HINTS & SOLUTIONS (PHYSICS – Chapter-wise Tests)

Speed Test-1

1. **(b)** In CGS system,

$$d = 4\frac{g}{cm^3}$$

The unit of mass is 100g and unit of length is 10 cm, so

$$\text{density} = \frac{4\left(\frac{100g}{100}\right)}{\left(\frac{10}{10}cm\right)^3}$$

$$= \frac{\left(\frac{4}{100}\right)}{\left(\frac{1}{10}\right)^3}\frac{(100g)}{(10cm)^3}$$

$$= \frac{4}{100}\times(10)^3\cdot\frac{100g}{(10cm)^3}$$

= 40 unit

2. **(a)** $T = P^a D^b S^c$

$M^0L^0T^1 = (ML^{-1}T^{-2})^a(ML^{-3})^b(MT^{-2})^c$

$= M^{a+b+c}L^{-a-3b}T^{-2a-2c}$

Applying principle of homogeneity

$a + b + c = 0;\ -a - 3b = 0;\ -2a - 2c = 1$

on solving, we get $a = -3/2, b = 1/2, c = 1$

3. **(a)** Number of significant figures in 23.023 = 5

Number of significant figures in 0.0003 = 1

Number of significant figures in $2.1\times10^{-3} = 2$

4. **(a)** $Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\text{Force / Area}}{\text{Dimensionless}} \Rightarrow Y = \text{Pressure}.$

5. **(d)** For angular momentum, the dimensional formula is $[ML^2T^{-1}]$. For other three, it is $[ML^2T^{-2}]$.

6. **(c)** $\frac{\Delta P}{P}\times100 = \frac{\Delta F}{F}\times100 + 2\frac{\Delta\ell}{\ell}\times100 = 4\% + 2\times2\%$

$= 8\%$

7. **(d)** Conductance,

$$G = \frac{1}{\text{resistance}} = \text{mho}(\Omega^{-1}) \text{ or siemen (S)}$$

8. **(d)** $F \propto v \Rightarrow F = kv \Rightarrow [k] = \left[\frac{F}{v}\right] = \left[\frac{MLT^{-2}}{LT^{-1}}\right] = [ML^0T^{-1}]$

9. **(c)** $\frac{0.2}{25}\times100 = 0.8\,\%$

10. **(c)** Weber is the unit of magnetic flux in S.I. system.

1 Wb(S.I unit) = 10^8 maxwell

11. **(b)** Solar constant = energy/area/time

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

12. **(b)** $b = \lambda_m T = LK = [M^0L^1T^0K^1]$

13. **(d)** Let unit 'u' related with e, a_0, h and c as follows.

$[u] = [e]^a[a_0]^b[h]^c[C]^d$

Using dimensional method,

$[M^{-1}L^{-2}T^{+4}A^{+2}] = [A^1T^1]^a[L]^b[ML2T^{-1}]^c[LT^{-1}]^d$

$[M^{-1}L^{-2}T^{+4}A^{+2}] = [M^cL^{b+2c+d}T^{a-c-d}A^a]$

$a = 2, b = 1, c = -1, d = -1$

$$\therefore\ u = \frac{e^2a_0}{hc}$$

14. **(c)** From $F = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$

$\therefore\ \frac{e^2}{\varepsilon_0} = 4\pi Fr^2$ (dimensionally)

$$\frac{e^2}{\varepsilon_0 hc} = \frac{4\pi Fr^2}{hc} = \frac{(MLT^{-2})L^2}{ML^2T^{-1}[LT^{-1}]} = [M^0L^0T^0A^0],$$

$\frac{e^2}{\varepsilon_0 hc}$ is called fine structure constant & has value $\frac{1}{137}$.

15. **(d)** $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$

$\rho = \frac{M}{L^3}$ $\quad\therefore\ \frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 3\frac{\Delta L}{L}$

% error in density = % error in Mass

+ 3 (% error in length]

= 4 + 3(3) = 13%

16. **(d)** Poisson's ratio is a unitless quantity.

17. **(d)** Dimensionally $\varepsilon_0 L$ = Capacitance (c)

$$\therefore\ \varepsilon_0 L\frac{\Delta V}{\Delta t} = \frac{C\Delta V}{\Delta t} = \frac{q}{\Delta t} = I$$

18. **(c)** $\frac{\Delta V}{V} = 3\frac{\Delta r}{r}$ or $6\% = 3\frac{\Delta r}{r}$ or $\frac{\Delta r}{r} = 2\%$

Now surface area $s = 4\pi r^2$ or $\log s = \log 4\pi + 2\log r$

$$\therefore\ \frac{\Delta s}{s} = 2\frac{\Delta r}{r} = 2\times2\% = 4\%.$$

19. **(d)** Let $(M) = V^aF^bE^c$

Putting the dimensions of V, F and E, we have

$(M) = (LT^{-1})^a\times(MLT^{-2})^b\times(ML^2T^{-2})^c$

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

Equating the powers of dimensions, we have

$b + c = 1$
$a + b + 2c = 0; \quad -a - 2b - 2c = 0$
which give $a = -2$, $b = 0$ and $c = 1$.
Therefore $(M) = (V^{-2} F^0 E)$.

20. **(d)** Number of significant figures in multiplication is three, corresponding to the minimum number
$107.88 \times 0.610 = 65.8068 = 65.8$

21. **(d)** A quantity which has dimensions and a constant value is called dimensional constant. Therefore, gravitational constant (G) is a dimensional constant.

22. **(a)** $\frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M^5][M^{-1}L^3T^{-2}]^2} = [M^0L^0T^0]$ = angle.

23. **(a)** The mean value of refractive index,

$$\mu = \frac{1.34 + 1.38 + 1.32 + 1.36}{4} = 1.35$$

and

$$\Delta\mu = \frac{|(1.35 - 1.34)| + |(1.35 - 1.38)| + |(1.35 - 1.32)| + |(1.35 - 1.36)|}{4}$$

$$= 0.02$$

Thus $\frac{\Delta\mu}{\mu} \times 100 = \frac{0.02}{1.35} \times 100 = 1.48$

24. **(c)** $\frac{eV}{T} = \frac{W}{T} = \frac{PV}{T} = R$

and $\frac{R}{N}$ = Boltzmann constant.

25. **(b)** Mobility $\mu = \frac{\text{drift velocity}}{\text{electric field}} \frac{V_d}{E} = \frac{(ms^{-1})}{(Vm^{-1})} = \frac{m^2 s^{-3}}{V}$

$$\left(\because \text{Volt} = V = \frac{\text{joule(J)}}{\text{coulomb(C)}}\right)$$

$$= \frac{m^2 s^{-1} C}{J} = \frac{m^2 s^{-1} As}{kg m^2 s^{-2}} [\text{Coulomb}, c = As]$$

$$= kg^{-1} s^2 A = M^{-1} T^2 A$$

26. **(a)**

27. **(b)** $v = k \lambda^a \rho^b g^c$

$$[M^0 LT^{-1}] = L^a (ML^{-3})^b (LT^{-2})^c$$
$$= M^b L^{a-3b+c} T^{-2c}$$

$\therefore \; b = 0; \; a - 3b + c = 1$

$-2c = -1 \Rightarrow c = 1/2 \qquad \therefore \; a = \frac{1}{2}$

$v \propto \lambda^{1/2} \rho^0 g^{1/2}$ or $v^2 \propto \lambda g$

28. **(b)** $[\text{momentum}] = [M][L][T^{-1}] = [MLT^{-1}]$

Planck's constant $= \frac{E}{\nu} = \frac{[M][LT^{-1}]^2}{T^{-1}} = ML^2T^{-1}$

29. **(d)** Let dimensions of length is related as,

$$L = [c]^x [G]^y \left[\frac{e^2}{4\pi\varepsilon_0}\right]^z$$

$$\frac{e^2}{4\pi\varepsilon_0} = ML^3T^{-2}$$

$L = [LT^{-1}]^x [M^{-1}L^3T^{-2}]^y [ML^3T^{-2}]^z$

$[L] = [L^{x+3y+3z} M^{-y+z} T^{-x-2y-2z}]$

Comparing both sides

$-y + z = 0 \Rightarrow y = z$ ...(i)

$x + 3y + 3z = 1$ ...(ii)

$-x - 4z = 0 \quad (\because y = z)$ ...(iii)

From (i), (ii) & (iii)

$z = y = \frac{1}{2}, \; x = -2$

Hence, $L = c^{-2}\left[G \cdot \frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

30. **(c)** Impulse = change in momentum

31. **(c)** We know that $\frac{Q^2}{2C}$ is energy of capacitor so it represent the dimension of energy = $[ML^2T^{-2}]$.

32. **(b)** Let $M = p^n v^m$

$$ML^{-2} T^{-1} = (ML^{-1} T^{-2})^n (LT^{-1})^m$$
$$= M^n L^{-n+m} T^{-2n-m}$$

$\therefore \; n = 1; \; -n + m = -2$

$\therefore \; m = -2 + n = -2 + 1 = -1 \qquad \therefore \; m = -n$

33. **(c)** $I = AT^2 e^{-B/kT}$

Dimensions of $A = I/T^2$; Dimensions of $B = kT$
($\because$ power of exponential is dimensionless)

$$AB^2 = \frac{I}{T^2}(kT)^2 = Ik^2$$

34. **(a)** $\eta = \frac{p(r^2 - x^2)}{4vl} = \frac{[ML^{-1}T^{-2}][L^2]}{[LT^{-1}][L]} = [ML^{-1}T^{-1}]$

35. **(a)** The unit of λ, x and A are the same

36. **(c)** $L + B = 2.331 + 2.1 \cong 4.4$ cm
Since minimum significant figure is 2.

37. **(c)** Given, $x = \cos(\omega t + kx)$
$(\omega t + kx)$ is an angle and hence it is a dimension less quantity.

$[(\omega t + kx)] = [M^0L^0T^0]$

or $[\omega t] = [M^0L^0T^0]$

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

38. **(c)** $10\,VD = 9MD, \; 1VD = \frac{9}{10}MD$

Vernier constant = 1 MD – 1 VD

$$= \left(1 - \frac{9}{10}\right)MD = \frac{1}{10}MD = \frac{1}{10} \times \frac{1}{2} = 0.05\,\text{mm}$$

39. (c) $[\text{Energy density}] = \frac{[\text{Work done}]}{[\text{Volume}]}$

$$= \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$$

$[\text{Young's Modulus}] = \left[\frac{F}{A} \times \frac{l}{\Delta l}\right]$

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

40. (b) As $\frac{a}{V^2} = P$

$$\therefore \; a = PV^2 = \frac{dyne}{cm^2}(cm^3)^2 = dyne\ cm^4$$

41. (a) Reyonld's constant is a pure number, hence it has no dimensions.

42. (d) $\omega k = \frac{1}{T} \times \frac{1}{L} = [L^{-1}\,T^{-1}]$

The dimensions of the quantities in a, b, c are of velocity $[LT^{-1}]$

43. (a) M = Pole strength × length

= amp – metre × metre = amp – metre^2

44. (b) According to the question.

$t = (90 \pm 1)$ or, $\frac{\Delta t}{t} = \frac{1}{90}$

$l = (20 \pm 0.1)$ or, $\frac{\Delta l}{l} = \frac{0.1}{20}$

$\frac{\Delta g}{g}\% = ?$

As we know,

$$t = 2\pi\sqrt{\frac{l}{g}}$$

$$\Rightarrow \quad g = \frac{4\pi^2 l}{t^2}$$

or, $$\frac{\Delta g}{g} = \pm\left(\frac{\Delta l}{l} + 2\frac{\Delta t}{t}\right)$$

$$= \left(\frac{0.1}{20} + 2 \times \frac{1}{90}\right)$$

$$= 0.027$$

$$\therefore \quad \frac{\Delta g}{g}\% = 2.7\%$$

45. (a) Dimension of magnetic flux

= Dimension of voltage × Dimension of time

$= [ML^2T^{-3}A^{-1}]\,[T] = [ML^2T^{-2}A^{-1}]$

$\because \text{Voltage} = \frac{\text{work}}{\text{charge}}$