2.UNITS AND MEASUREMENTS

Single Correct Answer Type

1. The length of a strip measured with a metre rod is 10.0 cm. Its width measured with a vernier callipers is 1.00 cm. The least count of the metre rod is 0.1 cm and that of vernier callipers is 0.01 cm. What will be the error in its area?
a) ± 0.01 cm^2 b) ± 0.1 cm^2 c) ± 0.11 cm^2 d) ± 0.2 cm^2
2. The frequency f of vibrations of a mass m suspended from a spring of spring constant k is given by $f = Cm^x k^y$, where C is a dimensionless constant. The values of x and y are, respectively
a) $\frac{1}{2}, \frac{1}{2}$ b) $-\frac{1}{2}, -\frac{1}{2}$ c) $\frac{1}{2}, -\frac{1}{2}$ d) $-\frac{1}{2}, \frac{1}{2}$
3. Which of the following quantities has its unit as newton- second?
a) Energy b) Torque c) Momentum d) Angular momentum
4. Which of the following number has least number of significant figures?
a) 0.80760 b) 0.80200 c) 0.08076 d) 80.267
5. The order of magnitude of 499 is 2, then the order of magnitude of 501 will be
a) 4 b) 2 c) 1 d) 3
6. A physical quantity X is represented by $X = (M^x L^{-y} T^{-z})$. The maximum percentage errors in the measurement of M, L and T, respectively, are $a\%$, $b\%$ and $c\%$. The maximum percentage error in the measurement of X will be
a) $(ax + by - cz)\%$ b) $(ax - by - cz)\%$ c) $(ax + by + cz)\%$ d) $(ax - by + cz)\%$
7. The effective length of a simple pendulum is the sum of the following three: Length of string, radius of bob, and length of hook
In a simple pendulum experiment, the length of the string, as measured by a metre scale, is 92.0 cm. The radius of the bob combined with the length of the hook, as measured by a vernier callipers, is 2.15 cm. The effective length of the pendulum is
a) 94.1 cm b) 94.2 cm c) 94.15 cm d) 94 cm
8. Given that $Y = a \sin \omega t + bt + ct^2 \cos \omega t$. The unit of abc is same as that of
a) y b) y/t c) $(y/t)^2$ d) $(y/t)^3$
9. While measuring the acceleration due to gravity by a simple pendulum, a student makes a positive error of 2% in the length of the pendulum and a negative error of 1% in the value of time period. His actual percentage error in the measurement of the value of g will be
a) 3% b) 0% c) 4% d) 5%
10. Dimensional formula of capacitance (or farad) is
a) $M^{-1}L^{-2}T^4A^2$ b) $ML^2T^4A^{-2}$ c) $MLT^{-4}A^2$ d) $M^{-1}L^{-2}T^{-4}A^{-2}$
11. Force F is give in terms of time t and distance x by $F = A \sin Ct + B \cos Dx$. Then the dimensions of A/B and C/D are
a) $[M^0L^0T^0], [M^0L^0T^{-1}]$ b) $[MLT^{-2}], [M^0L^{-1}T^0]$ c) $[M^0L^0T^0], [M^0LT^{-1}]$ d) $[M^0L^1T^{-1}], [M^0L^0T^0]$
12. If $X = a + b$, the maximum percentage error in the measurement of X will be
a) $\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right) \times 100\%$ b) $\left(\frac{\Delta a}{a+b} - \frac{\Delta b}{a+b}\right) \times 100\%$
c) $\left(\frac{\Delta a}{a+b} + \frac{\Delta b}{a+b}\right) \times 100\%$ d) $\left(\frac{\Delta a}{a} \times \frac{\Delta b}{b}\right) \times 100\%$
13. The mass of the liquid flowing per second per unit area of cross section of the tube is proportional to P^x and v^y, where P is the pressure difference and v is the velocity, then the relation between x and y is
a) $x = y$ b) $x = -y$ c) $y^2 = x$ d) $y = -x^2$
14. The dimensional formula for resistivity of conductor is
a) $[M L^2T^{-2}A^{-2}]$ b) $[ML^3T^{-3}A^{-2}]$ c) $[ML^{-2}T^{-2}A^2]$ d) $[ML^2T^{-2}A^{-3}]$
15. In the relation $V = \frac{\pi}{8}\frac{Pr^4}{nl}$, where the letters have their usual meanings, the dimensions of V are

a) $M^0L^3T^0$ b) $M^0L^3T^{-1}$ c) $M^0L^{-3}T^{-1}$ d) $M^1L^3T^0$

16. The resistance of a metal is given by $R = V/I$, where V is potential difference and I is the current. In a circuit, the potential difference across resistance is $V = (8 \pm 0.5)V$ and current in resistance, $I = (4 \pm 0.2)$Å. What is the value of resistance with its percentage error?
a) $(2 \pm 5.6\%)\ \Omega$ b) $(2 \pm 0.7\%)\ \Omega$ c) $(2 \pm 35\%)\ \Omega$ d) $(2 \pm 11.25\%)\ \Omega$

17. Suppose refractive index μ is given as
$$\mu = A + \frac{B}{\lambda^2}$$
Where A and B are constant and λ is wavelength, then dimensions of B are same as that of
a) Wavelength b) Volume c) Pressure d) Area

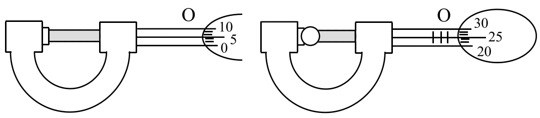
18. The percentage errors in the measurement of mass and speed are 2% and 3%, respectively. How much will be the maximum error in the estimation of KE obtained by measuring mass and speed?
a) 5% b) 1% c) 8% d) 11%

19. Inductance L can be dimensionally represented as
a) $ML^2T^{-2}A^{-2}$ b) $ML^2T^{-4}A^{-3}$ c) $ML^{-2}T^{-2}A^{-2}$ d) $ML^2T^4A^3$

20. A student writes four different expressions for the displacement y in a periodic motion as a function of time t, a as amplitude, T as time period. Which of the following can be correct?
a) $y = aT \sin\frac{2\pi t}{T}$ b) $y = a \sin Vt$
c) $y = \frac{a}{T}\sin\frac{t}{a}$ d) $y = \frac{a}{\sqrt{2}}\left[\sin\frac{2\pi t}{T} + \cos\frac{2\pi t}{T}\right]$

21. The dimension of self-induction are
a) $MLT^{-2}A^{-2}$ b) $ML^2T^{-1}A^{-2}$ c) $ML^2T^{-2}A^{-2}$ d) $ML^2T^{-2}A^{-1}$

22. The circular divisions of shown screw gauge are 50. It moves 0.5 mm on main scale in one rotation. The diameter of the ball is



a) 2.25 mm b) 2.20 mm c) 1.20 mm d) 1.25 mm

23. If force F, acceleration a, and time T are taken as the fundamental physical quantities, the dimensions of length on this system of units are
a) FAT^2 b) FAT c) FT d) AT^2

24. The heat generated in a circuit is given by $Q = I^2Rt$, where I is current, R is resistance, and t is time. If the percentage errors in measuring I, R, and t are 2%, 1%, and 1%, respectively, then the maximum error in measuring heat will be
a) 2% b) 3% c) 4% d) 6%

25. A student performs an experiment to determine the Young's modulus of a wire, exactly 2 m long, by Searle's method. In a particular reading, the student measures the extension in the length of the wire to be 0.8 mm with an uncertainty of $\pm$ 0.05 mm at a load of exactly 1.0 kg. The student also measures the diameter of the wire to be 0.4mm with an uncertainty of $\pm$ 0.01 mm. Take g = 9.8 ms^{-2} (exact). The Young's modulus obtained from the reading is
a) $(2.0 \pm 0.3) \times 10^{11} Nm^{-2}$ b) $(2.0 \pm 0.2) \times 10^{11} Nm^{-2}$
c) $(2.0 \pm 0.1) \times 10^{11} Nm^{-2}$ d) $(2.0 \pm 0.05) \times 10^{11} Nm^{-2}$

26. A spherical body of mass m and radius r is allowed to fall in a medium of viscosity η. The time in which the velocity of the body increases from zero to 0.63 times the terminal velocity (v) is called time constant (τ). Dimensionally τ can be represented by
a) $\frac{mr^2}{6\pi\eta}$ b) $\sqrt{\frac{6\pi mr\eta}{g^2}}$ c) $\frac{m}{6\pi\eta rv}$ d) None of these

27. Using mass (M), length (L), time (T), and electric current (A) as fundamental quantities, the dimensions of

permittivity will be

a) $[MLT^{-1}A^{-1}]$ b) $[MLT^{-2}A^{-2}]$ c) $[M^{-1}L^{-3}T^{4}A^{2}]$ d) $[M^{2}L^{-2}T^{-2}A]$

28. Out of the following the only pair that does not have identical dimension is

a) Angular momentum and Planck's constant b) Moment of inertia and moment of a force
c) Work and torque d) Impulse and momentum

29. Which of the following groups have 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

30. 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

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

a) 0 b) 2 c) -2 d) 1

32. A physical quantity depends upon five factors, all of which have dimensions; then method of dimensional analysis

a) Can be applied b) Cannot be applied
c) Depends upon factors involved d) Both a and c

33. A physical quantity x is calculated from $x = \frac{ab^2}{\sqrt{c}}$. Calculate the percentage error in measuring x when the percentage errors in measuring a, b, and c are 4, 2, and 3%, respectively

a) 7% b) 9% c) 11% d) 9.5%

34. In the relation $\frac{dy}{dt} = 2\omega \sin(\omega t + \phi_0)$, the dimensional formula for $\omega t + \phi_0$ is

a) MLT b) MLT^0 c) ML^0T^0 d) $M^0L^0T^0$

35. The relative density of a material of a body is found by weighing in first in air and then in water. If the weight of the body in air is $W_1 = 8.00 \pm 0.05$ N and weight in water is $W_2 = 6.00 \pm 0.05$ N, then the relative density $\rho_r = W_1/(W_1 - W_2)$ with the maximum permissible error is

a) $4.00 \pm 0.62\%$ b) $4.00 \pm 0.82\%$ c) $4.00 \pm 3.2\%$ d) $4.00 \pm 5.62\%$

36. In the determination of Young's modulus $\left(Y = \frac{4\,MLg}{\pi\,\ell d^2}\right)$ by using Searle's method, a wire of length $L = 2m$ and diameter $d = 0.5mm$ is used. For a load $M = 2.5\ kg$, an extension $\ell = 0.25mm$ in the length of the wire is observed. Quantities d and ℓ are measured using a screw gauge and a micrometer, respectively. They have the same pitch of $0.5\ mm$. The number of divisions on their circular scale is 100. The contributions to the maximum probable scale is 100. The contributions to the maximum probable error of the Y measurement

a) Due to the errors in the measurements of d and ℓ are the same
b) Due to the error in the measurement of d is twice that due to the error in the measurement of ℓ
c) Due to the error in the measurement of ℓ is twice that due to the error in the measurement of d
d) Due to the error in the measurement of d is four time that due to the error in the measurement of ℓ

37. If C, the velocity of light, g, the acceleration due to gravity, and P, the atmospheric pressure are the fundamental quantities in M.K.S. system, then the dimensions of length will be same as that of

a) $C/$g b) C/P c) PCg d) $C^2/$g

38. The relation $\tan\theta = v^2/rg$ gives the angle of banking of the cyclist going round the curve. Here v is the speed of the cyclist, r is the radius of the curve, and g is acceleration due to gravity. Which of the following statements about the relation is true?

a) It is both dimensionally as well as numerically correct
b) It is neither dimensionally correct nor numerically correct
c) It is dimensionally correct but not numerically
d) It is numerically correct but not dimensionally

39. A wire has a mass $0.3\ \pm 0.003$ g, radius $0.5\ \pm 0.005$ mm and length $6\ \pm 0.06$ cm. The maximum

percentage error in the measurement of its density is

a) 1 b) 2 c) 3 d) 4

40. A physical quantity x depends on quantities y and z as follows: $x = Ay + B\tan(Cz)$, where A, B and C are constants. Which of the following do not have the same dimensions?

a) x and B b) C and z^{-1} c) y and B/A d) x and A

41. The product PV has the dimension

a) $[M\,L^{-1}T^{-2}]$ b) $[M^1\,L^2T^{-1}]$ c) $[M^1\,L^2T^{-2}]$ d) $[M^1\,L^2T^{-3}]$

42. Choose the physical quantity that is different from others in some respect

a) Moment of inertia b) Electric current
c) Pressure energy d) Rate of change in velocity

43. The potential energy of a particle varies with distance x as $U = \frac{Ax^{1/2}}{x^2+B}$, where A and B are constants. The dimensional formula for $A \times B$ is

a) $M^1L^{7/2}T^{-2}$ b) $M^1L^{11/2}T^{-2}$ c) $M^1L^{5/2}T^{-2}$ d) $M^1L^{9/2}T^{-2}$

44. Dimensional formula for angular momentum is

a) ML^2T^{-2} b) $ML^2\,T^{-1}$ c) MLT^{-1} d) $M^0L^2T^{-2}$

45. The dimensional representation of latent heat is identical to that of

a) Internal energy b) Angular momentum
c) Gravitational potential d) Electric potential

46. The dimensional formula for Planck's constant (h) is

a) $ML^{-2}T^{-3}$ b) ML^2T^{-2} c) ML^2T^{-1} d) $ML^{-2}T^{-2}$

47. If L, C and R represent inductance, capacitance and resistance respectively, then which of the following does not represent dimensions of frequency

a) $\frac{1}{RC}$ b) $\frac{R}{L}$ c) $\frac{1}{\sqrt{LC}}$ d) $\frac{C}{L}$

48. While measuring the acceleration due to gravity by a simple pendulum, a student makes a positive error of 1% in the length of the pendulum and a negative error of 3% in the value of time period. His percentage error in the measurement of g by the relation $g = 4\pi^2(l/T^2)$ will be

a) 2% b) 4% c) 7% d) 10%

49. The dimensional formula for magnetising field H is

a) $[M^0L^{-1}T^0A]$ b) $[M^0LT^{-3}A]$ c) $[M^0LTA^{-1}]$ d) $[M^0L^1T^{-1}A]$

50. If L and R denote inductance and resistance, respectively, then the dimensions of L/R are

a) $M^1L^0T^0Q^{-1}$ b) $M^0L^0TQ^0$ c) $M^0L^1T^{-1}Q^0$ d) $M^{-1}LT^0Q^{-1}$

51. Write the dimensions of a/b in the relation $P = \frac{a-t^2}{bx}$, where P is the pressure, x is the distance, and t is the time

a) $M^{-1}L^0T^{-2}$ b) ML^0T^{-2} c) ML^0T^2 d) MLT^{-2}

52. If the percentage errors of A, B, and C are a, b, and c, respectively, then the total percentage error in the product ABC is

a) abc b) $a + b + c$ c) $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}$ d) $ab + bc + ca$

53. A student when discussing the properties of a medium (except vacuum) writes
Velocity of light in vacuum = velocity of light in medium
This formula is

a) Dimensionally correct b) Dimensionally incorrect
c) Numerically incorrect d) Both a and c

54. Of the following quantities, which one has the dimensions different from the remaining three?

a) Energy density b) Force per unit area
c) Product of charge per unit volume and voltage d) Angular momentum per unit mass

55. Dimensional formula of magnetic flux is

a) $ML^2T^{-2}A^{-1}$ b) $ML^0T^{-2}A^{-2}$ c) $M^0L^{-2}T^{-2}A^{-3}$ d) $ML^2T^{-2}A^3$

56. The dimensional formula for the modulus of rigidity is
a) ML^2T^{-2} b) $ML^{-1}T^{-3}$ c) $ML^{-2}T^{-2}$ d) $ML^{-1}T^{-2}$

57. Which of the following pairs do not have identical dimensions?
a) Pressure and stress b) Work and pressure energy
c) Angular momentum and Planck's constant d) Moment of force and momentum

58. The unit of surface tension may be expressed as
a) Joule metre b) Newton metre c) Joule metre^{-2} d) Newton metre^{-2}

59. Which of the following does not have the dimension of velocity? (Given, ε_0 is the permittivity of free space, μ_0 is the permittivity of free space, ν is frequency, λ is wavelength, P is the pressure, and ρ is density, k is wave number, ω is the angular frequency)
a) ωk b) $\nu\lambda$ c) $\frac{1}{\sqrt{\varepsilon_0\mu_0}}$ d) $\sqrt{\frac{P}{\rho}}$

60. What are the dimensions of gas constant?
a) $[MLT^{-2}K^{-1}]$ b) $[M^0LT^{-2}K^{-1}]$ c) $[M\,L^2T^{-2}\,K^{-1}\text{mol}^{-1}]$ d) $[M^0L^2T^{-2}K^{-1}]$

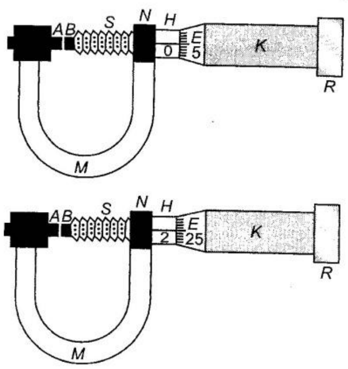
61. A length is measured as 7.60 m. This is the same as
a) 7600 mm b) 0.0076 mm c) 760 cm d) 0.76 dm

62. A highly rigid cubical block A of small mass M and side L is fixed rigidly on the other cubical block of same dimensions and of modulus of rigidity η such that the lower face of A completely covers the upper face of B. The lower face of B is rigidly held on a horizontal surface. A small force F is applied perpendicular to one of the side faces of A. After the force is withdrawn, block A executes small oscillations, the time period of which is given by
a) $2\pi\sqrt{M\eta L}$ b) $2\pi\sqrt{M\eta/L}$ c) $2\pi\sqrt{ML/\eta}$ d) $2\pi\sqrt{M/\eta L}$

63. The dimensions of surface tension are
a) $ML^{-1}T^{-2}$ b) MLT^{-2} c) $ML^{-1}T^{-1}$ d) MT^{-2}

64. The equation of the stationery wave is
$$y = 2\,A\sin\left(\frac{2\pi ct}{\lambda}\right)\cos\left(\frac{2\pi x}{\lambda}\right)$$
Which of the following statements is wrong?
a) The unit of ct is same as that of λ b) The unit of x is same as that of λ
c) The unit of $2\pi c/\lambda$ us same as that of $2\pi x/\lambda t$ d) The unit f c/λ is same as that of x/λ

65. The circular scale of a screw gauge has 50 divisions and pitch of 0.5 mm. Find the diameter of sphere. Main scale reading is 2.



a) 1.2 b) 1.25 c) 2.20 d) 2.25

66. An experiment measures quantities a, b, and c, and then X is calculated from $X = \frac{a^{1/2}b^2}{c^3}$. If the percentage errors in a, b, and c are $\pm1\%$, $\pm3\%$, and $\pm2\%$, respectively, then the percentage error in X can be
a) $\pm12.5\%$ b) $\pm7\%$ c) $\pm1\%$ d) $\pm4\%$

67. If the velocity of light C, the universal gravitational constant G, and Planck's constant h are chosen as fundamental units, the dimensions of mass in this system are
a) $h^{1/2}C^{1/2}G^{1/2}$ b) $h^{-1}C^{-1}G$ c) hCG^{-1} d) hCG

68. The order of magnitude of 0.00701 is

a) -2 b) -1 c) 2 d) 1

69. The dimensional formula for a physical quantity x is $[M^{-1}L^3T^{-2}]$. The errors in measuring the quantities M, L, and T, respectively, are 2%, 3%, and 4%. The maximum percentage of error that occurs in measuring the quantity x is

a) 9 b) 10 c) 14 d) 19

70. The order of magnitude of 379 is

a) 1 b) 2 c) 3 d) 4

71. The number of significant figures in 5.69×10^{15} kg is

a) 1 b) 2 c) 3 d) 18

72. Dimensional representation of coefficient of friction is

a) $[ML^2T^{-2}]$ b) $[ML\,T^{-2}]$ c) $[M^0L^0T^0]$ d) $[MLT^{-1}]$

73. A student performs an experiment for determination of g $\left(=\frac{4\pi^2 l}{T^2}\right)$, $l \approx 1$m, and he commits an error of Δl. For T he takes the time of n oscillations with the stop watch of least count ΔT and he commits a human error of 0.1 s. For which of the following data, the measurement of g will be most accurate?

a) $\Delta L = 0.5, \Delta T = 0.1, n = 20$ b) $\Delta L = 0.5, \Delta T = 0.1, n = 50$

c) $\Delta L = 0.5, \Delta T = 0.01, n = 20$ d) $\Delta L = 0.5, \Delta T = 0.05, n = 50$

74. Write the dimensions of $a \times b$ in the relation $E = \frac{b-x^2}{at}$, where E is the energy, x is the displacement, and t is time

a) ML^2T b) $M^{-1}L^2T^1$ c) ML^2T^{-2} d) MLT^{-2}

75. The pair having the same dimensions is

a) Angular momentum, work b) Work, torque

c) Potential energy, linear momentum d) Kinetic energy, velocity

76. If the velocity (V), acceleration (A), and force (F) are taken as fundamental quantities instead of mass (M), length (L), and time (T), the dimensions of Young's modulus (Y) would be

a) FA^2V^{-4} b) FA^2V^{-5} c) FA^2V^{-3} d) FA^2V^{-2}

77. The dimensions of intensity of wave are

a) $[ML^2T^{-3}]$ b) $[ML^0T^{-3}]$ c) $[ML^{-2}T^{-3}]$ d) $[M^1L^2T^3]$

78. Assuming that the mass m of the largest stone that can be moved by a flowing river depends upon the velocity v of the water, its density ρ and the acceleration due to gravity g. Then m is directly proportional to

a) v^3 b) v^4 c) v^5 d) v^6

79. The position x of a particle at time t is given by $x = \frac{V_0}{a}(1 - e^{-\alpha t})$, where V_0 is constant and $a > 0$. The dimensions of V_0 and a are

a) M^0LT^{-1} and T^{-1} b) M^0LT^0 and T^{-1} c) M^0LT^{-1} and LT^{-2} d) M^0LT^{-1} and T

80. A cube has a side of length 1.2×10^{-2} m. Calculate its volume.

a) 1.7×10^{-6} m^3 b) 1.73×10^{-6} m^3 c) 1.70×10^{-6} m^3 d) 1.732×10^{-6} m^3

81. Students I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and/or record time for different number of oscillations. The observations are shown in the table

Least count for length $= 0.1\ cm$

Least count for time $= 0.1\ s$

Student	Length of the pendulum (cm)	Number of oscillation (n)	Total time for (n) oscillations (s)	Time period (s)

I	64.0	8	128.0	16.0
I	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If $E_{\text{I}}, E_{\text{II}}$ and E_{III} are the percentage errors in $g, i.e., \left(\frac{\Delta g}{g} \times 100\right)$ for students I, II and III, respectively

a) $E_{\text{I}} = 0$ b) E_{I} is minimum c) $E_{\text{I}} = E_{\text{II}}$ d) E_{II} is maximum

82. The dimensions of $\varepsilon_0\mu_0$ are

a) $[LT^{-1}]$ b) $[LT^{-2}]$ c) $[L^2T^{-2}]$ d) $[L^{-2}T^2]$

83. A liquid drop of density ρ, radius r, and surface tension σ oscillates with time period T. Which of the following expression for T^2 is correct?

a) $\frac{\rho r^3}{\sigma}$ b) $\frac{\rho\sigma}{r^3}$ c) $\frac{r^3\sigma}{\rho}$ d) None of these

84. If E, M, J, and G, respectively, denote energy, mass, angular momentum, and gravitational constant, then EJ^2/M^5G^2 has the dimensions of

a) Time b) Angle c) Mass d) Length

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

a) Torque b) Work c) Stress d) Angular momentum

86. Which of the following is not measured in units of energy?

a) Couple × angle turned through
b) Moment of inertia × (angular velocity)^2
c) Force × distance
d) Impulse × time

87. The internal and external diameters of a hollow cylinder are measured with the help of a vernier callipers. Their values are 4.23 ± 0.01 cm, respectively. The thickness of the wall of the cylinder is

a) 0.36 ± 0.02 cm b) 0.18 ± 0.02 cm c) 0.36 ± 0.01 cm d) 0.18 ± 0.01 cm

88. The mass of a body is 20.000 g and its volume is 10.00 cm^3. If the measured values are expressed to the correct significant figures, the maximum error in the value of density is

a) 0.001 g cm^{-3} b) 0.010 g cm^{-3} c) 0.100 g cm^{-3} d) None of these

89. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is

a) 0.9% b) 2.4% c) 3.1% d) 4.2%

90. The moment of inertia of a body rotating about a given axis is 12.0 kgm^2 in the SI system. What is the value of the moment of inertia in a system of units in which the unit of length is 5 cm and the unit of mass is 10 g?

a) 2.4×10^3 b) 6.0×10^3 c) 5.4×10^5 d) 4.8×10^5

91. The best method to reduce random error is

a) To change the instrument used for measurement
b) To take help of experienced observer
c) To repeat the experiment many times and to take the average results
d) None of the above

92. The dimensional formula for electric potential is

a) $[M\ L^2T^{-3}A^{-1}]$ b) $[MLT^{-3}A^{-1}]$ c) $[ML^2T^{-3}K^{-1}]$ d) None of these

93. Which of the following is the most precise instrument for measuring length?

a) Metre rod of least count 0.1 cm
b) Vernier callipers of least count 0.01 cm
c) Screw gauge of least count 0.001 cm
d) Data is not sufficient to decide

94. Which of the following product of e, h, μ, G (where μ is the permeability) be taken so that the dimensions of the product are same as that of speed of light?

a) $he^{-2}\mu^{-1}G^0$ b) $h^2eG^0\mu$ c) $h^0e^2G^{-1}\mu$ d) $hGe^{-2}\mu^0$

95. A vernier callipers has 1 mm marks on the main scale. It has 20 equal divisions on the Vernier scale which match with 16 main scale divisions. For this Vernier callipers , the least count is

a) 0.02 mm b) 0.05 mm c) 0.1 mm d) 0.2 mm

96. The length l, breadth b, and thickness t of a block of wood were measured with the help of a measuring scale. The result with permissible errors (in cm) are
$l = 15.12 \pm 0.01, b = 10.15 \pm 0.01$, and $t = 5.28 \pm 0.01$. The percentage error in volume up to proper significant figures is
a) 0.28% b) 0.35% c) 0.48% d) 0.64%

97. If frequency F, velocity V, and density D are considered fundamental units, the dimensional formula for momentum will be
a) DVF^2 b) DV^2F^{-1} c) $D^2V^2F^2$ d) DV^4F^{-3}

98. The quantities A and B are related by the relation $A/B = m$, where m is the linear mass density and A is force, the dimensions of B will be
a) Same as that of pressure
b) Same as that of work
c) That of momentum
d) Same as that of latent heat

99. The dimensions of shear modulus of rigidity are
a) $M^1L^1T^{-2}$ b) $M^1L^1T^{-1}$ c) ML^2T^2 d) $ML^{-1}T^{-2}$

100. Dimensional formula for torque is
a) L^2MT^{-2} b) $L^{-1}MT^{-2}$ c) L^2MT^{-3} d) LMT^{-2}

101. Student I, II and III perform an experiment for measuring the acceleration due to gravity (g) using a simple pendulum. They use different lengths of the pendulum and/or record time for different number of oscillations. The observations are shown in the table..
Least count for length = 0.1 cm.
Least count for time = 0.1 s.

Student	Length of the pendulum (cm)	Number of oscillations (n)	Total time for (n) oscillations (s)	Time period (s)
I	64.0	8	128.0	16.0
II	64.0	4	64.0	16.0
III	20.0	4	36.0	9.0

If E_1, E_{II} and E_{III} are the percentage errors in g, *ie*, $\left(\frac{\Delta g}{g} \times 100\right)$, for students I, II and III respectively.
a) $E_{\text{I}} = 0$
b) E_{I} is minimum
c) $E_{\text{I}} = E_{\text{II}}$
d) E_{II} is maximum

102. The velocity of transverse wave in a string is $v = \sqrt{\frac{T}{m}}$, where T is the tension in the string and m is mass per unit length. If $T = 3.0$ kgf, mass of string is 2.5 g and length of string is 1.000 m, then the percentage error in the measurement of velocity is
a) 0.5 b) 0.7 c) 2.3 d) 3.6

103. Given that: $y = A \sin\left[\left(\frac{2\pi}{\lambda}\right)(ct - x)\right]$, where y and x are measured in the unit of length. Which of the following statements is true?
a) The unit of λ is same as that of x and A
b) The unit of λ is same as that of x but may not be same as that of A
c) The unit of c is same as that of $2\pi/\lambda$
d) The unit of $(ct - x)$ is same as that of $2\pi/\lambda$

104. A student performs an experiment for determination of $g = \frac{4\pi^2 l}{T^2}$ and he commits an error of Δl. For that he takes the time of n oscillations with the stop watch of least count ΔT and he commits a human error of 0.1 *sec*. For which of the following data, the measurement of g will be most accurate

Δl	ΔT	n	Ampli. of oscill.

a) 5 mm 0.2sec 10 5mm
b) 5 mm 0.2sec 20 5mm
c) 5 mm 0.1sec 20 1mm
d) 1 mm 0.1sec 50 1mm

105. The frequency (n) of vibration of a string is given as $n = \frac{1}{2l}\sqrt{\frac{T}{m}}$, where T is tension and l is the length of vibrating string, then the dimensional formula is
a) $[M^0L^1T^1]$ b) $[M^0L^0T^0]$ c) $[M^1L^{-1}T^0]$ d) $[ML^0T^0]$

106. The relative density of a material is found by weighing the body first in air and then in water. If the weigh in air is (10.0 ± 0.1) gf and weight in water is (5.0 ± 0.1) gf, then the maximum permissible percentage error in relative density is
a) 1 b) 2 c) 3 d) 5

107. The dimensions of the formula of capacitance are
a) $[M^{-1}L^{-2}TA^2]$ b) $[M^{-1}L^{-2}T^3A^2]$ c) $[M^{-1}L^{-2}T^4A^2]$ d) $[M^{-1}L^{-2}T^2A^2]$

108. The specific resistance ρ of a circular wire of radius r, resistance R, and length l is given by $\rho = \frac{\pi r^2 R}{l}$. Given: $r = 0.24 \pm 0.02$ cm, $R = 30 \pm 1\ \Omega$, and $l = 4.80 \pm 0.01$ cm. the percentage error in ρ is nearly
a) 7% b) 9% c) 13% d) 20%

109. If L, R, C, and V, respectively, represent inductance, resistance, capacitance and potential difference, then the dimensions of L/RCV are the same as those of
a) Charge b) 1/Charge c) Current d) 1/Current

110. Which of the following sets have different dimensions?
a) Pressure, Young's modulus, Stress
b) Emf, Potential difference, Electric potential
c) Heat, Work done, Energy
d) Dipole moment, Electric flux, Electric field

111. The number of particles crossing a unit area perpendicular to the x —axis in a unit time is given by $n = -D\left(\frac{n_2-n_1}{x_2-x_1}\right)$, where n_1 and n_2 are the number of particles per unit volume at $x = x_1$ and $x = x_2$, respectively, and D is the diffusion constant. The dimensions of D are
a) $[M^0LT^{-2}]$ b) $[M^0L^2T^{-4}]$ c) $[M^0L^2T^{-2}]$ d) $[M^0L^2T^{-1}]$

112. The time dependence of a physical quantity P is give by $P = P_0e^{-\alpha t^2}$, where α is a constant and t is time. Then constant α is
a) Dimensionless
b) Has dimensions of T^{-2}
c) Has dimensions of P
d) Has dimensions of T^2

113. The dimensional formula for latent heat is
a) $M^0L^2T^{-2}$ b) MLT^{-2} c) ML^2T^{-2} d) ML^2T^{-1}

114. In the relation $y = r\sin(\omega t - kx)$, the dimensions of ω/k are
a) $[M^0L^0T^0]$ b) $[M^0L^1T^{-1}]$ c) $[M^0L^0T^1]$ d) $[M^0L^1T^0]$

115. Given that T stands for time period and l stands for the length of simple pendulum. If g is the acceleration due to gravity, then which of the following statements about the relation $T^2 = (l/\mathrm{g})$ is correct?
a) It is correct both dimensionally as well as numerically
b) It is neither dimensionally correct nor numerically
c) It is dimensionally correct but not numerically
d) It is numerically correct but not dimensionally

116. The density of a solid ball is to be determined in an experiment. The diameter of the ball is measured with a screw gauge, whose pitch is 0.5 mm and there are 50 divisions on the circular scale. The reading on the main scale is 2.5 mm and that on the circular scale is 20 divisions. If the measured mass of the ball has a relative error of 2%, the relative percentage error in the density is
a) 0.9% b) 2.4% c) 3.1% d) 4.2%

Multiple Correct Answers Type

117. Pressure is dimensionally
a) Force per unit area
b) Energy per unit volume
c) Momentum per unit area per second
d) Momentum per unit volume
118. The velocity, acceleration, and force in two systems of units are related as under:
i. $v' = \frac{\alpha^2}{\beta} v$ ii. $a' = (\alpha\beta) a$ iii. $F' = \left(\frac{1}{\alpha\beta}\right) F$
All the primed symbols belong to one system unprimed ones belong to the other system. α and β are dimensionless constants. Which of the following is/are correct?
a) Length standards of the two systems are related by $L' = \left(\frac{\alpha^3}{\beta^3}\right) L$
b) Mass standards of the two systems are related by $m' = \left(\frac{1}{\alpha^2\beta^2}\right) m$
c) Time standards of the two systems are related by $T' = \left(\frac{\alpha}{\beta^2}\right) T$
d) Momentum standards of the two systems are related by $P' = \left(\frac{1}{\beta^3}\right) P$
119. L, C, and R represent the physical quantities inductance, capacitance, and resistance, respectively. The combinations which have the dimensions of frequency are
a) $1/RC$
b) R/L
c) $1/\sqrt{LC}$
d) C/L
120. The dimensions of the quantities in one (or more) of the following pairs are the same. Identify the pairs(s)
a) Torque and work
b) Angular momentum and work
c) Energy and Young's modulus
d) Light year and wavelength
121. Which of following pairs have the same dimensions?
(L= inductance, C=capacitance, R=resistance)
a) $\frac{L}{R}$ and CR
b) LR and CR
c) $\frac{L}{R}$ and $\sqrt{LC}$
d) RC and $\frac{1}{LC}$
122. Which of the following pairs have the same dimensions?
a) Reynold number and coefficient of friction
b) Curie and frequency of light wave
c) Latent heat and gravitational potential
d) Planck's constant and torque
123. Which of the following pairs have different dimensions?
a) Frequency and angular velocity
b) Tension and surface tension
c) Density and energy density
d) Linear momentum and angular momentum
124. How many seconds are there is a light fermi?
a) 10^{-15}
b) 3.0×10^{8}
c) 3.33×10^{-24}
d) 3.3×10^{-7}
125. Let $[\varepsilon_0]$ denote the dimensional formula of the permittivity of vacuum and $[\mu_0]$ that of the permeability of vacuum. If M =mass, L =length, T =time, and I = electric current, then
a) $[\varepsilon_0] = M^{-1}L^{-3}T^2I$
b) $[\varepsilon_0] = M^{-1}L^{-3}T^4I^2$
c) $[\mu_0] = MLT^{-2}I^{-2}$
d) $[\mu_0] = ML^2T^{-1}I$
126. Which of the following is a unit of permeability
a) H/m
b) Wb/AM
c) Ohm×s/m
d) V×s/m^2
127. The values of measurement of a physical quantity in five trials were found to be 1.51, 1.53, 1.53, 1.52, and 1.54. Then
a) Average absolute error is 0.01
b) Relative error is 0.01
c) Percentage error is 0.01%
d) Percentage error is 1%
128. If S and V are one main scale and one veriner scale and $n-1$ divisions on the main scale are equivalent to n divisions of the vernier, then
a) Least count is S/n
b) Vernier constant is S/n
c) The same vernier constant can be used for circular verniers also
d) The same vernier constant cannot be used for cicular verniers
129. A vernier callipers has 1 mm marks on the main scale. It has 20 equal divisions on the vernier scale which match with 16 main scale divisions. For this vernier calipers, the least count is
a) 0.02 mm
b) 0.05 mm
c) 0.1 mm
d) 0.2 mm
130. The S.I. unit of inductance, henry, can be written as

a) Weber/ampere b) Volt-sec/amp c) Joule/(ampere)^2 d) Ohm-second

131. A student performed the experiment of determination of focal length of a concave mirror by $u - v$ method using an optical bench of length 1.5 m. The focal length of the mirror used is 24 cm. The maximum error in the location of the image can be 0.2 cm. The 5 sets of (u, v) values recorded by the student (in cm) are : (42, 56), (48, 48), (60, 40), (66, 33), (78, 39). The data set(s) that cannot come from experiment and is (are) incorrectly recorded, is (are)
a) (42, 56) b) (48, 48) c) (66, 33) d) (78, 39)

132. If L, C, R represent inductance, capacitance and resistance respectively, the combination having dimensions of frequency are
a) $\frac{1}{\sqrt{CL}}$ b) $\frac{L}{C}$ c) $\frac{R}{L}$ d) $\frac{R}{C}$

133. Which of the following combination have the dimensions of time? L, C, R represent inductance capacitance and resistance respectively
a) RC b) $\sqrt{LC}$ c) R/L d) C/L

134. A quantity X is given by $\varepsilon_0 L \frac{\Delta V}{\Delta t}$, where ε_0 is the permittivity of the free space, L is length, ΔV is potential difference, and Δt is time interval. The dimensional formula for X is the same as that of
a) Resistance b) Charge c) Voltage d) Current

135. The pitch of a screw guage 15 mm and there are 100 divisions on the circular scale. While measuring diameter of a thick wire. The pitch scale reads 1 mm and 63 rd division on the circular scale coincides with the reference. The length of the wire is 5.6 cm.
a) The least count of screw gauge wire is 5.6 cm.
b) The volume of the wire is 0.117 cm^3
c) The diameter of the wire is 1.36m
d) The cross-section area of the wire is 0.0209 cm^3

136. The dimensions of $(1/2)\varepsilon_0 E^2$ (ε_0 is permittivity of free space, E is electric field) are
a) MLT^{-1} b) ML^2T^{-2} c) $ML^{-1}T^{-2}$ d) ML^2T^{-1}

137. 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) Planck's constant and torque

138. Which of the following pairs have the same dimension?
a) Torque and work
b) Angular momentum and Planck's constant
c) Energy and Young's modulus
d) Light year and wavelength

139. A student uses a simple pendulum of exactly 1 m length to determine g, the acceleration due to gravity. He uses a stop watch with the least count of 1 s for this and records 40 s for 20 oscillations. For this observation, which of the following statements (s) is/are true?
a) Error ΔT in measuring T, the time period, is 0.05s
b) Error ΔT in measuring T, the time period, is 1s
c) Percentage error in the determination of g is 5%
d) Percentage error in the determination of g is 2.5%

140. The SI unit of inductance, the henry can be written as
a) Weber/ampere b) Volt-sec/amp c) Joule/(ampere)^2 d) Ohm-second

141. If the dimensions of length are expressed as $G^x c^y h^z$; where G, c and h are the universal gravitational constant, speed of light and Planck's constant respectively, then
a) $x = \frac{1}{2}, y = \frac{1}{2}$ b) $x = \frac{1}{2}, z = \frac{1}{2}$ c) $y = \frac{1}{2}, z = \frac{3}{2}$ d) $y = -\frac{3}{2}, z = \frac{1}{2}$

142. Let $[\varepsilon_0]$ denotes the dimensional formula of the permittivity of the vacuum and $[\mu_0]$ that of the permeability of the vacuum. If $M =$ mass , $L =$ length, $T =$Time and $I =$ electric current, then
a) $[\varepsilon_0] = M^{-1}L^{-3}T^2I$ b) $[\varepsilon_0] = M^{-1}L^{-3}T^4I^2$ c) $[\mu_0] = MLT^{-2}I^{-2}$ d) $[\mu_0] = ML^2T^{-1}I$

143. A student uses a simple pendulum of exactly $1m$ length to determine g, the acceleration due to gravity. He uses a stop watch with the least count of 1 sec for this and records 40 seconds for 20 oscillations. For this

observation, which of the following statement (s) is (are) true

a) Error ΔT in measuring T, the time period, is 0.05 seconds

b) Error ΔT in measuring T, the time period, is 1 second

c) Percentage error in the determination of g is 5%

d) Percentage error in the determination of g is 2.5%

144. Choose the correct statement (s)

a) A dimensionally correct equation must be correct

b) A dimensionally correct equation may be correct

c) A dimensionally incorrect equation must be incorrect

d) A dimensionally incorrect equation may be correct

145. Which of the following pairs have the same dimensions?

a) h/e and magnetic flux
b) h/e and electric flux
c) Electric flux and q/ε_0
d) Electric flux and $\mu_0 I$

146. Consider three quantities:$x = \frac{E}{b}, y = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$, and $z = \frac{l}{CR}$. Here, l is the length of a wire, C is the capacitance, and R is a resistance. All other symbols have usual meanings. Then

a) x and y have the same dimensions

b) x and z have the same dimensions

c) y and $z$have the same dimensions

d) None of the above three pairs have the same dimensions

147. Which of the following combinations have the dimensions of time?$L - C - R$ represent inductance, capacitance and resistance respectively

a) RC
b) $\sqrt{LC}$
c) R/C
d) C/L

148. For equation $F \propto A^a v^b D^c$, where F is force, A is area, v is velocity and D is density the values of the dimensions are

a) $a = 1, b = 2, c = 1$
b) $a = 2, b = 1, c = 1$
c) $a = 1, b = 1, c = 2$
d) $a = 0, b = 1, c = 1$

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 149 to 148. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

149

Statement 1: Force cannot be added to pressure

Statement 2: Because their dimensions are different

150

Statement 1: Parallax method cannot be used for measuring distances of stars more than 100 light years away

Statement 2: Because parallax angle reduces so much that it cannot be measured accurately

151

Statement 1: Mass, length, and time are fundamental quantities

Statement 2: Mass, length, and time are independent of one another

152

Statement 1: Out of three measurements, $l = 0.7\ m$; $l = 0.70\ m$ and $l = 0.700\ m$, the last one is most accurate

Statement 2: In every measurement, only the last significant digit is not accurately known

153

Statement 1: The size of the nucleus of an atom is not very small

Statement 2: One Fermi is equal to $10^{-12}\ m$.

154

Statement 1: Surface tension and surface energy have the same dimensions

Statement 2: Because both have the same S.I unit

155

Statement 1: Now a days a standard *metre* is defined in terms of the wavelength of light

Statement 2: Light has no relation with length

156

Statement 1: The light year and wavelength consist of dimensions of length.

Statement 2: Both light year and wavelength represent distances.

157

Statement 1: The number of significant figures in 0.001 is 1, while in 0.100 it is 3

Statement 2: Zeros before a non-zero significant digit are not counted while zeros after a non-zero significant digit are counted

158

Statement 1: The time period of a pendulum is given by the formula, $T = 2\pi\sqrt{g/l}$

Statement 2: According to the principle of homogeneity of dimensions, only that formula is correct in which the dimensions of L.H.S. is equal to dimensions of R.H.S

159

Statement 1: If error in measurement of distance and time are 3% and 2% respectively, error in calculation of velocity is 5%.

Statement 2: Velocity $= \frac{\text{distance}}{\text{time}}$

160

Statement 1: Impulse has the dimensions of force.

Statement 2: Impulse=force×time.

161

Statement 1: The graph between P and Q is straight line, when P/Q is constant

Statement 2: The straight line graph means that P proportional to Q or P is equal to constant multiplied by Q

162

Statement 1: Pressure has the dimensions of energy density

Statement 2: Energy density $= \frac{\text{energy}}{\text{volume}} = \frac{[\text{ML}^2\text{T}^{-2}]}{[\text{L}^3]} = [\text{ML}^{-1}\text{T}^{-2}] = \text{pressure}$

163

Statement 1: A.U. is much bigger than Å

Statement 2: A.U. stands for astronomical unit and Å stands from $Angstrom$

164

Statement 1: Mass, length and time are fundamental physical quantities

Statement 2: They are independent of each other

165

Statement 1: Units of Rydberg constant R is m^{-1}

Statement 2: It follows from Bohr's formula
$\bar{v} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$,
where the symbols have their usual meaning

166

Statement 1: In $y = A\sin(\omega t - kx)$, $(\omega t - kx)$ is dimensionless

Statement 2: Because dimension of $\omega = [M^0 L^0 T]$

167

Statement 1: AU is much bigger than Å.

Statement 2: 1 AU=1.5× 10^{11} m and 1 Å $= 10^{-10}$ m.

168

Statement 1: In the relation $n = \frac{1}{2l}\sqrt{\frac{T}{2}}$ where symbols have standard meaning, m represents total mass.

Statement 2: Linear mass density = mass /volume.

169

Statement 1: The dimensions of rate of flow are $[\text{M}^0\text{L}^3\text{T}^{-1}]$

Statement 2: Rate of flow is velocity/sec.

170

Statement 1: Avogadro number is not a dimensionless constant.

Statement 2: It is number of atoms is one gram mole.

171

Statement 1: Dimensional constants are the quantities whose values are constant

Statement 2: Dimensional constants are dimensionless

172

Statement 1: Linear mass density has the dimensions of $[M^1L^{-1}T^0]$

Statement 2: Because density is always mass per unit per volume

173

Statement 1: The unit used for measuring nuclear cross-section is barn.

Statement 2: 1 barn$=10^{-4}m^2$.

174

Statement 1: The unit used for measuring nuclear cross section is 'barn'.

Statement 2: 1 barn $= 10^{-14}$ m^2.

175

Statement 1: If the error in measurement of mass is 2% and that in measurement of velocity is 5%, then the error in measurement of kinetic energy is 6%

Statement 2: Error in kinetic energy is

$$\frac{\Delta K}{K} = \left(\frac{\Delta m}{m} + 2\frac{\Delta v}{v}\right)$$

176

Statement 1: Linear momentum and impulse have same dimensions $[MLT^{-1}]$

Statement 2: Impulse is equal to final momentum

177

Statement 1: Å (Angstrom) and AU are different units of length

Statement 2: Å (Angstrom) is a small unit of length while AU is a big unit of length

178

Statement 1: The error in the measurement of radius of the sphere is 0.3% The permissible error in its surface area is 0.6 %

Statement 2: The permissible error is calculated by the formula $\frac{\Delta A}{A} = \frac{4\Delta R}{r}$

179

Statement 1: 'Light year' and 'Wavelength' both measure distance

Statement 2: Both have dimensions of time

180

Statement 1: When we change the unit of measurement of a quantity, its numerical value changes

Statement 2: Smaller the unit of measurement smaller is its numerical value

181

Statement 1: Avogadro number is the number of atoms in one gram mole

Statement 2: Avogadro number is a dimensionless constant

182

Statement 1: Light year and wavelength have same dimensions

Statement 2: Light year represents time while wavelength represents distance

183

Statement 1: In the relation $f = \frac{1}{2l}\sqrt{\frac{T}{m}}$, where symbols have standard meaning, m represents linear mass density

Statement 2: The frequency has the dimensions of inverse of time

Matrix-Match Type

This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

184. There are four vernier scales, whose specifications are given in Column I and the least count is given in Column II. Match the Columns I and II with correct specification and corresponding least count (s = value of main scale division, n = number of marks on vernier). Assume $(n-1)$ main scale divisions are equal to n vernier divisions

Column-I	Column- II
(A) $s = 1$ mm, $n = 10$	(p) 0.05 mm
(B) $s = 0.5$ mm, $n = 10$	(q) 0.01 mm
(C) $s = 0.5$ mm, $n = 20$	(r) 0.1 mm
(D) $s = 1$ mm, $n = 100$	(s) 0.025 mm

CODES :

	A	**B**	**C**	**D**
a)	c	a	d	b
b)	a	c	b	d
c)	d	a	c	b
d)	b	d	a	c

185. If R is resistance, L is inductance, C is capacitance, H is latent heat, and s is specific heat, then match the quantity given in Column I with the dimensions given in Column II

Column-I	Column- II
(A) LC	(p) L^2T^{-2}
(B) LR	(q) $L^2T^{-2}K^{-1}$
(C) H	(r) T^2
(D) s	(s) $M^2L^4T^{-5}A^{-4}$

CODES :

	A	B	C	D
a)	d	a	d	c
b)	c	d	a	b
c)	a	c	a	d
d)	d	b	c	a

186. Match the columns

Column-I	Column- II
(A) Blacklash error	(p) Always subtracted
(B) Zero error	(q) Least count = 1 MSD−1 VSD
(C) Vernier callipers	(r) May be negative or positive
(D) Error in screw gauge	(s) Due to lose fittings

CODES :

	A	B	C	D
a)	b	d	a,c	c
b)	d	a,c	b	c,d
c)	b,d	c,d	a	b
d)	a	c	b	d

187. Column I gives three physical quantities. Select the appropriate units for the choices given in Column II. Some of the physical quantities may have more than one choice correct

Column-I	Column- II
(A) Capacitance	(p) Ohm-second
(B) Inductance	(q) Coulomb^2-joule^{-1}
(C) Magnetic induction	(r) Coulomb (volt)$^{-1}$
	(s) Newton (ampere metre)$^{-1}$

(t) Volt-second $(ampere)^{-1}$

CODES :

	A	B	C	D
a)	q,r	p,t	s	
b)	p,t	q	s	
c)	q,r	s	p,t	
d)	q	s	p,t	

188. Names of units of some physical quantities are given in List I and their dimensional formulae are given in List II. Match the correct pairs in the lists.

Column-I	Column- II
(A) Pa-s	(1) $[L^2T^{-2}K^{-1}]$
(B) $Nm - K^{-1}$	(2) $[MLT^{-2}A^{-1}K^{-1}]$
(C) $J\ kg^{-1}\ K^{-1}$	(3) $[ML^{-1}T^{-1}]$
(D) $Wm^{-1}K^{-1}$	(4) $[ML^2T^{-2}K^{-1}]$

CODES :

	A	B	C	D
a)	4	3	1	2
b)	3	2	4	1
c)	3	1	4	2
d)	3	4	1	2

189. Match the following

Column-I	Column- II
(A) Capacitance	(p) Volt $(ampere)^{-1}$
(B) Magnetic induction	(q) Volt-sec $(ampere)^{-1}$
(C) Inductance	(r) Newton $(ampere)^{-1}$ $(metre)^{-1}$
(D) Resistance	(s) $Coulomb^2 (joule)^{-1}$

CODES :

	A	B	C	D
a)	ii	iii	iv	i
b)	iv	iii	ii	i
c)	iii	iv	i	ii

d)	iv	i	ii	iii

190. Some physical quantities are given in Column I and some possible SI units in which these quantities may be expressed are given in Column II. Match the physical quantities in Column I with the units in Column II.

Column-I	Column- II
(A) GM_eM_s G – universal gravitational constant , M_e – mass of earth, M_s – mass of sun	(p) (Volt)-(coulomb) (metre)
(B) $\frac{3RT}{M}$ R – universal gas constant, T – absolute temperature,	(q) (kilogram) (metre)^3 (second)$^{-2}$
(C) $\frac{F^2}{q^2B^2}$ F – force, q – charge, B – magnetic field	(r) (metre)^2 (second)$^{-2}$
(D) $\frac{GM_e}{R_e}$ G – universal gravitational constant, M_e – mass of earth R_e – radius of earth	(s) (Farad)(volt)^2(kg)$^{-1}$

CODES :

	A	**B**	**C**	**D**
a)	R,s	r,s	r,s	p, q
b)	p, q	r,s	r,s	r,s
c)	p, q	r,s	r,s	r,s
d)	r,s	p, q	r,s	r,s

191. Some physical constants are given in List I and their dimensional formulae are given in List II. Match the following lists. The correct answer is

Column-I	Column- II
(A) Planck's constant	(1) $[ML^{-1}T^{-2}]$
(B) Gravitational constant	(2) $[ML^{-1}T^{-1}]$
(C) Bulk modulus	(3) $[ML^2T^{-1}]$
(D) Coefficient of viscosity	(4) $[M^{-1}L^3T^{-2}]$

CODES :

	A	**B**	**C**	**D**
a)	4	3	2	1
b)	2	1	3	4

c)	3	2	3	4
d)	3	4	1	2

192. Match List-I with List-II and select the correct answer using the codes given below the lists

Column-I	**Column- II**
(A) Distance between earth and stars	(1) Micron
(B) Inter-atomic distance in a solid	(2) Angstrom
(C) Size of the nucleus	(3) Light year
(D) Wavelength of infrared laser	(4) *Fermi*
	(5) *Kilometre*

CODES :

	A	**B**	**C**	**D**
a)	5	4	2	1
b)	3	2	4	1
c)	5	2	4	3
d)	3	4	1	2

193. Using significant figures, match the following

Column-I	**Column- II**	
(A) 0.12345	(p)	5
(B) 0.12100 cm	(q)	4
(C) $47.23 \div 2.3$	(r)	1
(D) 3×10^8	(s)	2

CODES :

	A	**B**	**C**	**D**
a)	b	a	c	d
b)	d	a	b	a
c)	a	a	d	c
d)	c	b	c	d

Linked Comprehension Type

This section contain(s) 17 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 194 to -194

Planck, propounder of the quantum nature of radiation found dimentionally that dimensions of $\sqrt{\frac{Gh}{C^3}}$ are same as that or a base quantity used in mechanics, where
G = gravitational constant=6.67×10^{-11}N m^2 kg^{-2},
h = planck's constant =6.63×10^{34} J-s and
c = speed of light =3.0×10^8 ms^{-1}.

194. The numerical value of $\sqrt{\frac{Gh}{c^3}}$ is of the order of

a) 10^{-35} b) 10^{-31} c) 10^{-32} d) 10^{-36}

Paragraph for Question Nos. 195 to - 195

All quantities is mechanics are represented in terms of base units of length, mass and time. Additional base unit of temperature (kelvin) is used in heat and thermodynamics. An magnetism and electricity, the additional base unit of electric current (ampare) is used.

195. The dimensions of distance travelled in nth second are

a) $[M^0LT]$ b) $[M^0L^0T^0]$ c) $[M^0LT^{-1}]$ d) $[M^0LT^0]$

Paragraph for Question Nos. 196 to - 196

All quantities is mechanics are represented in terms of base units of length, mass and time. Additional base unit of temperature (kelvin) is used in heat and thermodynamics. An magnetism and electricity, the additional base unit of electric current (ampare) is used.

196. The dimensions of distance travelled in nth second are

a) $[M^0LT]$ b) $[M^0L^0T^0]$ c) $[M^0LT^{-1}]$ d) $[M^0LT^0]$

Paragraph for Question Nos. 197 to - 197

The van der Waals' equation of state for some gases can be expressed as

$$\left(P+\frac{a}{V^2}\right)(V-b)=RT$$

Where P is the pressure, V is the molar volume, and T is the absolute temperature of the given sample of gas and a, b, and R are constants

197. The dimensions of a are

a) ML^5T^{-2} b) $ML^{-1}T^{-2}$ c) L^3 d) L^6

Paragraph for Question Nos. 198 to - 198

Dimensional methods provide three major advantages in verification, derivation, and changing the system of units. Any empirical formula that is derived based on this method has to be verified and proportionality constants found by experimental means. The presence or absence of certain factors—non dimensional constants or variables—cannot be identified by this method. So every dimensionally correct relation cannot be taken as perfectly correct

198. If α kilogram, β metre, and γ second are the fundamental units, 1 cal can be expressed in new units as [1 cal =4.2 J]
a) $\alpha^{-1}\beta^{2}\gamma$
b) $\alpha^{-1}\beta^{-2}\gamma$
c) $4.2\alpha^{-1}\beta$
d) $4.2\alpha^{-1}\beta^{-2}\gamma^{2}$

Paragraph for Question Nos. 199 to - 199

Accuracy of measurement also lies in the way the result is expressed. The number of digits to which a value is to be expressed is one digit more than number of sure numbers. Rules do exist to deal with number of digit after an operation is carried out on the given values. The error can be minimised by many trials and using the correct methods and instruments

199. If length and breadth are measured as 4.234 and 1.05 m, the area of the rectangle is
a) 4.4457 m^2
b) 4.45 m^2
c) 4.446 m^2
d) 0.4446 m^2

: ANSWER KEY :

1)	d	2)	d	3)	c	4)	c
5)	d	6)	c	7)	b	8)	d
9)	b	10)	a	11)	c	12)	c
13)	b	14)	b	15)	b	16)	d
17)	d	18)	c	19)	a	20)	d
21)	c	22)	c	23)	d	24)	d
25)	b	26)	d	27)	c	28)	b
29)	d	30)	d	31)	b	32)	b
33)	d	34)	d	35)	d	36)	a
37)	d	38)	a	39)	d	40)	d
41)	c	42)	d	43)	b	44)	b
45)	c	46)	c	47)	d	48)	c
49)	a	50)	b	51)	b	52)	b
53)	d	54)	d	55)	a	56)	d
57)	d	58)	c	59)	a	60)	c
61)	c	62)	d	63)	d	64)	d
65)	a	66)	a	67)	a	68)	a
69)	d	70)	b	71)	c	72)	c
73)	d	74)	b	75)	b	76)	a
77)	b	78)	d	79)	a	80)	a
81)	b	82)	d	83)	a	84)	b
85)	d	86)	d	87)	b	88)	d
89)	c	90)	d	91)	c	92)	a
93)	c	94)	a	95)	d	96)	b
97)	d	98)	d	99)	d	100)	a
101)	b	102)	d	103)	b	104)	d
105)	c	106)	d	107)	c	108)	d
109)	d	110)	d	111)	d	112)	b
113)	a	114)	b	115)	c	116)	c
1)	a,b,c	2)	a,b,c,d	3)	a,b,c	4)	
	a,d						
5)	a,c	6)	a,b,c	7)	b,c,d	8)	c
9)	a	10)	a,b,c	11)	a,b,d	12)	
	a,b,c						
13)	a,d	14)	a,b,c,d	15)	c,d	16)	
	a,c						
17)	a,b	18)	d	19)	a,c,d	20)	c
21)	a,b,c	22)	a,b,d	23)	a,c	24)	
	a,b,c,d						
25)	b,d	26)	b,c	27)	a,c	28)	
	b,d						
29)	a,c	30)	a,b,c	31)	a,b	32)	a
1)	a	2)	a	3)	a	4)	b
5)	d	6)	c	7)	c	8)	a
9)	a	10)	d	11)	b	12)	d
13)	a	14)	a	15)	b	16)	a
17)	a	18)	c	19)	a	20)	c

21)	c	22)	a	23)	c	24)	c
25)	c	26)	c	27)	d	28)	c
29)	a	30)	c	31)	c	32)	c
33)	c	34)	c	35)	b	1)	a
	2)	b	3)	b	4)	a	
5)	d	6)	b	7)	b	8)	d
9)	b	10)	c	1)	a	2)	c
	3)	c	4)	a			
5)	d	6)	b				

: HINTS AND SOLUTIONS :

1 **(d)**

$\Delta A = \left(\frac{\Delta l}{l} + \frac{\Delta b}{b}\right) A$

$= \pm\left(\frac{0.1}{10.0} + \frac{0.01}{1.00}\right) \times (10.0 \times 1.00)\ \text{cm}^2$

$= \pm 0.02 \times 10 = \pm 0.2\ \text{cm}^2$

2 **(d)**

$f = Cm^x k^y$. Writing dimensions on both sides,

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

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

Comparing dimensions on both sides, we have

$0 = x + y$ and $-1 = -2y \Rightarrow y = \frac{1}{2}, x = -\frac{1}{2}$

Aliter. Remembering that frequency of oscillation of loaded spring is

$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}} = \frac{1}{2\pi}(k)^{1/2}m^{-1/2}$

Which gives $x = -\frac{1}{2}$ and $y = \frac{1}{2}$

3 **(c)**

Momentum = Force × Time = N s

4 **(c)**

0.08076 has least number of significant figures, i.e., 4

5 **(d)**

$501 = 0.501 \times 10^3 \Rightarrow$ order of magnitude of 501 is 3

6 **(c)**

$X = M^xL^{-y}T^{-z}$

$\therefore \frac{\Delta X}{X} \times 100 = x\left(\frac{\Delta M}{M} \times 100\right) + y\left(\frac{\Delta L}{L} \times 100\right) + z\left(\frac{\Delta T}{T} \times 100\right)$

(errors are always added)

$\therefore \frac{\Delta X}{X} \times 100 = (ax + by + cz)$ per cent

7 **(b)**

(92.0+2.15) cm = 94.15 cm. Rounding off to first decimal place, we get 94.2 cm

8 **(d)**

$y = a\sin\omega t + bt + ct^2\cos\omega t$

Here $a = y; b = y/t; c = y/t^2$

$\therefore a \times b \times c = y \times y/t \times y/t^2 = (y/t)^3$

9 **(b)**

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

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

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

Actual % error in g $= \frac{\Delta L}{L} \times 100 - 2\frac{\Delta T}{T} \times 100$

$= +2\% - 2 \times 1\% = 0\%$

10 **(a)**

$[C] = \left(\frac{Q}{V}\right) = \left(\frac{Q^2}{W}\right) = \left[\frac{A^2T^2}{ML^2T^{-2}}\right] = [M^{-1}L^{-2}T^4A^2]$

11 **(c)**

$\frac{A}{B} = \frac{\text{Force}}{\text{Force}} = [M^0L^0T^0]$

$Ct = \text{angle} \Rightarrow C = \frac{\text{Angle}}{\text{Time}} = \frac{1}{T} = T^{-1}$

$Dx = \text{angle} \Rightarrow D = \frac{\text{Angle}}{\text{Distance}} = \frac{1}{L} = L^{-1}$

$\therefore \frac{C}{D} = \frac{T^{-1}}{L^{-1}} = [M^0LT^{-1}]$

12 **(c)**

$X = a + b \Rightarrow \Delta X = \Delta a + \Delta b$

Now $\frac{\Delta X}{X} \times 100 = \frac{(\Delta a + \Delta b)}{a+b} \times 100$

$= \left(\frac{\Delta a}{a+b} + \frac{\Delta b}{a+b}\right) \times 100$

13 **(b)**

$\frac{M}{At} \propto P^xv^y \Rightarrow ML^{-2}T^{-1} = [ML^{-1}T^{-2}]^x[L^1T^{-1}]^y$

$= M^xL^{-x+y}T^{-2x-y}$

$x = 1, -x + y = -2$ and $-2x - y = -1$

From here, we get $y = -1$

Thus $x = -y$

14 **(b)**

Resistivity $= \frac{\text{Resistance} \times \text{Area}}{\text{Length}}$

$= \frac{ML^2T^{-3}A^{-2} \times L^2}{L} = [ML^3T^{-3}A^{-2}]$

15 **(b)**

$V = \frac{\pi}{8}\frac{Pr^4}{nl} = \frac{ML^{-1}T^{-2}L^4}{ML^{-1}T^{-1}L} = M^0L^3T^{-1}$

16 **(d)**

$R = \frac{V}{I} = \frac{8}{4} = 2\ \Omega$

$\frac{\Delta R}{R} \times 100 = \frac{\Delta V}{V} \times 100 + \frac{\Delta I}{I} \times 100$

$= \frac{0.5}{8} \times 100 + \frac{0.2}{4} \times 100 = 11.25\%$

$\Rightarrow R = (2 \pm 11.25\%)\ \Omega$

17 **(d)**

As $\mu = \frac{\text{Velocity of light in vaccum}}{\text{Velocity of light in medium}}$

Hence μ is dimensionless. Thus each term on the

R.H.S. of give equation should be dimensionless, i.e., B/λ^2 is dimensionless, i.e., B should have dimension of λ^2, i.e., cm^2, i.e., area

18 **(c)**

Kinetic energy, $E = \frac{1}{2}mv^2$

$$\frac{\Delta E}{E} \times 100 = \frac{\Delta m}{m} \times 100 + 2\frac{\Delta v}{v} \times 100$$

$= 2 + 2 \times 3 = 8\%$

19 **(a)**

$E = \frac{1}{2}Li^2$ hence $L = [ML^2T^{-2}A^{-2}]$

20 **(d)**

Since L.H.S. is displacement, so R.H.S. should have dimensions of displacement. In (a), aT does not have the dimensions of displacement. Also the argument of a trigonometric function should be dimensionless. In (b), argument is not dimensionless and in (c), a/T does not have the dimensions of displacement. Hence, the correct choice is (d)

21 **(c)**

Induced e.m.f. $|e| = L\frac{dI}{dt}$

$$[L] = \frac{[e]}{[dI/dt]} = \frac{[W/q]}{[dI/dt]} = \frac{[ML^2T^{-2}/AT]}{[AT^{-1}]}$$

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

22 **(c)**

Zero error $= 5 \times \frac{0.5}{50} = 0.05\ mm$

Actual measurement $= 2 \times 0.5\ mm + 25 \times \frac{0.5}{50} - 0.05\ mm$

$= 1\ mm + 0.25\ mm - 0.05\ mm = 1.20\ mm$

23 **(d)**

$AT^2 = LT^{-2} \times T^2 = [M^0LT^0]$

24 **(d)**

Required error is $2 \times 2\% + 1\% + 1\%$, i.e., 6%

25 **(b)**

Young's modulus $Y = \frac{FL}{Al} = \frac{4FL}{\pi d^2 l}$

$$= \frac{(4)(1.0 \times 9.8)(2)}{\pi(0.4 \times 10^{-3})^2(0.8 \times 10^{-3})}$$

$$= 2.0 \times 10^{11}\ \text{Nm}^{-2}$$

Further, $\frac{\Delta Y}{Y} = 2\left(\frac{\Delta d}{d}\right) + \left(\frac{\Delta l}{l}\right)$

$\therefore$ $\Delta Y = \left\{2\left(\frac{\Delta d}{d}\right) + \left(\frac{\Delta l}{l}\right)\right\} Y$

$$= \left\{2 \times \frac{0.01}{0.4} + \frac{0.05}{0.8}\right\} \times 2.0 \times 10^{11}$$

$$= 0.2 \times 10^{11}\ \text{Nm}^{-2}$$

Or $(Y + \Delta Y) = (2 + 0.2) \times 10^{11}\ \text{Nm}^{-2}$

26 **(d)**

$$\left[\frac{mr^2}{6\pi\eta}\right] = \left[\frac{ML^2}{ML^{-1}T^{-1}}\right] = [L^3T]$$

As we have $[\eta] = [ML^{-1}T^{-1}]$

$$\left[\left(\frac{6\pi mr\eta}{g^2}\right)^{1/2}\right] = \left[\left(\frac{MLML^{-1}T^{-1}}{L^2T^{-4}}\right)^{1/2}\right]$$

$$\left[\frac{m}{6\pi\eta rv}\right] = \left[\frac{M}{ML^{-1}T^{-1}LLT^{-1}}\right] = [L^{-1}T^2]$$

Thus, none of the given expressions have the dimensions of time

27 **(c)**

By Coulomb's laws, $F = \frac{1}{4\pi\varepsilon_0} \times \frac{q_1q_2}{r^2}$

$$\varepsilon_0 = \frac{q_1q_2}{4\pi \times F \times r^2}$$

Taking dimensions

$$\varepsilon_0 = \frac{(AT)(AT)}{ML^1T^{-2} \times L^2} = [M^{-1}L^{-3}T^4A^2]$$

28 **(b)**

[Moment of inertia] $= [ML^2]$

[Moment of force] $= [ML^2T^{-2}]$

30 **(d)**

$[\varepsilon_0 L] = [C] \therefore X = \frac{\varepsilon_0 LV}{t} = \frac{C \times V}{t} = \frac{Q}{t} =$ current

31 **(b)**

Here x^n has the same dimensions as a^2 . Thus $n = 2$ will make the expression dimensionally correct

32 **(b)**

If a quantity depends upon more than three factors, each having dimensions, then the method of dimensional analysis cannot be applied. It is because applying principle of homogeneity will give only three equations

33 **(d)**

Here $\frac{\Delta x}{x} \times 100 = \frac{\Delta a}{a} \times 100 + 2\frac{\Delta b}{b} \times 100 + \frac{1}{2}\frac{\Delta c}{c} \times 100$

$= [4 + 2 \times 2 + 1/2 \times 3]\% = 9.5\%$

34 **(d)**

Here $(\omega t + \phi_0)$ is dimensionless because it is an argument of a trigonometric function

35 **(d)**

Relative density $\rho_r = \frac{W_1}{W_1 - W_2}$

$$= \frac{8.00}{8.00 - 6.00} = 4.00$$

$$\frac{\Delta\rho_r}{\rho_r} \times 100 = \frac{\Delta W_1}{W_1} \times 100 + \frac{\Delta(W_1 - W_2)}{W_1 - W_2} \times 100$$

$= \frac{0.05}{8.00} \times 100 + \frac{0.05 + 0.05}{2} \times 100 = 5.62\%$

$\therefore \rho_r = 4.00 \pm 5.62\%$

36 **(a)**

Least count of both instrument

$\Delta d = \Delta \ell = \frac{0.5}{100}\ mm = 5 \times 10^{-3}\ mm$

$Y = \frac{4MLg}{\pi \ell d^2}$

$\left(\frac{\Delta Y}{Y}\right)_{\max} = \frac{\Delta \ell}{\ell} + 2\frac{\Delta d}{d}$

Error due to ℓ measurement $\frac{\Delta \ell}{\ell} = \frac{0.5/100\ mm}{0.25\ mm} = 2\%$

Error due to d measurement $2\frac{\Delta d}{d} = \frac{2 \times \frac{0.5}{100}}{0.5\ mm}$

$= \frac{0.5/100}{0.25} = 2\%$

Hence due to the errors in the measurements of d and ℓ are the same

37 **(d)**

$\frac{C^2}{g} = \frac{L^2T^{-2}}{LT^{-2}} = [L]$

38 **(a)**

Here, $[\tan \theta] = \left[\frac{v^2}{rg}\right] = M^0L^0T^0$. Also, in actual expression for the angle of banking of a road, there is no numerical factor involved. Therefore, the relation is both numerically and dimensionally correct

39 **(d)**

Density

$\rho = \frac{m}{\pi r^2 L}$

$\therefore \frac{\Delta \rho}{\rho} \times 100 = \left(\frac{\Delta m}{m} + 2\frac{\Delta r}{r} + \frac{\Delta L}{L}\right) \times 100$

After substituting the values we get the maximum percentage error in density =4%

40 **(d)**

$[x] = [Ay] = [B] \Rightarrow [y] = [B/A]$

Also, $[x] \neq [A]$ and $[Cz]$ =dimensionless

$\Rightarrow [C] = [z^{-1}]$

41 **(c)**

Pressure × volume gives work $= [ML^2T^{-2}]$

42 **(d)**

Rate of change of velocity is equal to acceleration, which is a vector quantity and all others are scalar quantities

43 **(b)**

Here x^2 has the dimensions of $L^2, B = [L^2]$

Also $ML^2T^{-2} = \frac{AL^{1/2}}{L^2}$ or $A = ML^{7/2}T^{-2}$

$\therefore A \times B = ML^{11/2}T^{-2}$

44 **(b)**

Angular momentum $= mvr$

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

45 **(c)**

Latent heat, $L = \frac{\text{Heat}}{\text{Mass}}, L = \frac{[ML^2T^{-2}]}{[M]} = [L^2T^{-2}]$

Gravitational potential, $V = \frac{\text{Work done}}{\text{Mass}}$

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

46 **(c)**

$E = hv \Rightarrow [ML^2T^{-2}] = [h][T^{-1}] \Rightarrow [h]$

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

47 **(d)**

$f = \frac{1}{2\pi\sqrt{LC}}$

$\therefore \left(\frac{C}{L}\right)$ does not represent the dimensions of frequency

48 **(c)**

Given that $\frac{\Delta l}{l} \times 100 = +1\%$

and $\frac{\Delta T}{T} \times 100 = -3\%$

Percentage error in the measurement of g is

$\left[\frac{4\pi^2 l}{T^2}\right] = 100 \times \frac{\Delta l}{l} - 2 \times \frac{\Delta T}{T} \times 100$

$= 1\% - 2[-3\%] = +7\%$

49 **(a)**

$H = \frac{B}{\mu_0} \Rightarrow H = \left[\frac{I}{r}\right] = [AL^{-1}]$

50 **(b)**

Dimension of L/R is same as that of time

51 **(b)**

Here a has the same dimensions as t^2

$a = [T^2], b = \frac{T^2}{P \cdot x} = \frac{T^2}{ML^{-1}T^{-2}L^1} = \frac{T^4}{M} = [M^{-1}T^4]$

Now $\frac{a}{b} = \frac{T^2}{M^{-1}T^4} = ML^0T^{-2}$

52 **(b)**

In a product, percentage errors are added up

53 **(d)**

The formula can be writer as

$\frac{\text{Velocity of light in vacuum}}{\text{Velocity of light in medium}} = 1$

This formula is dimensionally correct as both the sides are dimensionless. Numerically, this ratio is equal to refractive index which is greater than 1. Hence, equation is numerically incorrect

54 **(d)**

Energy density $= \frac{\text{Energy}}{\text{Volume}} = [ML^{-1}T^{-2}]$
Force/Area $= ML^{-1}T^{-2}$
[Charge/Volume]× [Voltage] $= \frac{Q}{\text{vol.}} \times \frac{W}{Q}$
$= \frac{\text{Work}}{\text{Volume}} = ML^{-1}T^{-2}$
The dimensions of (d) are different, i.e.,
$\frac{ML^2T^{-1}}{M} = M^0L^2T^{-1}$

55 **(a)**
$\phi = BA = \frac{F}{I \times L}A = \frac{[MLT^{-2}][L^2]}{[A][L]} = [ML^2T^{-2}A^{-1}]$

56 **(d)**
Modulas of rigidity $= \frac{\text{Shear stress}}{\text{Shear strain}} = [ML^{-1}T^{-2}]$

57 **(d)**
Moment of force $= F \times \perp$ distance $= [ML^2T^{-2}]$
Momentum = mass × velocity $= [MLT^{-1}]$

58 **(c)**
Unit of surface tension is Nm^{-1}
Also, $\text{Jm}^{-2} = \text{Nmm}^{-2} = \text{Nm}^{-1}$

59 **(a)**
Here $\omega \times k = T^{-1}L^{-1}$, which are not the dimensions of velocity. All others have got the dimensions of velocity

60 **(c)**
$PV = nRT \Rightarrow R = \frac{PV}{nT} = \frac{ML^{-1}T^{-2} \times L^3}{\text{mol} \times K}$
$= [ML^2T^{-2}K^{-1}\ \text{mol}^{-1}]$

61 **(c)**
All the choices are equivalent but the answer must possess three significant digits as significant digits does not change on conversion from one system to another. So appropriate choice is (c)

62 **(d)**
$[\eta] = [ML^{-1}T^{-2}]$
Hence $\left[\sqrt{\frac{M}{\eta L}}\right] = \sqrt{\frac{[M]}{[ML^{-1}T^{-2}][L]}} = [T]$

63 **(d)**
Surface tension $= \frac{\text{Force}}{\text{Length}} = \frac{[MLT^{-2}]}{L} = [MT^{-2}]$

64 **(d)**
Here $(2\pi ct/\lambda)$as well as $(2\pi x/\lambda)$ are dimensionless. So unit of ct is same as that of λ. Unit of x is same as that unit of ct is same as that of λ. Unit of x is same as that of λ. Also,
$\left[\frac{2\pi ct}{\lambda}\right] = \left[\frac{2\pi x}{\lambda}\right] = M^0L^0T^0$
Hence $\left[\frac{2\pi c}{\lambda}\right] = \left[\frac{2\pi x}{\lambda t}\right]$. In the option (d), x/λ is unit less. This is not the case with c/λ

65 **(a)**
Least count LC
$= \frac{Pitch}{Number\ of\ divisions\ on\ circular\ scale}$
$= \frac{0.5}{50} = 0.01\ mm$
Now, diameter of ball
$= (2 \times 0.5\ mm) + (25 - 5)(0.01) = 1.2mm$

66 **(a)**
$X = \frac{a^{1/2}b^2}{c^3}$
$\frac{\Delta X}{X} \times 100 = \frac{1}{2}\frac{\Delta a}{a} \times 100 + 2\frac{\Delta b}{b} \times 100 + 3\frac{\Delta c}{c} \times 100$
$= \frac{1}{2} \times 1 + 2 \times 3 + 3 \times 2 = 12.5\%$

67 **(a)**
$h = [ML^2T^{-1}], G = [M^{-1}L^3T^{-2}], C = [LT^{-1}]$
$\therefore h^{1/2}G^{-1/2}C^{1/2}$
$= M^{1/2}LT^{-1/2} \times M^{1/2}\,L^{-3/2}T^1 \times L^{1/2}T^{-1/2}$
$= ML^0T^0 =$ Mass

68 **(a)**
$0.00701 = 0.701 \times 10^{-2}$
Order of magnitude of 0.00701 is -2

69 **(d)**
$X = M^{-1}L^3T^{-2}$
$\frac{\Delta X}{X} = \frac{\Delta M}{M} + 3\frac{\Delta L}{L} + 2\frac{\Delta T}{T}$
$= 2 + 3 \times 3 + 2 \times 4 = 19$

70 **(b)**
$379 = 3.79 \times 10^2 \Rightarrow$ Order of magnitude of 379 is 2

71 **(c)**
5.69×10^{15} kg has three significant figures as the power of 10 is not considered for significant figures

72 **(c)**
Coefficient of friction is a dimensionless quantity

73 **(d)**
$\frac{\Delta g}{g} = \frac{\Delta l}{l} + 2\frac{\Delta T}{T}$

In option (d) error in Δg is minimum and number of observations made are maximum. Hence, in this case error in g will be minimum.

74 **(b)**
Here, b and $x^2 = L^2$ have same dimensions

Also, $a = \frac{L^2}{E\times t} = \frac{L^2}{(ML^2T^{-2})T} = M^{-1}T^1$

$a \times b = [M^{-1}L^2T^1]$

75 **(b)**

Dimension of work and torque $= [ML^2T^{-2}]$

76 **(a)**

Let $Y = [V^a A^b F^c]$

$[ML^{-1}T^{-2}] = [LT^{-1}]^a[LT^{-2}]^b[MLT^{-2}]^c$

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

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

On solving, we get $a = -4$, $b = 2$ and $c = 1$

77 **(b)**

Intensity of wave

$= \frac{\text{Energy}}{\text{Area} \times \text{Time}} = \frac{M\,L^2T^{-2}}{L^2T} = [ML^0T^{-3}]$

78 **(d)**

$m \propto v^a \rho^p g^c$

$ML^0T^0 \propto (LT^{-1})^a(ML^{-3})^b(LT^{-2})^c$

Comparing the powers of M, L and T and solving, we get $b = 1, c = -3, a = 6 \Rightarrow m \propto v^6$

79 **(a)**

Here at is dimensionless. So

$a = \frac{1}{t} = \left[\frac{1}{T}\right] = [T^{-1}]$

$x = \frac{V_0}{a}$ and $V_0 = xa = [LT^{-1}] = [M^0LT^{-1}]$

80 **(a)**

Volume $V = I^3 = (1.2 \times 10^{-2}m)^3 = 1.728 \times 10^{-6}m^3$

$\because$ length $l$has two significance figures. Therefore, the correct answer is

$V = 1.7 \times 10^{-6}m^3$

81 **(b)**

% error in $g = \frac{\Delta g}{g} \times 100 = \left(\frac{\Delta l}{l}\right) \times 100 + 2\left(\frac{\Delta T}{T}\right) \times 100$

$E_I = \frac{0.1}{64} \times 100 + 2\left(\frac{0.1}{128}\right) \times 100 = 0.3125\%$

$E_{II} = \frac{0.1}{64} \times 100 + 2\left(\frac{0.1}{64}\right) \times 100 = 0.4687\%$

$E_{III} = \frac{0.1}{20} \times 100 + 2\left(\frac{0.1}{36}\right) \times 100 = 1.055\%$

82 **(d)**

We know that speed of electromagnetic wave is

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

83 **(a)**

Let $T^2 = \rho^a r^b \sigma^c$

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

$a + c = 0, -3a + b = 0$ and $-2c = 2$

Hence, $a = 1, b = 3$ and $c = -1$

$T^2 = \rho r^3 \sigma^{-1} = \frac{\rho r^3}{\sigma}$

84 **(b)**

$\frac{E\,J^2}{M^5G^2} = \frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{M^5 \times [M^{-1}L^3T^{-2}]^2} = M^0L^0T^0$

This comes out to be dimensionless and angle is also dimensionless

85 **(d)**

Angular momentum, $J = mvr$

$J = [MLT^{-1}L] = [ML^2L^{-1}]$

This is same as that of Planck's constant

86 **(d)**

Couple $\tau \times$ angle $d\theta = dW$

$\frac{1}{2}I\omega^2$ =kinetic energy and $Fdx = dW$

87 **(b)**

Subtract 3.87 from 4.23 and then divide by 2

88 **(d)**

Maximum error in measuring mass = 0.001 g, because least count is 0.001 g. Similarly, maximum error in measuring volume is 0.01 cm^3

$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{0.001}{20.000} + \frac{0.01}{10.00}$

$= (5 \times 10^{-5}) + (1 \times 10^{-3}) = 1.05 \times 10^{-3}$

$\Delta\rho = (1.05 \times 10^{-3}) \times \rho$

$= 1.05 \times 10^{-3} \times \frac{20.000}{10.00} = 0.002 \text{ g cm}^{-3}$

89 **(c)**

Least count $= \frac{0.5}{50} = 0.01\ mm$

Diameter of ball $D = 2.5\ mm + (20)(0.01)$

$D = 2.7\ mm$

$\rho = \frac{M}{vol} = \frac{M}{\frac{4}{3}\pi\left(\frac{D}{2}\right)^3} \Rightarrow \left(\frac{\Delta\rho}{\rho}\right)_{\max} = \frac{\Delta M}{M} + 3\frac{\Delta D}{D}$

$\left(\frac{\Delta\rho}{\rho}\right)_{\max} = 2\% + 3\left(\frac{0.01}{2.7}\right) \times 100\% \Rightarrow \frac{\Delta\rho}{\rho} = 3.1\%$

90 **(d)**

$n_2 = n_1\left(\frac{M_1}{M_2}\right)^a\left(\frac{L_1}{L_2}\right)^b\left(\frac{T_1}{T_2}\right)^c$

Dimensional formula of moment of inertia

$= [ML^2T^0]$

$\therefore a = 1, b = 2, c = 0$

$n_1 = 12.0, M_1 = 1 \text{ kg}, M_2 = 10 \text{ g}$

$L_1 = 1 \text{ m}, L_2 = 5 \text{ cm}, T_1 = 1 \text{ s}, T_2 = 1 \text{ s}$

$n_2 = 12.0\left(\frac{1 \text{ kg}}{10 \text{ g}}\right)^1\left(\frac{1 \text{ m}}{5 \text{ cm}}\right)^2\left(\frac{1 \text{ s}}{1 \text{ s}}\right)^0$

$= 12 \times \left(\frac{1000 \text{ g}}{10 \text{ g}}\right)^1\left(\frac{100 \text{ cm}}{5 \text{ cm}}\right)^2 \times 1$

$= 12 \times 100 \times 400 = 4.8 \times 10^5$

91 **(c)**

Random error is reduced by making large number of observations and taking mean of all the results

92 **(a)**

Electric potential $= \frac{\text{Work}}{\text{Charge}}$

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

93 **(c)**

Screw gauge has minimum least count of 0.001 cm; hence, it is the most precise instrument

94 **(a)**

Here $v = e^a h^b \mu^c G^d$. Taking the dimensions $M^0LT^{-1}A^0$

$= [AT^1]^a[ML^2T^{-1}]^b\ [MLT^{-2}A^{-2}]^c[M^{-1}L^3T^{-2}]^d$

There will be four simultaneous equations by equating the dimensions of M, L, T and A. These are $a - 2c = 0, a - b - 2c - 2d = -1, b + c - d = 0$ and $2b + c + 3d = 1$. Solving for a, b, c and d, we get

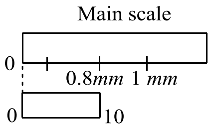
$a = -2, b = 1, c = -1, d = 0$

Thus $v = e^{-2}h\mu^{-1}G^0$

95 **(d)**

$20\ VSD = 16\ MSD$

$1\ VSD = 0.8\ MSD$



Least count $= MSD - VSD$

$= 1\ mm - 0.8\ mm = 0.2\ mm$

96 **(b)**

Percentage error in volume is

$\dfrac{0.01}{15.12} \times 100 + \dfrac{0.01}{10.15} \times 100 + \dfrac{0.01}{5.28} \times 100$

$= 0.35\%$

97 **(d)**

Momentum, $p = mv = MLT^{-1} = ML^{-3}L^4T^{-4}T^3$

$= DV^4F^{-3}$

98 **(d)**

$\dfrac{A}{B} = m, B = \dfrac{A}{m} = \dfrac{\text{Force}}{\text{Linear density}} = \dfrac{MLT^{-2}}{M\,L^{-1}}$

$\therefore B = [M^0L^2T^{-2}]$

Latent heat $= \frac{\text{Heat energy}}{\text{Mass}}$

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

Thus, B has same dimensions as that of latent heat

99 **(d)**

$\eta = \dfrac{\text{Tangential stress}}{\text{Shearing strain}} = \dfrac{T}{\theta} = \dfrac{F/A}{x/L}$

$[\eta] = \dfrac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$

100 **(a)**

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

101 **(b)**

Time period $T = 2\pi\sqrt{\frac{l}{g}}$

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

$\therefore\ g = \dfrac{(4\pi^2)(n^2)l}{t^2}$

%error in g $= \dfrac{\Delta g}{g} \times 100 = \left(\dfrac{\Delta l}{l} + \dfrac{2\Delta t}{t}\right) \times 100$

$E_{\text{I}} = \left(\dfrac{0.1}{64} + \dfrac{2 \times 0.1}{128}\right) \times 100 = 0.3125\%$

$E_{\text{II}} = \left(\dfrac{0.1}{64} + \dfrac{2 \times 0.1}{64}\right) \times 100 = 0.46875\%$

$E_{\text{III}} = \left(\dfrac{0.1}{20} + \dfrac{2 \times 0.1}{36}\right) \times 100 = 1.055\%$

Hence, E_I is minimum.

102 **(d)**

$v = \sqrt{\dfrac{T}{m}} = \left[\dfrac{m'g}{\frac{M}{l}}\right]^{1/2} = \left[\dfrac{m'l'g}{M}\right]^{1/2}$

It follows from here,

$\dfrac{\Delta v}{v} = \dfrac{1}{2}\left[\dfrac{\Delta m'}{m'} + \dfrac{\Delta l}{l} + \dfrac{\Delta M}{M}\right]$

$= \dfrac{1}{2}\left[\dfrac{0.1}{3.0} + \dfrac{0.001}{1.000} + \dfrac{0.1}{2.5}\right]$

$= \dfrac{1}{2}[0.03 + 0.001 + 0.04] = 0.036$

Percentage error in the measurement

$= 0.036 \times 100 = 3.6$

103 **(b)**

Here units of y and A will be same and that of x and λ will be same. $\frac{2\pi}{\lambda}(ct - x)$ is dimensionless. Here ct/λ and x/λ are dimensionless. Unit of ct is same as that of λ or x

104 **(d)**

For best results amplitude of oscillation should be as small as possible and more oscillations should be taken

105 **(c)**

$n = \dfrac{1}{2l}\sqrt{\dfrac{T}{m}} \Rightarrow n^2 = \dfrac{1}{4l^2}\dfrac{T}{m}$

$m = \dfrac{T}{4l^2n^2} = \left[\dfrac{MLT^{-2}}{L^2 \times T^{-2}}\right] = [ML^{-1}]$

106 **(d)**

Relative density $= \frac{W_a}{W_a - W_w}, \rho = \frac{W_a}{w}$

Where ρ is relative density, W_a is weight in air and w is loss in weight

$$\frac{\Delta\rho}{\rho} = \frac{\Delta W_a}{W_a} - \frac{\Delta w}{w}$$

For maximum error $= \frac{\Delta\rho}{\rho} = \frac{\Delta W_a}{W_a} + \frac{\Delta w}{w}$

For maximum percentage error

$$\frac{\Delta\rho}{\rho} \times 100 = \frac{\Delta W_a}{W_a} \times 100 + \frac{\Delta w}{w} \times 100$$

Given $\Delta W_a = 0.1$ gf and $W_a = 10.0$ gf

$w = 10.0 - 5.0 = 5.0$ gf

$\Delta w = \Delta W_a + \Delta W_w = 0.1 + 0.1 = 0.2$ gf

$$\frac{\Delta\rho}{\rho} \times 100 = \left(\frac{0.1}{10.0}\right) \times 100 + \left(\frac{0.2}{5.0}\right) \times 100$$

$= 1 + 4 = 5$

107 **(c)**

Capacitance, $C = \frac{\text{Charge}}{\text{Potential}} = \frac{AT}{ML^2T^{-3}A^{-1}}$

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

108 **(d)**

Required percentage $= 2 \times \frac{0.02}{0.24} \times 100 + \frac{1}{30} \times 100 + \frac{0.01}{4.80} \times 100$

$= 16.7 + 3.3 + 0.2 = 20\%$

109 **(d)**

$$\frac{L}{RCV} = \frac{L}{T\left(L\frac{dI}{dt}\right)} = \frac{1}{dI} = \frac{1}{\text{Current}}$$

[As RC = time constant T and potential difference $= L\frac{dI}{dt}$]

110 **(d)**

Dipole momen = (charge) × (distance)

Electric flux = (electric field) × (area)

111 **(d)**

$$n = -\frac{D(n_2 - n_1)}{x_2 - x_1} \Rightarrow T^{-1}L^{-2} = \frac{D(L^{-3})}{L}$$

$$\Rightarrow D = \frac{T^{-1}L^{-2} \times L}{L^{-3}} \Rightarrow D = [M^0L^2T^{-1}]$$

112 **(b)**

Here αt^2 is a dimensionless. Therefore, $\alpha = \frac{1}{t^2}$ and has the dimensions of T^{-2}

113 **(a)**

As $Q = \mathrm{m}L$,

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

114 **(b)**

$y = r\sin(\omega t - kx)$

Here ωt = angle $\Rightarrow \omega = \frac{1}{T} = T^{-1}$

Similarly kx = angle $\Rightarrow k = \frac{1}{x} = L^{-1}$

$$\therefore \frac{\omega}{k} = \frac{T^{-1}}{L^{-1}} = LT^{-1}$$

Or simply $\frac{\omega}{k}$ represents wave velocity

$\frac{\omega}{k} = \frac{2\pi f}{2\pi/\lambda} = f\lambda = v$, where f is frequency

115 **(c)**

The correct relation for time period of simple pendulum is $T = 2\pi(l/\mathrm{g})^{1/2}$. So the given relation is numerically incorrect as the factor of 2π is missing. But it is correct dimensionally

116 **(c)**

Least count of screw gauge $= \frac{0.5}{50}$

$= 0.01$ mm $= \Delta r$

Diameter $r = 2.5$ mm $+ 20 \times \frac{0.5}{50} = 2.70$ mm

$$\frac{\Delta r}{r} = \frac{0.01}{2.70}$$

Or $\frac{\Delta r}{r} \times 100 = \frac{1}{2.7}$

Now density $d = \frac{m}{V} = \frac{m}{\frac{4}{3}\pi\left(\frac{r}{2}\right)^3}$

Here, r is the diameter.

$$\therefore \quad \frac{\Delta d}{d} \times 100 = \left\{\frac{\Delta m}{m} + 3\left(\frac{\Delta r}{r}\right)\right\} \times 100$$

$$= \frac{\Delta m}{m} \times 100 + 3 \times \left(\frac{\Delta r}{r}\right) \times 100$$

$$= 2\% + 3 \times \frac{1}{2.7}$$

$= 3.11\%$

117 **(a,b,c)**

Pressure has dimensions $[ML^{-1}T^{-2}]$, force per area, energy per unit volume and momentum per unit area per second have same dimensions $[ML^{-1}T^{-2}]$

118 **(a,b,c,d)**

Velocity = Length/Time

Acceleration = Length/(Time)^2

$\Rightarrow$ Length $= \frac{(\text{Velocity})^2}{\text{Acceleration}}$, i.e., $L' = \frac{v'^2}{a'}$ and $L = \frac{v^2}{a}$

$$\Rightarrow \frac{L'}{L} = \left(\frac{v'}{v}\right)^2\left(\frac{a}{a'}\right) = \left(\frac{\alpha^2}{\beta}\right)^2\frac{1}{\alpha\beta} = \alpha^3/\beta^3$$

Now, $m' = \frac{F'}{a'}$ and $m = \frac{F}{a}$

$$\Rightarrow \frac{m''}{m} = \frac{F''}{F}\frac{a}{a''} = \frac{1}{\alpha\beta} \times \frac{1}{\alpha\beta} = \frac{1}{\alpha^2\beta^2}$$

Time = Velocity/Acceleration, i.e., $T' = \frac{v'}{a'}$ and $T = \frac{v}{a}$

$$\Rightarrow \frac{T''}{T} = \frac{v''}{v}\frac{a}{a''} = \frac{\alpha^2}{\beta}\frac{1}{\alpha\beta} = \frac{\alpha}{\beta^2}$$

Momentum = Mass × Velocity, i.e.,
$P' = m'v'$ and $P = mv$

$$\Rightarrow \frac{P'}{P} = \frac{m'}{m}\frac{v'}{v} = \frac{1}{\alpha^2\beta^2}\frac{\alpha^2}{\beta} = \frac{1}{\beta^3}$$

119 **(a,b,c)**

RC has the dimensions of time, so $1/RC$ will have the dimensions of frequency. Similarly, L/R has the dimensions of time, so R/L will have will have the dimensions of frequency

Now $\frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{\frac{L}{R}RC}} = \frac{1}{\sqrt{T\times T}} = \frac{1}{T}$ is the dimension of frequency

120 **(a,d)**

$\tau = F \times r \times \sin\theta$; $W = F \times d$;

Light year = wavelength = $[L]$

121 **(a,c)**

$L/R, CR$ and $\sqrt{LC}$ all have dimensions of time $[T]$

122 **(a,b,c)**

1. Reynold number and coefficient of friction both are dimensionless

2. Curie has unit disintegrations/second. Curie and frequency both have dimensions $[T^{-1}]$

3. Latent heat $= \frac{\text{Heat energy}}{\text{Mass}}$

Gravitation potential $= \frac{\text{Gravitational energy}}{\text{Mass}}$

Both have dimensions $[L^2T^{-2}]$

Planck's constant has dimensions $[ML^2T^{-1}]$ whereas torque has dimensions $[ML^2T^{-2}]$

123 **(b,c,d)**

Frequency and angular velocity have the same dimension $[T^{-1}]$

Tension has dimensions of force and surface tension has dimension of force/length. Density has dimensions of mass/volume and energy density has dimensions of energy/volume. Angular momentum has dimensions of linear momentum × distance

124 **(c)**

One light Fermi is time taken by light to travel a distance of 1 fermi *ie*, 10^{-15}m.

At $= l/v$

1 light Fermi is $= \frac{10^{-15}}{3\times10^8} = 3.33 \times 10^{-24}$s

125 **(a)**

B,c

126 **(a,b,c)**

Units of permeability (μ) are $\text{WbA}^{-1}\text{m}^{-1} = \text{Hm}^{-1}$ =ohm-s-m^{-1}

127 **(a,b,d)**

Mean value $= \frac{1.51+1.53+1.53+1.52+1.54}{5} = 1.53$

Absolute errors are $(1.53 - 1.51 = 0.02)$, $(1.53 - 1.53 = 0.00)$, $(1.53 - 1.53 = 0.00)$, $(1.53 - 1.52 - 0.01)$ and $(1.54 - 1.53 = 0.01)$

Mean absolute error is

$$\frac{0.02 + 0.00 + 0.00 + 0.01 + 0.01}{5} = \frac{0.04}{5} = 0.008 \approx 0.01$$

So choice (a) is correct

Relative error $= \frac{0.01}{1.53} = 0.00653 \approx 0.01$

% error $= \frac{0.01}{1.53} \times 100 = 1\%$

128 **(a,b,c)**

Least count = 1 MSD − 1 VSD $= S - V$

$$= S - \left(\frac{n-1}{n}\right)S = \frac{S}{n} \quad [\because nV = (n-1)S]$$

It is also called vernier constant

So choice (a) and (b) are correct

Choice (d) is wrong and choice (c) is correct, since for all vernier scales similar approach can be used

129 **(a,d)**

Least count of vernier callipers

$$\text{LC} = 1\text{ MSD} - 1\text{ VSD}$$

$$= \frac{\text{Smallest division on main scale}}{\text{Number of divisions on vernier scale}}$$

20 divisions of vernier scale = 16 divisions of main scale

$$\therefore\ 1\text{ VSD} = \frac{16}{20}\text{ mm} = 0.8\text{ mm}$$

$$\text{LC} = 1\text{ MSD} - 1\text{ VSD}$$

$$= 1\text{ mm} - 0.8\text{ mm} = 0.2\text{ mm}$$

The correct option is (d).

130 **(a,b,c,d)**

$L = \frac{\phi}{I}; L = -e/\left(\frac{dI}{dt}\right); L = \frac{2U}{I^2}; L = R \times t$

131 **(c,d)**

Values of options © and (d) don't match with the mirror formula,

$$\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$$

132 **(a,c)**

The dimensions of frequency is given by $[M^0L^0T^{-1}]$

Now, $\frac{1}{\sqrt{LC}} - [M^0L^0T^{-1}]$

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

$\frac{L}{C} - [M^2L^4T^{-6}\ A^{-4}]$

$\frac{R}{C} - [M^2L^4T^{-7}A^{-4}]$

Thus, only $\frac{1}{\sqrt{LC}}$ and $\frac{R}{L}$ have the dimensions same as of frequency

133 **(a,b)**

The quantity RC have dimensions $[M^1L^2T^{-3}A^{-2}][M^{-1}L^{-2}T^4A^2] = [M^0L^0T^{-1}]$

The quantity $\sqrt{LC}$ will also have dimensions of time

But R/L and C/L will not have the same dimensions

134 **(d)**

Dimensionally $\varepsilon_0 L = C$, where C =capacitance

Dimensionally $C\Delta V = q$, where q is charge

Dimensionally $\frac{q}{\Delta t} = I$, where I is current

135 **(a,c,d)**

Least count $1 = \frac{1\text{mm}}{100} = 0.01\text{mm}=0.001$ cm

Diameter of wire $D = 1\text{mm} + 63 \times 0.01\text{mm}$ $= 1.63$ mm or 0.163 cm

Volume of wire $= \frac{\pi D^2 l}{4} = \frac{3.14\times(0.163)^2\times5.6}{4}$

$=0.0209\text{cm}^3$

136 **(c)**

Here, (1/2) $\varepsilon_0 E_2$ represents energy per unit volume

$$|\varepsilon_0|[E^2] = \frac{\text{Energy}}{\text{Volume}} = \frac{[ML^2T^{-2}]}{[L^3]} = ML^{-1}T^{-2}$$

137 **(a,b,c)**

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 the dimensions of Planck's constant is $[ML^2T^{-1}]$ and torque is $[ML^2T^{-2}]$

138 **(a,b,d)**

Torque $= \vec{r} \times \vec{F}$. Work $= \vec{r} \cdot \vec{F}$

Both have dimensions $[ML^2T^{-2}]$

Angular momentum and Planck's constant have same dimensions $[ML^2T^{-1}]$

Light year and wavelength have the same dimension $[L]$

139 **(a,c)**

$T = \frac{40}{20}$ s = 2s

Further, $t = nT = 20\,T$

Or $\Delta t = 20\,\Delta T$

$$\frac{\Delta t}{t} = \frac{\Delta T}{T}$$

Or $\Delta T = \frac{T}{t}\,.\Delta t = \left(\frac{2}{40}\right)(1) = 0.05$ s

Further, $T = 2\pi\sqrt{\frac{1}{g}}$

Or $T \propto g^{-1/2}$

$\therefore \quad \frac{\Delta T}{T} \times 100 = -\frac{1}{2} \times \frac{\Delta g}{g} \times 100$

Or % error in determination of g is

$$\frac{\Delta g}{g} \times 100 = -200 \times \frac{\Delta T}{T}$$

$$= -\frac{200 \times 0.05}{2} = -5\%$$

$\therefore$ Correct options are (a) and (c).

140 **(a,b,c,d)**

$\phi = L.I \Rightarrow [L] = \frac{\text{weber}}{\text{ampere}}$

$e = L\frac{dl}{dt} \Rightarrow [L] = \left(\frac{\text{volt} - \text{second}}{\text{ampere}}\right)$

$U = \frac{1}{2}LI^2 \Rightarrow [L] = \frac{\text{joule}}{\text{ampere}^2}$

$e = L\frac{\Delta i}{\Delta t} \Rightarrow \left(\frac{e}{\Delta i}\right)(\Delta t)$

= (Resistance) × (Time)

= (ohm × second)

141 **(b,d)**

Length $\propto G^x c^y h^z$

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

By comparing the power of M, L and T in both

sides we get $-x+z=0, 3x+y+2z=1$ and $-2x-y-z=0$
By solving above three equations we get
$x=\frac{1}{2}, y=-\frac{3}{2}, z=\frac{1}{2}$

143 **(a,c)**
Since, $t=nT$. So, $T=\frac{t}{n}=\frac{40}{20}$ or $T=2$ sec
Now, $\Delta t=n\Delta T$ and $\frac{\Delta t}{t}=\frac{\Delta T}{T}$
So, $\frac{1}{40}=\frac{\Delta T}{2} \Rightarrow \Delta T=0.05$
Time period, $T=2\pi\sqrt{\frac{l}{g}}$
So, $\frac{\Delta T}{T}=-\frac{1}{2}\frac{\Delta g}{g}$ or $-\frac{\Delta g}{g}=2\frac{\Delta T}{T}$
So, percentage error in $g=\frac{\Delta g}{g}=\times 100$
$=-2\frac{\Delta T}{T}\times 100=-2\times\frac{0.05}{2}\times 100=5\%$

144 **(b,d)**
A dimensionally correct equation may or may not be correct. For example, $s=ut+at^2$ is dimensionally correct, but not correct actually
A dimensionally incorrect equation may be correct also. For example, $s=u+\frac{a}{2}(2n-1)$ is a correct equation, but not correct dimensionally

145 **(a,c)**
Dimensions of magnetic flux = magnetic field × area
$=\left[\frac{F}{iL}\right]\times[\text{Area}]=\frac{MLT^{-2}}{AL}L^2=[ML^2T^{-2}A^{-1}]$
Dimensions of $\frac{h}{a}=\left[\frac{\text{Planck's constant}}{\text{Charge}}\right]$
$=\left[\frac{ML^2T^{-1}}{AT}\right]=[ML^2T^{-2}A^{-1}]$
From Gauss theorem, electric flux $=\frac{q}{\varepsilon_0}$

146 **(a,b,c)**
Unit of $x=\frac{\text{Unit of }E}{\text{Unit of }B}=$ Unit of velocity
Because $E=vB$
$y=\frac{1}{\sqrt{\mu_0\varepsilon_0}}=c\rightarrow$ velocity of light
Unit of $z=\frac{\text{Unit of }l}{\text{Unit of }RC}=\frac{\text{Length}}{\text{Time}}=$ Velocity

147 **(a,b)**
We know,
$R=[M^1L^2T^{-3}A^{-2}], [M^{-1}L^{-2}T^4A^2]$
$L=[ML^2T^{-2}A^{-2}]$
$\therefore\ RC=[T]$ and $\sqrt{LC}=[T]$

148 **(a)**
$F=A^av^bD^c$
$[MLT^{-2}]\propto[L^2]^a[LT^{-1}]^b[ML^{-3}]^c$
$[MLT^{-2}]\propto[M]^c[L^{2a+b-3c}T^{-b}]$
Equating the power of M, L and T, we get
$c=1, 2a+b-3c=1, -b=-2$
Solving. We get, $a=1, b=2, c=1$

149 **(a)**
Addition and subtraction can be done between quantities having same dimensions

150 **(a)**
As the distance of star increases, the parallax angle decreases, and great degree of accuracy is required for its measurement. Keeping in view the practical limitation in measuring the parallax angle, the maximum distance a star we can measure is limited to 100 light year

151 **(a)**
Fundamental quantity is that quantity which does not depend upon other quantities. Since mass, length and time are independent of one another, so they are fundamental quantities

152 **(b)**
The last number is most accurate because it has greatest significant figure (3)

153 **(d)**
The radius of the nucleus of an atom is of the order of 1 fermi.

1 fermi $=10^{-15}\ m(small\ unit)$

154 **(c)**
As surface tension and surface energy both have different S.I. unit and same dimensional formula

155 **(c)**
Because representation of standard metre in terms of wavelength of light is most accurate

156 **(a)**
Light year is distance travelled by light in vacuum in 1 year.

1 light year=$9.45\times 10^{15}\ m$

The wavelength is the diatance between two consecutive crests or through of a wave.

The dimension of both light year and wavelength is $[M^\circ LT^\circ]$. So, both represent distances.

157 **(a)**
Zeros before a non-zero significant digit are not counted, while zeros after a non-zero significant

digit are counted

158 **(d)**
Let us write the dimensions of various quantities on two sides of the given relation

L.H.S.$= T = [T]$

$$\text{R. H. S.} = 2\pi\sqrt{g/l} = \sqrt{\frac{LT^{-2}}{L}} = [T^{-1}]$$

[$\therefore$ 2π has no dimension]. As dimensions of L.H.S is not equal to dimension of R.H.S. therefore according to the principle of homogeneity the relation

$T = 2\pi\sqrt{g/l}$ is not valid

159 **(b)**
Both the assertion and reason are true. But reason is not the correct explanation of the assertion. In fact,

$$[v] = \frac{[\text{L}]}{[\text{T}]}$$

$$\frac{\Delta v}{v} = \pm\left(\frac{\Delta \text{L}}{\text{L}} + \frac{\Delta \text{T}}{\text{T}}\right)$$

$$= \pm(3\% + 2\%) = \pm 5\%$$

160 **(d)**
Impulse = Force × time

$\therefore$ Impulse has no dimension of force

161 **(a)**
According to statement of reason, as the graph is a straight line, $P \propto Q$, or $P =$ constant $\times$ Q

$$i.e. \frac{P}{Q} = \text{constant}$$

162 **(a)**
Both assertion and reason are true and the reason is correct explanation of the assertion.

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

$$= \frac{\text{Force} \times \text{distance}}{\text{Area} \times \text{distance}} = \frac{\text{energy}}{\text{volume}} = \text{energyh density}$$

163 **(b)**
A.U. (Astronomical unit) is used to measure the average distance of the centre of the sun from the centre of the earth, while angstrom is used for very short distances. 1 A.U. $= 1.5 \times 10^{-11} m$; 1Å $= 10^{-10} m$

164 **(a)**
As length, mass and time represent our basic scientific notations, therefore they are called fundamental quantities and they cannot be obtained from each other

166 **(c)**
As ω (angular velocity) has the dimension of $[T^{-1}]$ not $[T]$

167 **(a)**
Au is an astronomical unit. This is the mean distance between earth and sun

$1AU = 1.496 \times 10^{11}\ M = 1.5 \times 10)$^11 M

Å *is angstrom units 1* Å$=10^{-10} m$

168 **(c)**
From $n = \frac{1}{2l}\sqrt{\frac{T}{m}}, n^2 = \frac{T}{4l^2 m}$

$$m = \frac{T}{4l^2 n^2} = \frac{[\text{MLT}^{-2}]}{[\text{L}^2\text{T}^{-2}]} = \frac{[\text{M}]}{[\text{T}]} = \frac{\text{mass}}{\text{length}}$$

$=$ linear mass density

169 **(c)**
The assertion is true, but the reason is false.

$$\text{Rate of flow} = \frac{\text{volume}}{\text{time}} = \frac{[\text{L}^3]}{\text{T}} = [\text{L}^3\text{T}^{-1}]$$

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

170 **(a)**
Avogadro number has the unit per gram mole. So, it is not diamensionless.

171 **(c)**
Dimensional constants are the quantities whose values are constant and they posses dimensions. For example, velocity of light in vacuum, universal gravitational constant, Boltzman constant, Planck's constant etc

172 **(c)**
Density is not always mass per unit volume

173 **(c)**
Nuclear cross-section is measured in unit barn. but in SI system the value of 1 barn$=10^{-28}\ m^2$.

Therefore, assertion is true and reason is false.

174 **(c)**
The assertion is true, but the reason is false, became 1 barn $=10^{-28}\text{m}^2$.

175 **(d)**
$$\frac{\Delta K}{K}\times 100=\left(\frac{\Delta m}{m}+2\frac{\Delta v}{v}\right)\times 100=2+2\times 5$$
$$=12\%$$

176 **(c)**
Impulse is equal to change in momentum. Dimensionally both are same

177 **(a)**
Å is equal to 10^{-10}m, whereas 1 AU is the distance between Sun and Earth

178 **(c)**
$A=4\pi r^2$ [error will not be involved in constant 4π]

Fractional error $\frac{\Delta A}{A}=\frac{2\Delta r}{r}$

$$\frac{\Delta A}{A}\times 100=2\times 0.3\%=0.6\%$$

But $\frac{\Delta A}{A}=\frac{4\Delta r}{r}$ is false

179 **(c)**
Light year and wavelength both represent the distance, so both have dimensions of length not of time

180 **(c)**
We know that $Q=n_1u_1=n_2u_2$ are the two units of measurement of the quantity Q and n_1, n_2 are their respective numerical values. From relation $Q_1=n_1u_1=n_2u_2, nu=\text{constant}\Rightarrow n\propto 1/u$ *i.e.*, smaller the unit of measurement, greater is its numerical value

181 **(c)**
Avogadro number (N) represents the number of atom in 1 gram mole of an element, i.e. it has the dimensions of mole^{-1}

182 **(c)**
Light year and wavelength both have same dimensions of length

183 **(b)**
From, $f=\frac{1}{2l}\sqrt{\frac{T}{m}}, f^2=\frac{T}{4l^2m}$

Or, $m=\frac{T}{4l^2f^2}=\frac{[MLT^{-2}]}{L^2T^{-2}}$

$$=\frac{M}{L}=\frac{\text{Mass}}{\text{length}}$$

= linear mass density

184 **(a)**
We know that least count is given by s/n, so
(i)least count $=s/n=1/10=0.1$ mm
(ii) least count $=s/n=0.5/10=0.05$ mm
(iii) least count $=s/n=0.5/20=0.025$ mm
(iv) least count $=s/n=1/100=0.01$ mm

185 **(b)**
(i)$[LC]=\left[\frac{L}{R}RC\right]=T^2$

(ii)$[LR]=\left[\frac{L}{R}R^2\right]=T[R^2]=T\left[\frac{V}{I}\right]^2=T\left[\frac{W}{QI}\right]^2$

$$=T\left(\frac{W}{I^2t}\right)^2=T\left(\frac{ML^2T^{-2}}{A^2T}\right)^2=M^2L^4T^{-5}A^{-4}$$

(iii) $[H]=\left[\frac{\text{Heat}}{\text{Mass}}\right]=\frac{ML^2T^{-2}}{M}=L^2T^{-2}$

(iv) $[s]=\left[\frac{\text{Heat}}{\text{Mass}\times\text{Temperature}}\right]=\frac{ML^2T^{-2}}{MK}$

$=L^2T^{-2}K^{-1}$

186 **(b)**
Backlash error is caused by loose fittings, wear and tear, etc. in the screw mechanisms.
Zero error may be positive or negative but will always be subtracted.
In vernier callipers, least count is the difference between 1 MSD and 1 VSD
Error in screw gauge may be positive or negative and may be due to loose fitting of the circular scale

187 **(a)**
(A) Capacitance – Coulomb/volt, Coulomb^2/joule

(B) Inductance – Ohm-second, volt-second (ampere)$^{-1}$

(C) Magnetic induction – Newton(ampere – metre –*1*

Thus, use the following formulae for getting the given units

$L = R.t$; [$t \to$ time constant]

$U = \frac{q^2}{2C} \therefore \frac{q^2}{U} = C$ [C − capacitance; q − charge]

$q = CV$ and $L\frac{di}{dt} = (e)$

Also $F = IlB \sin\theta$

188 **(d)**

Dimensions of Pa-s is

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

$= [ML^{-1}T^{-1}]$

Dimensions of Nm K^{-1} is

$= [MLT^{-2}][L][K^{-1}]$

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

Dimensions of $J - kg^{-1}K^{-1}$

$= [ML^2T^{-2}][M^{-1}][K^{-1}]$

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

Dimensions of $Wm^{-1}K^{-1}$

$= [ML^2T^{-2}A^{-1}][L^{-1}][K^{-1}]$

$= [MLT^{-2}A^{-1}K^{-1}]$

190 **(b)**

(A) $GM_eM_s\}F = \frac{GM_eM_s}{r^2}$

$\therefore GM_eM_s = F.r^2 = (N.m^2) = [ML^3T^{-2}]$

(B) $\frac{3RT}{M}\}\ v = \sqrt{\frac{3RT}{M}};\ \therefore \frac{3RT}{M} = v^2$

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

(c) $\frac{F^2}{q^2B^2}\}\ F = qvB \Rightarrow \left(\frac{F}{qB}\right)^2 = v^2$

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

(D) $\frac{GM_e}{R_e}\}\frac{U}{m} = \frac{GM_e}{R_e}$

$\therefore \frac{joule}{kg} = \frac{ML^2T^{-2}}{M} = [L^2T^{-2}]$

Thus compare the dimension

191 **(d)**

(1) Planck's constant

$[h] = \frac{[E]}{[v]}$

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

(2) Gravitational constant

$[G] = \frac{[Fr^2]}{[m_1m_2]}$

$= \frac{[MLT^{-2}][L^2]}{[M^2]}$

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

(3) Bulk modulus

$[B] = \frac{[\text{Normal stress}]}{[\text{Volumetric strain}]}$

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

(4) Coefficient of viscosity,

$\eta = \frac{[F]}{[A][dvdy]} = \frac{[MLT^{-2}][L]}{[L^2][LT^{-1}]}$

$= [ML^{-1}T^{-1}]$

193 **(c)**

All digits are significant after decimal

$47.23 \div (2.3) = 20.5 \approx 21$ (should have only two significant digits)

3 is a number with one significant digit

194 **(a)**

$\sqrt{\frac{Gh}{c^3}} = \sqrt{\frac{(6.67 \times 10^{-11})(6.63 \times 10^{-34})}{(3 \times 10^8)^3}}$

$= \sqrt{1.64 \times 10^{-69}} = 4.04 \times 10^{-35} \simeq 10^{-35}$

195 **(c)**

Distance travelled in n^{th} second

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

196 **(c)**

Distance travelled in n^{th} second

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

197 **(a)**

$[a] = [PV^2] = \left[\frac{FV^2}{A}\right] = \frac{[MLT^{-2}L^6]}{[L^2]} = [ML^5T^{-2}]$

198 **(d)**

1 cal $= 4.2 \text{ J} = 4.2 \text{ kgm}^2\text{s}^{-2} = n_2(\alpha \text{ kg})(\beta \text{ m})^2(\gamma \text{s})^{-2}$

$\Rightarrow n_2 = 4.2\alpha^{-1}\beta^{-2}\gamma^2$

So, 1 cal $= (4.2\ \alpha^{-1}\beta^{-2}\gamma^2)$ new units

199 **(b)**

$A = lb = 4.4457 \text{ m}^2 = 4.45 \text{ m}^2$

One should retain only three significant figures