30.3 cm and second resonance occurs at 63.7cm. The maximum possible error in the speed is:

(A) 51.2 cm/sec. (B) 102.4 cm/sec

(C) 204.8 cm/sec (D) 153.6 cm/sec

Answer: [C]

$v = 2n(\ell_2 - \ell_1)$

$\Delta v = 2n(\Delta \ell_2 + \Delta \ell_1)$

$= 2 \times 512 \times (0.1 + 0.1) = 204.8 \text{ cm / sec}$

5. The density of a cube is measured by measuring its mass and length of its sides. If the maximum errors in the measurement of its mass and length are 4%and 3% respectively, the maximum error in density is

(A) 1% (B) 7% (C) 5% (D) 13%

Answer: [D]

$d = \frac{Mass}{L^3}$

Or % error in d = % error in mass + 3 [% error in length]

$= 4\% + 3[3\%] = 13\%$

6. The dimensions of h/e (h = Planck's constant and e = electronic charge) are same as that of:

(A) magnetic flux (B) electric flux

(C) electric field (D) magnetic field

Answer: [A]

Electric potential $V \equiv \frac{d\phi}{dt}$ ...(1)

(Faraday's law)

and eV=hν(photo-electric effect)

or $V = \left(\frac{h}{e}\right)\nu$ ...(2)

From Eqs. (1) and (2) we can see that magnetic flux (φ) and $\frac{h}{e}$ have the same dimensions.

7. $\frac{E^2}{\mu_0}$ has the dimensions (E = electric field, μ_0 = permeability of free space)

(A) $[M^2L^3T^{-2}A^2]$ (B) $[MLT^{-4}]$ (C) $[ML^3T^{-2}]$ (D) $[M^{-1}L^2TA]$

Answer: [B]

$$\left[\frac{E^2}{\mu_0}\right] = \left[\frac{\varepsilon_0 E^2}{\varepsilon_0 \mu_0}\right] = \left[\frac{\text{energy/volume}}{(1/\text{speed of light})^2}\right]$$

$$= \left[\frac{\text{energy}(\text{speed})^2}{\text{volume}}\right]$$

$$= \left[\frac{ML^2T^{-2}L^2T^{-2}}{L^3}\right] = [MLT^{-4}]$$

8. The dimensions of σb^4 (σ = Stefan's constant and b = Wein's constant) are:

(A) $[M^0L^0T^0]$ (B) $[ML^4T^{-3}]$ (C) $[ML^{-2}T]$ (D) $[ML^6T^{-3}]$

Answer: [B]

$\lambda_m T = b$ or $b^4 = \lambda_m^4 T^4$

and $\frac{\text{energy}}{\text{area} - \text{time}} = \sigma T^4$ or $\sigma = \frac{\text{energy}}{(\text{area} - \text{time})\, T^4}$

$\therefore \sigma b^4 = \left[\frac{\text{energy}}{\text{area} - \text{time}}\right] \lambda_m^4$ or $[\sigma b^4] = \frac{[ML^2T^{-2}]}{[L^2][T]}[L^4] = [ML^4T^{-3}]$

9. The kilowatt hour is a unit of:

(A) Energy (B) electric charge

(C) Force (D) electric power

Answer: [A]

Energy

10. The dimensional formula of kinetic energy is the same as that of:

(A) pressure (B) work

(C) momentum (D) force

Answer: [B]

Work

11. The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by relation of the type $f=cm^x k^y$, where c is a dimensionless constant. The values of x and y are:

(A) 1/2,1/2 (B) −1/2,−1/2

(C) 1/2,−1/2 (D) −1/2,1/2

Answer: [D]

$f = cm^x k^y$

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

$M^0L^0T^{-1} = M^{x+y}L^0T^{-2y}$

$x + y = 0$ ...(1)

$-2y = -1$ ...(2)

12. If $S = \frac{1}{3}ft^3$, 'f ' has the dimensions of:

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

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

Answer: [C]

$f = \frac{3S}{t^3}$

$= \frac{M^0 L^1 T^0}{T^3} = [L^1T^{3}]$

13. A rectangular plate has length (4±0.04)cmand width (2±0.02)cm.The maximum percentage error in the measurement of its area is:

(A) 2% (B) 6% (C) 3% (D) 4%

Answer: [B]

$\frac{\Delta A}{A} \times 100 = \frac{\Delta \square}{\square} \times 100 + \frac{\Delta}{b} \times 100$

$= \frac{0.04}{4} \times 100 + \frac{0.02}{2} \times 100 = 6\%$

14. A wire is of mass (0.3±.003)gm.the radius is (0.5±0.005)cmand length is (6±.6)cm. the maximum percentage error in density is:

(A) 3% (B) 4% (C) 8% (D) 16%

Answer: [B]

$\frac{\Delta P}{P} \times 100$

$= \frac{\Delta m}{m} \times 100 + \frac{\Delta \square}{\square} \times 100 + \frac{2\Delta r}{r} \times 100$

15. A pressure of 106dyne cm^{-2} is equivalent to:

(A) $10^5 Nm^{-2}$ (B) $10^4 Nm^{-2}$ (C) $10^6 Nm^{-2}$ (D) $10^7 Nm^{-2}$

Answer: [A]

$10^6 \frac{dyne}{cm^2} = 10^6 \times \frac{10^{-5} N}{10^{-4} m^2} = 10^5 \frac{N}{m^2}$

16. Dimensional formula for latent heat is:

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

Answer: [A]

$Q = mL \Rightarrow L = \frac{Q}{m}$ (Heat is a form of energy)

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

17. To keep on object moving in a circle at constant speed requires a force $F \propto m^a v^b r^c$. According to dimensional analysis the a, b, c are:

(A) $a=1, b=2, c=-1$

(B) $a=1, b=2, c=1$

(C) $a=0, b=2, c=-1$

(D) $a=1, b=2, c=0$

Answer: [A]

$F \propto m^a v^b r^c$

i.e. $[F] = [m]^a [v]^b [r]^c$

or $[MLT^{-2}] = [M]^a [LT^{-1}]^b [L]^c$

or $[M^1L^1T^{-2}] = [M^a L^{b+c} T^{-b}]$

Comparing LHS and RHS

$a=1, b+c=1 \& -b=-2$

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

18. In the formula $X=3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively. The dimensions of Y in MKSA system are:

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

(B) ML^{-2}

(C) $M^{-3}L^{-2}A^4T^8$

(D) $M^{-3}L^{-2}A^4T^4$

Answer: [C]

$X = 3YZ^2$

$[Y] = \frac{[X]}{[Z]^2} = \frac{[M^{-1}L^{-2}T^4A^2]}{[MT^{-2}A]^2} = [M^{-3}L^{-2}T^8A^4]$

19. Which of the following sets cannot enter into the list of fundamental quantities in any system of units?

(A) length, mass, velocity (B) length, time, velocity

(C) length, time, mass (D) mass, time, velocity

Answer: [B]

Length, time and velocity cannot enter in to the list of fundamental quantities because velocity can be expressed in terms of length and time.

20. In a certain system of units, 1 unit of time is 5 sec, 1 unit of mass is 20 kg and unit of length is 10 m. In this system, one unit of power will correspond to:

(A) 16 watts (B) $\frac{1}{16}$ watts (C) 25 watts (D) None of these

Answer: [A]

$[P] = ML^2T^{-3}$

$\therefore$ Unit of P $= 20\,kg \times (10\,m)^2 \times (5\,sec)^{-3} = 16\,W$

21. The time dependence of a physical quantity p is given by $p = p_0 e^{-\alpha t^2}$, where α is constant and t is time. The constant α:

(A) is dimensionless (B) has dimensions T−2

(C) has dimensions T2 (D) has dimensions of p

Answer: [B]

Powers are always dimensionless

$\therefore [\alpha t2]=[M0L0T0]$ or $[\alpha]=[M0L0T-2]$

22. The force F is given in terms of time t and displacement x by the equation F=AcosBx+CsinDT.The dimensional formula of D/B is

(A) [M0L0T0] (B) [M0L0T−1] (C) [M0L−1T0] (D) [M0L1T−1]

Answer: [D]

$Bx = \theta$ (constant); $x = L-1$

$DT = \theta$ (constant); $D = T^{-1}$

$\frac{D}{B} = \frac{T^{-1}}{L^{-1}} = LT^{-1}$

23. The dimensions of $\frac{e2}{4\pi\varepsilon 0hc}$, where e, ε0, h and c are electronic charge, electric permittivity, Planck's constant and velocity of light in vacuum respectively is :

(A) [M0L0T0] (B) [M1L0T0] (C) [M0L1T0] (D) [M0L0T1]

Answer: [A]

$\frac{e^2}{4\pi\varepsilon 0hc}$

$\frac{kq2}{r2} = F \Rightarrow ke2 = Fr2$

Energy $E = \frac{hc}{\lambda} \Rightarrow hc = E\lambda$

$\frac{Fr2}{hc} = \frac{Fr2}{E}\lambda = [M0\ L0\ T0\ ]$

24. Which of the following groups has different dimensions?

(A) Potential difference, emf, voltage

(B) Pressure, stress, Young's modulus

(C) Heat, energy, work done

(D) Dipole moment, electric flux, electric field

Answer: [D]

(A) Potential difference =[M1L2T−3A−1]

= voltage = emf

(B) Pressure, stress, young's modulus, =[M1L2T−2]

(C) Heat, energy, work done =[M1L2T−2]

(D) Dipole moment =[L1T1A1]

Electric flux =[M1L3T−3A−1]

Electric field =[M1L3T−3A−1]

25. If 1gcms−1=xnewton-second, then the number x is equal to :

(A) 1×10−1 (B) 3.6×10−3 (C) 1×10−5 (D) 6×10−4

Answer: [C]

1gcms−1=1(10−3kg)(10−2m)s−1

$=10-5kg\frac{m}{s}\times\frac{s}{s}=10-5N.s$

26. 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 unit of force in this system will be :

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

Answer: [A]

1N=n2unit

$$n_2 = 1\left(\frac{1kg}{10g}\right)^1\left(\frac{1m}{10cm}\right)^1\left(\frac{1s}{0.1s}\right)^{-2}$$

27. If y represents distance and x-represents time, dimensions of $\frac{d^2y}{dx^2}$ are:

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

Answer: [D]

$$\frac{d^2y}{dx^2} = \frac{d}{dx}\left(\frac{dy}{dx}\right)$$

$= \frac{d}{dx}(v)$=rate of change of speed w.r.t. time

= acceleration

28. The dimensional representation of Planck's constant is identical to that of

(A) Torque (B) Power

(C) Linear momentum (D) angular momentum

(D)

As Planck's constant has dimensions of $\frac{E}{\nu}$

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

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

and Dimensions of angular momentum $=r \times p$

$=(L \times MLT^{-1})$

$=ML2T-1$

29. If the units of M and L are quadrupled, then the units of torque becomes

(A) 16 times (B) 64 times (C) 8 times (D) 4 times

Answer: [B]

Dimensions of torque $=ML2T-2$

$= (4M)(4L)^{3} T^{-2}$

$= 64ML^{2}T-2$

30. A radar signal is beamed towards a planet from earth and its echo is received seven minutes later. If distance between the planet and earth is 6.3×1010m,then velocity of the signal will be

(A) 3×108m/s (B) 2.97×106m/s (C) 3.10×105m/s (D) 300m/s

Answer: [A]

Velocity of signal, c $= \frac{2x}{t} = \frac{2\times 6.3\times 10^{10}}{7\times 60} = 3\times 108 \text{ m/s}$

31. The displacement of a particle is given by x =Asin2kt,where t denotes time. The unit of k is

(A) htz (B) metre (C) radian (D) second

Answer: [A]

Here, kt is dimensionless. Hence, k = 1/t $= sec^{-1}$ = htz

32.Dimensions of ohm are same as those of (h is Planck's constant and e is charge)

(A) $\frac{h}{e}$ (B) $\frac{h^2}{e}$ (C) $\frac{h}{e^2}$ (D) $\frac{h^2}{e^2}$

Answer: [C]

$\frac{h}{e^2} = \frac{[ML^2T^{-1}]}{[AT]^2} = [ML^2T^{-3}A^{-2}]$ = resistance

33.Which of the following is not a unit of time

(A)solar year (B) tropical year (C) leap year (D) light year

Answer: [D]

Tropical year is the year in which there is total eclipse. Light year represents distance

34.Dimensional formula of Stefan's constant

(A) $ML^2T^{-2}\theta^{-4}$ (B) $ML^2T^{-3}\theta^{-4}$

(C) $ML^{\circ}T^{-3}\theta^{-4}$ (D) none of these

Ans wer: [C]

$\sigma = \frac{E}{At\theta^4} = [ML^{\circ}T^{-3}\theta^{-4}]$

35. A cube has side 1.2×10^{-2} m. Its volume will be recorded as

(A) $1.728\times10^{-6}m^3$ (B) $1.72\times10^{-6}m^3$

(C) $1.7\times 10^{-6}m^3$ (D) $0.72\times10^{-6}m^3$

Answer: [C]

v= 3=1.728 × 10−6

Length has two significant figure v=1.7×10−6m3

36.An athlete’s coach told his team that muscle times speed equals power. What dimensions does he view for “muscle”?

(A) MLT2 (B) ML2T−2 (C) MLT−2 (D)L

Answer: (C)

Power = force × velcoity

= muscle times speed

∴muscle represents force

miscle =$[MLT^{-2}]$

37.If force, length and time would have been the fundamental units what would have been the dimensional formula for mass?

(A) FL−1T−2 (B) FL−1T2 (C) FLT−2 (D)F

Answer: [B]

Let M = K FaLbTc

= [MLT−2]a [Lb] Tc

= [MaL(a+b)T(−2a+c)]

a=1,a+b=0& −2a+c=0

⇒ a=1,b=−1,c=2

Hence, (B) is correct.

38. A wave is represented by

y =asin(At − Bx + C)

where A, B, C are constants. The Dimensions of A, B, C are:

(A) T−1,L,M0L0T0 (B) T−1,L−1,M0L0T0

(C)T, L, M (D)T−1,L−1,M−1

Answer: [B]

y = A sin(At − Bx + c)

At−Bx+cis dimension less

i.e. [At]=[Bx]=C=[M0L0T0]

or [A]=[T−1]

and [B]=[L−1]

and [C]=[M0L0T0]

39. The density of wood is 0.5gcm−3in cgs system of units. The corresponding value of SI units is

(A)5000 (B) 500 (C)5 (D)0.5

Answer: [B]

Density = M/V

$1cm = 10^{-2} m; 1gm = 10^{-3} kg$

0.5 g cm−3 = 0.5(10−3) kg $(10^{-2} m)^{-3}$

= 0.5 ×10−3 ×106 = 500

40. The dimensions of Planck’s constant are

(A) $ML2T-2$

(B) $ML2T-1$

(C) ML^2T

(D) ML^2T^2

Answer: [B]

$E = h\nu$

Therefore,

$[h] = \frac{[E]}{[\nu]} = \frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1}$

41. 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) $a=L, b=LT, c=T^2$

Answer: (C)

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

42. The position of a particle at time t is given by the relation $x(t) = \left(\frac{v_0}{\alpha}\right)(1-e^{-\alpha t})$, where v_0 is a constant and $\alpha > 0$. The dimensions of v_0 and α are respectively.

(A) $M^0L^1T^{-1}$ and T^{-1}

(B) $M^0L^1T^0$ and T^{-1}

(C) $M^0L^1T^{-1}$ and LT^{-2}

(D) $M^0L^1T^{-1}$ and T

Answer: [A]

Dimension of $\alpha t = [M^0L^0T^0] \therefore [\alpha] = [T^{-1}]$

Again $\left[\frac{v_0}{\alpha}\right] = [L]$ so $[v_0] = [LT^{-1}]$

43. The dimensions of $\frac{a}{b}$ in the equation $P = \frac{a - t^2}{bx}$, where P is pressure, x is distance and t is time, are

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

Answer: [A]

$[a] = [T^2]$ and $[b] = \frac{[a - t^2]}{[P][x]} = \frac{T^2}{[ML^{-1}T^{-2}][L]}$

$\Rightarrow [b] = [M^{-1}T^4]$

So $\left[\frac{a}{b}\right] = \frac{[T^2]}{[M^{-1}T^4]} = [MT^{-2}]$

44. The velocity of a freely falling body changes as $g^p h^q$ where g is acceleration due to gravity and h is the height. The values of p and q are

(A) $1, \frac{1}{2}$ (B) $\frac{1}{2}, \frac{1}{2}$ (C) $\frac{1}{2}, 1$ (D) 1, 1

Answer: [B]

$[V] = [g]^p [h]^q$

$[M^0L^1T^{-1}] = [LT^{-2}]^p [M^0L^1T^0]^q = M^0L^{p+q}T^{-2p}$

$\Rightarrow 1 = p + q$ and $-1 = -2p$

$\therefore p = \frac{1}{2}, q = \frac{1}{2}$

45. The density of the material of a cube is measured by measuring its mass and length of its side. If the maximum errors in the measurement of mass and the length are 3% and 2% respectively, the maximum error in the measurement of density is:

(A) 1% (B) 5% (C) 7% (D) 9%

Answer: [D]

$$d = \frac{m}{v} \Rightarrow d = \frac{m}{L^3}$$

$$\frac{\Delta d}{d} = 1\left(\frac{\Delta m}{m}\right) + 3\left(\frac{\Delta L}{L}\right)$$