UNITS AND MEASUREMENTS

Single Correct Answer Type

1. One femtometer is equivalent to

a) 10^{15} m　b) 10^{-15} m
c) 10^{-12} m　d) 10^{12} m

2. A body travels uniformly a distance of (13.8 ± 0.2) m in a time (4.0 ± 0.3) s. The velocity of the body within error limits is

a) (3.45 ± 0.2) ms^{-1}　b) (3.45 ± 0.3) ms^{-1}
c) (3.45 ± 0.4) ms^{-1}　d) (3.45 ± 0.5) ms^{-1}

3. 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) $ML^2T^{-2}A^3$

4. Two quantities A and B are related by the relation $\frac{A}{B}$=m, where m is linear mass den sity and A is force. The dimensions of B will be

a) Mass as that of latent heat　b) Same a that of pressure
c) Same as that of work　d) Same as that of momentum

5. Which of the following quantities is dimensionless

a) Gravitational constant　b) Planck's constant
c) Power of a convex lens　d) None

6. In a system of units if force (F), acceleration (A), and time (T) are taken as fundamental units then the dimensional formula of energy is

a) FA^2T　b) FAT^2
c) F^2AT　d) FAT

7. Dimensions of CR are those of

a) Frequency　b) Energy
c) Time period　d) Current

8. Dimensional formula for angular momentum is

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

9. The unit of Planck's constant is

a) Joule　b) Joule/s
c) Joule/m　d) Joule-s

10. A physical quantity is represented by $X = M^{\alpha}L^{b}T^{-c}$. If percentage errors in the measurements of M, L and T are α%, β%and γ% respectively, then total, percentage error is

a) $(\alpha a + \beta b - \gamma c)\%$　b) $(\alpha a + \beta b + \gamma c)\%$
c) $(\alpha a - \beta b - \gamma c)\%$　d) 0%

11. The equation of state of some gases can be expressed as $\left(P + \frac{a}{V^2}\right)(V - b) = RT$. Here P is the pressure, V is the volume, T is the absolute temperature and a, b, R are constants. The dimensions of 'a' are

a) ML^5T^{-2}　b) $ML^{-1}\,T^{-2}$
c) $M^0L^3T^0$　d) $M^0L^6T^0$

12. The pair having the same dimensions is
a) Angular momentum, work b) Work, torque
c) Potential energy, linear momentum d) Kinetic energy, velocity

13. 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) $E_I = 0$ b) E_I is minimum
c) $E_I = E_{II}$ d) E_{II} is maximum

14. The physical quantities not having same dimensions are
a) Torque and work b) Momentum and Planck's constant
c) Stress and Young's modules d) Speed and $(\mu_0\varepsilon_0)^{-1/2}$

15. The dimensional formula of relative density is
a) ML^{-3} b) LT^{-1}
c) MLT^{-2} d) Dimensionless

16. If force (F), length (L) and time (T) are assumed to be fundamental units, then the dimensional formula of the mass will be
a) $FL^{-1}T^2$ b) $FL^{-1}T^{-2}$
c) $FL^{-1}T^{-1}$ d) FL^2T^2

17. The internal and external diameters of a hollow cylinder are measured with the help of a vernier calipers. Their values are 4.23 ± 0.01 cm and 3.87 ± 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

18. According to Joule's law of heating, heat produced $H = I^2Rt$, where I is current, R is resistance and t is time. If the errors in the measurement of I, R and t are 3%, 4% and 6% respectively then error in the measurement of H is
a) $\pm 17\%$ b) $\pm 16\%$
c) $\pm 19\%$ d) $\pm 25\%$

19. The dimensions of resistance are same as those of ………. Where h is the Planck's constant and e is the charge.
a) $\frac{h^2}{e^2}$ b) $\frac{h^2}{e}$
c) $\frac{h}{e^2}$ d) $\frac{h}{e}$

20. If I is the moment of inertia and ω the angular velocity, what is the dimensional formula of rotational kinetic energy $\frac{1}{2}I\omega^2$?
a) $[ML^2T^{-1}]$ b) $[M^2L^{-1}T^{-2}]$
c) $[ML^2T^{-2}]$ d) $[M^2L^{-1}T^{-2}]$

21. The dimension of magnetic field in M, L, T and C (coulomb) is given as
a) MT^2C^{-2} b) $MT^{-1}C^{-1}$
c) $MT^{-2}C^{-1}$ d) $MLT^{-1}C^{-1}$

22. The physical quantities not having same dimensions are
a) Speed and $(\mu_0\varepsilon_0)^{-1/2}$ b) Torque and work
c) Momentum and Planck's constant d) Stress and Young's modulus

23. What is the unit of k in the relation $U = \frac{ky}{y^2+a^2}$ where U represents the potential energy, y represents the displacement and a represents the maximum displacement ie, amplitude?
a) $m\,s^{-1}$ b) m s
c) J m d) $J\,s^{-1}$

24. The unit of angular acceleration in the SI system is
a) $N\,kg^{-1}$ b) ms^{-2}
c) $rad\,s^{-2}$ d) $m\,kg^{-1}K$

25. The SI unit of universal gas constant (R) is
a) Watt $K^{-1}mol^{-1}$ b) Newton $K^{-1}mol^{-1}$
c) Joule $K^{-1}mol^{-1}$ d) Erg $K^{-1}mol^{-1}$

26. A highly rigid cubical block A of small mass M and side L is fixed rigidly on to another cubical block of same dimensions and of low 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 o which is given by
a) $2\pi\sqrt{M\eta L}$ b) $2\pi\sqrt{\frac{M\eta}{L}}$
c) $2\pi\sqrt{\frac{ML}{\eta}}$ d) $2\pi\sqrt{\frac{M}{\eta L}}$

27. SI unit of pressure is
a) Pascal b) $dynes/cm^2$
c) cm of Hg d) Atmosphere

28. 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) $ML^2T^4A^3$

29. The equation of a wave is given by
$$Y = A\sin\omega\left(\frac{x}{\upsilon} - k\right)$$
where ω is the angular velocity and υ is the linear velocity.
The dimension of k is
a) LT b) T
c) T^{-1} d) T^2

30. The concorde is the fastest airlines used for commercial service. It can cruise at 1450 mile per hour (about two times the speed of sound or in other words mach 2). What is it in m/s?
a) 644.4m/s b) 80 m/s
c) 40 m/s d) None of these

31. Dimensional formula for volume elasticity is
a) $M^1L^{-2}T^{-2}$ b) $M^1L^{-3}T^{-2}$
c) $M^1L^2T^{-2}$ d) $M^1L^{-1}T^{-2}$

32. If C is the capacitance and V is the potential, the dimensional formula for CV^2 is
a) $[ML^2T^{-1}]$ b) $[ML^{-2}T^{-3}]$
c) $[ML^2\,T^{-2}]$ d) $[ML^{-2}T^{-2}]$

33. The time taken by an electron to go from ground state to excited state is one shake (one shake = 10^{-8}s). This time in nanosecond will be
a) 10 ns b) 4 ns
c) 2 ns d) 25 ns

34. Out of following four dimensional quantities , which one quantity is to be called a dimensional constant
a) Acceleration due to gravity b) Surface tension of water
c) Weight of a standard kilogram mass d) The velocity of light in vacuum

35. One yard in SI units is equal
a) 1.9144 metre b) 0.9144 metre
c) 0.09144 kilometre d) 1.0936 kilometre

36. Which of the following is not the unit of energy
a) Calorie b) Joule
c) Electron volt d) Watt

37. If p represents radiation pressure, C represents speed of light and q represents radiation energy striking a unit area per second, then non-zero integers a, b and c are such that $p^a q^b C^c$ is dimensionless, then
a) $a = 1, b = 1, c = -1$ b) $a = 1, b = -1, c = 1$
c) $a = -1, b = 1, c = 1$ d) $a = 1, b = 1, c = 1$

38. The Martians use force (F), acceleration (A) and time (T) as their fundamental physical quantities. The dimensions of length on Martians system are
a) FT^2 b) $F^{-1}T^2$
c) $F^{-1}A^2T^{-1}$ d) AT^2

39. The square root of the product of inductance and capacitance has the dimension of
a) Length b) Mass
c) Time d) No dimension

40. E, m, I and G denote energy, mass, angular momentum and gravitational constant respectively, then the dimensions of $\frac{EI^2}{m^5G^2}$ are
a) Angle b) Length
c) Mass d) Time

41. Size of universe is about
a) Ten million light years b) Million light years
c) Hundred million light years d) 10 million light years

42. In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half-a-degree ($= 0.5°$), then the least count of the instrument is
a) One minute b) Half minute
c) One degree d) Half degree

43. $S = A(1 - e^{-Bxt})$, where S is speed and x is displacement. The unit of B is
a) $m^{-1}s^{-1}$ b) $m^{-2}s$
c) s^{-2} d) s^{-1}

44. The density of a material in CGS system of units is $4 g/cm^3$, In a system of units which unit of length is 10 cm and unit of mass is 100 g , the value of density of material will be
a) 400 b) 0.04
c) 0.4 d) 40

45. Given $X = (Gh/c^3)^{1/2}$, where G, h and c are gravitational constant, Planck's constant and the velocity of light respectively. Dimensions of X are the same as those of
a) Mass b) Time
c) Length d) Acceleration

46. One femtometre is equivalent to

a) 10^{15} m
b) 10^{-15} m
c) 10^{-12} m
d) 10^{12} m

47. If the value of the resistance is 10.845Ω and the value of the current is 3.23 A, then the potential difference is 35.02935 V. its value in correct significant figures would be

a) 35 V
b) 35.0 V
c) 35.03 V
d) 35.029 V

48. 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

49. The modulus of elasticity is dimensionally equivalent to

a) Strain
b) Force
c) Stress
d) Coefficient of viscosity

50. Density of wood is 0.5 gm/cc in the CGS system of units. The corresponding value in MKS units is

a) 500
b) 5
c) 0.5
d) 5000

51. The dimensional formula for the modulus of rigidity is

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

52. Crane is British unit of volume (one crane = 170.4742). convert crane into SI units.

a) 0.170474 m^3
b) 17.0474m^3
c) 0.00170474m^3
d) 1704.74m^3

53. The mass and volume of a body are found to be 500 ± 0.05 kg and 1.00 ± 0.05m^3 respectively. Then the maximum possible percentage error in its density is

a) 6%
b) 3%
c) 10%
d) 5%

54. R and L represent respectively resistance and self inductance, which of the following combinations has the dimensions of frequency

a) $\frac{R}{L}$
b) $\frac{L}{R}$
c) $\sqrt{\frac{R}{L}}$
d) $\sqrt{\frac{L}{R}}$

55. If the length of a rectangle l = 10.5 cm, breadth b = 2.1 cm and minimum possible measurement by scale = 0.1 cm, then the area is

a) 22.0 cm^2
b) 22.1 cm^2
c) 22.05 cm^2
d) 22 cm^2

56. 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) $\frac{C}{L}$

57. A small steel ball of radius r is allowed to fall under gravity through a column of a viscous liquid of coefficient of viscosity η. After some time the velocity of the ball attains a constant value known as terminal velocity υ_T. The terminal velocity depends on (i) the mass of the ball m, (ii) η, (iii) r and (iv) acceleration due to gravity g. Which of the following relations is dimensionally correct

a) $\upsilon_T \propto \frac{mg}{\eta r}$
b) $\upsilon_T \propto \frac{\eta r}{mg}$
c) $\upsilon_T \propto \eta rmg$
d) $\upsilon_T \propto \frac{mgr}{\eta}$

58. Young's modulus of a material has the same units as

a) Pressure b) Strain

c) Compressibility d) Force

59. $Dyne/cm^2$ is not a unit of

a) Pressure b) Stress

c) Strain d) Young's modulus

60. The potential energy of a particle varies with distance x from a fixed origin as $U = \left(\frac{A\sqrt{X}}{x+B}\right)$; where A and B are constants. The dimensions of AB are

a) $[ML^{5/2}T^{-2}]$ b) $[ML^2T^{-2}]$

c) $[M^{3/2}L^{3/2}T^{-2}]$ d) $[ML^{7/2}T^{-2}]$

61. The unit of self inductance of a coil is

a) Farad b) Henry

c) Weber d) Tesla

62. One nanometre is equal to

a) 10^9 mm b) 10^{-6}cm

c) 10^{-7}cm d) 10^{-9}cm

63. The dimensions of $e^2/4\pi\varepsilon_0 hc$, where e, ε_0, h and c are electronic charge, electric permittivity, Planck's constant and velocity of light in vacuum respectively, are

a) $[M^0L^0T^0]$ b) $[ML^0T^0]$

c) $[M^0LT^0]$ d) $[M^0L^0T^1]$

64. The dimensions of $1/2\ \varepsilon E^2$ are same as

a) Energy density (energy per unit volume)

b) Energy

c) Power

d) None of the above

65. Dimensions of $\frac{1}{\mu_0\epsilon_0}$, where symbols have their usual meaning, are

a) $[lT^{-1}]$ b) $[L^{-1}T]$

c) $[L^{-2}T^2]$ d) $[L^2T^{-2}]$

66. A gas bubble from an explosion under water oscillates with a time period T, depends upon static pressure p, density of water ρ and the total energy of explosion E. Find the expression for the time period T.(where, k is a dimensionless constant)

a) $T = kp^{-5/6}\rho^{1/2}E^{1/3}$ b) $T = kp^{-4/7}\rho^{1/2}E^{1/3}$

c) $T = kp^{-5/6}\rho^{1/2}E^{1/2}$ d) $T = kp^{-4/7}\rho^{1/3}E^{1/2}$

67. If C and L denote capacitance and inductance respectively, then the dimensions of LC are

a) $M^0L^0T^0$ b) $M^0L^0\ T^2$

c) $M^2L^0T^2$ d) MLT^2

68. The length, breadth and thickness of a metal block is given by l = 90 cm, b = 8 cm, t = 2.45 cm. The volume of the block is

a) $2 \times 10^2 cm^3$ b) $1.8 \times 10^2 cm^3$

c) $1.77 \times 10^2 cm^3$ d) $1.764 \times 10^2 cm^3$

69. Position of a body with acceleration a is given by $x = ka^m t^n$. Here t is time. Find the dimensions of m and n.

a) $m = 1, n = 1$ b) $m = 1, n = 2$

c) $m = 2, n = 1$ d) $m = 2, n = 2$

70. Which physical quantities have the same dimension

a) Couple of force and work b) Force and power

c) Latent heat and specific heat d) Work and power

71. The dimensions of electric potential are
a) $[ML^2T^{-2}Q^{-1}]$
b) $[MLT^{-2}Q^{-1}]$
c) $[ML^2T^{-1}Q]$
d) $[ML^2T^{-2}Q]$

72. Which of the following is the smallest unit
a) Millimetre
b) Angstrom
c) Fermi
d) Metre

73. The values of two resistors are $R_1 = (6 \pm 0.3)\ k\Omega$ and $R_2 = (10 \pm 0.2)k\Omega$. The percentage error in the equivalent resistance when they are connected in parallel is
a) 5.125%
b) 2%
c) 3.125%
d) 10.125%

74. SI unit of permittivity is
a) $C^2m^2N^2$
b) $C^2m^{-2}N^{-1}$
c) $C^2m^2N^{-1}$
d) $C^{-1}m^2N^{-2}$

75. The physical quantity having the dimensions $[M^{-1}L^{-3}A^2]$ is
a) Resistance
b) Resistivity
c) Electrical conductivity
d) Electromotive force

76. The SI unit of length is the metre. Suppose we adopt a new unit of length which equal x metre. The area of 1 m^2 expressed in terms of the new unit has a magnitude
a) x
b) x^2
c) x^{-1}
d) x^{-2}

77. If the velocity $v(is\ cms^{-1})$ of a particle is given in terms of t (in second) by the relation $v = at + \frac{b}{t+c}$ then, the dimensions of $a, b\ and\ c$ are

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

78. Ins is defined as
a) $10^{-9}\ s\ of\ Kr - clock\ of\ 1650763.73\ oscillations$
b) 10^{-9} s $of\ Kr - clock\ of\ 6521389.63\ oscillations$
c) $10^{-9}\ s\ of\ Cs - clock\ of\ 1650763.73\ oscillations$
d) $10^{-9}\ s\ of\ Cs - clock\ of\ 9192631770\ oscillations$

79. In which of the following system of units, *weber* is the unit of magnetic flux
a) CGS
b) MKS
c) SI
d) None of these

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

81. A spectrometer gives the following reading when used to measure the angle of a prism
Main scale reading : 58.5 degree
Vernier scale reading : 09 divisions
Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data
a) 58.59 *Degree*
b) 58.77 *Degree*
c) 58.65 *Degree*
d) 59 *Degree*

82. In a new system of units, unit f mass is 10 kg, unit of length is 1 km and unit of time is 1 min. The value of 1 joule in this new hypothertical system is

a) 3.6×10^{-4} new units b) 6×10^{7} new units
c) 10^{11} new units d) 1.67×10^{4} new units

83. The energy (E), andgular momentum (L) and universal gravitational constant (G) are chosen as fundamental quantities. The dimensions of universal gravitational constant in the dimensional formula of Planck's constant (h) is

a) Zero b) -1
c) $\frac{5}{3}$ d) 1

84. The unit of reduction factor of tangent galvanometer is

a) *Ampere* b) *Gauss*
c) *Radian* d) None of these

85. If the unit of length and force be increased four times, then the unit of energy is

a) Increased 4 times b) Increased 8 times
c) Increased 16 times d) Decreased 16 times

86. What are the units of $K = 1/4\pi\varepsilon_0$

a) $C^2N^{-1}m^{-2}$ b) Nm^2C^{-2}
c) Nm^2C^2 d) Unitless

87. Frequency is the function of density (ρ) , length (a) and surface tension (T). Then its value is

a) $k\rho^{1/2}a^{3/2}/\sqrt{T}$ b) $k\rho^{3/2}a^{3/2}/\sqrt{T}$
c) $k\rho^{1/2}a^{3/2}/T^{3/4}$ d) None of these

88. A suitable unit for gravitational constant is

a) $kg\text{-}m\ sec^{-1}$ b) $N\ m^{-1}sec$
c) $N\ m^2\ kg^{-2}$ d) $kg\ m\ sec^{-1}$

89. 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

90. A physical quantity is given by $X = [M^aL^bT^c]$. The percentage error in measurement of $M, L\ and\ T$ are $\alpha, \beta\ and\ \gamma$ respectively. Then, the maximum % error in the quantity X is

a) $a\alpha + b\beta + c\gamma$ b) $a\alpha + b\beta - c\gamma$
c) $\frac{a}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma}$ d) None of these

91. The dimensional formula of angular velocity is

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

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

a) 3.32 mm b) 3.73 mm
c) 3.67 mm d) 3.38 mm

93. If $f = x^2$, then the relative error in f is

a) $\frac{2\Delta x}{x}$ b) $\frac{(\Delta x)^2}{x}$
c) $\frac{\Delta x}{x}$ d) $(\Delta x)^2$

94. In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half-a-degree ($= 0.5°$) then the least count of the instrument is

a) One minute b) Half minute
c) One degree d) Half-degree

95. The percentage errors in the measurement of length and time period of a simple pendulum are 1% and 2% respectively. Then the maximum error in the measurement of acceleration due to gravity is

a) 8% b) 3%
c) 4% d) 5%

96. The unit of $e.m.f.$ is

a) $Joule$ b) $Joule - coulomb$
c) $Volt - coulomb$ d) $Joule/coulomb$

97. The velocity of a body is given by the equation $v = \frac{b}{t} + ct^2 + dt^2$

The dimensional formula of b is

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

98. If C is capacitance and q is charge, then the dimension of q^2/C is same as that of

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

99. If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be

a) 8% b) 2%
c) 4% d) 6%

100. Write dimensional formula for the intensity of radiation

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

101. Out of the following pairs, which one does not have identical dimensions

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

102. The radius of a wire is 0.24 mm. Then its area of cross section by taking significant figures into consideration is

a) 0.1 mm^2 b) 0.2 mm^2
c) 0.18 mm^2 d) 0.180 mm^2

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

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

104. Universal time is based on

a) Rotation of earth on its axis b) Oscillations of quartz crystal
c) Vibrations of cesium atom d) Earth's orbital motion around the sun

105. The speed (v) of ripples on the surface of water depends on surface tension (σ), density (ρ) and wavelength (λ). The square of speed (v) is proportional to

a) $\frac{\sigma}{\rho\lambda}$ b) $\frac{\rho}{\sigma\lambda}$
c) $\frac{\lambda}{\sigma\rho}$ d) $\rho\lambda\sigma$

106. A physical quantity P is given by $P = \frac{A^3B^{\frac{1}{2}}}{C^{-4}D^{\frac{3}{2}}}$. The quantity which brings in the maximum percentage error in P is

a) A b) B

c) C d) D

107. The speed (v) of ripples on the surface of water depends on surface tension (σ), density (ρ) and wavelength (λ). The square of speed (v) is proportional to

a) $\frac{\sigma}{\rho\lambda}$ b) $\frac{\rho}{\sigma\lambda}$

c) $\frac{\lambda}{\sigma\rho}$ d) $P\lambda\sigma$

108. What is the dimensional formula of mc^2, where the letters have their usual meanings?

a) $[MLT^{-1}]$ b) $[ML^0T^0]$

c) $[ML^2T^{-2}]$ d) $[M^{-1}L^3T^6]$

109. A student performs an experiment for determination of $g\left(=\frac{4\pi^2 l}{T^2}\right), l \approx 1m$, 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) $\Delta L = 0.5, \Delta T = 0.05, n = 50$

110. One light year is defined as the distance travelled by light in one year. The speed of light is $3 \times 10^8 ms^{-1}$. The same in metre is

a) 3×10^{12}m b) 9.461×10^{15}m

c) 3×10^{15}m d) None of these

111. The mass of a box is 2.3 g. Two gold pieces, each of mass 0.035 g, are placed in it. The total mass of the box and gold pieces is

a) 2.3 g b) 2.4 g

c) 2.37 g d) 2.370 g

112. The pressure on a square plate is measured by measuring the force on the plate and the length of the sides of the plate. If the maximum error in the measurement of force and length are respectively 4% and 2%, the maximum error in the measurement of pressure is

a) 1% b) 2%

c) 6% d) 8%

113. Unit of impulse is

a) $Newton$ b) $kg - m$

c) $kg - m/s$ d) $Joule$

114. Dimensions of impulse are same as that of

a) Force b) Momentum

c) Energy d) Acceleration

115. The physical quantity which has the dimensional formula M^1T^{-3} is

a) Surface tension b) Solar constant

c) Density d) Compressibility

116. The dimensions of pressure is equal to

a) Force per unit volume b) Energy per unit volume

c) Force d) energy

117. In the equation S_{nth} the $= u + \frac{a}{2}(2n - 1)$, the letters have their usual meanings. The dimensional formula of S_{nth} is

a) $[ML^0T]$ b) $[ML^{-1}T^{-1}]$

c) $[M^0LT^{-1}]$ d) $[M^0LT^0]$

118. The ratio of the dimension of Planck's constant and that of moment of inertia is the dimension of

a) Frequency b) Velocity
c) Angular momentum d) Time

119. Error in the measurement of radius of sphere is 2%. The error in the measurement of volume is

a) 1% b) 5%
c) 3% d) 6%

120. 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

121. If 1 g cm $s^{-1} = x$ newton-second, then the number x is equal to

a) 1×10^{-3} b) 3.6×10^{-3}
c) 1×10^{-5} d) 6×10^{-4}

122. $1kWh\ =$

a) $1000\ W$ b) $36 \times 10^{5}\ J$
c) $1000\ J$ d) $3600\ J$

123. A physical quantity is given by $X = M^a L^b T^c$. The percentage error in measurement of M, L and T are α, β and γ respectively. The maximum percentage error in the quantity X is

a) $a\alpha + b\beta + c\gamma$ b) $a\alpha + b\beta - c\gamma$
c) $\frac{a}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma}$ d) None of these

124. If P represents radiations pressure, c represents speed of light and Q represents radiation energy striking a unit area per *second*, the non-zero integers x, y and z such that $P^x Q^y c^z$ is dimensionless, are

a) $x = 1, y = 1, z = -1$ b) $x = 1, y = -1, z = 1$
c) $x = -1, y = 1, z = 1$ d) $x = 1, y = 1, z = 1$

125. If energy (E), velocity (v) and force (F) be taken as fundamental quantity, then what are the dimensions of mass

a) Ev^2 b) Ev^{-2}
c) Fv^{-1} d) Fv^{-2}

126. The air bubble formed by explosion inside water performed oscillation with time period T that is directly proportional to $p^a\ d^b\ E^c$, where p is the pressure, d is the density and E is the energy due to explosion. The values of a, b *and* c will be

a) -5/6, 1/2, 1/3 b) 5/6, 1/3, 1/2
c) 5/6, 1/2, 1/3 d) None of these

127. The difference in the lengths of a mean solar day and a sidereal day is about

a) 1 *min* b) 4 *min*
c) 15 *min* d) 56 *min*

128. In $S = a + bt + ct^2$. S is measured in metre and t in *second*. The unit of c is

a) None b) m
c) ms^{-1} d) ms^{-2}

129. The physical quantity angular momentum has the same dimensions as that of

a) Work b) Force
c) Momentum d) Planck's constant

130. The unit of momentum is

a) N s b) Ns^{-1}
c) N m d) $N\ m^{-1}$

131. Given that v is speed, r is the radius and g is the acceleration due to gravity. Which of the following is dimensionless

a) v^2/rg b) v^2r/g

c) v^2g/r d) v^2rg

132. Dimensional formula of Stefan's constant is

a) $MT^{-3}K^{-4}$ b) $ML^2T^{-2}K^{-4}$

c) ML^2T^{-2} d) $MT^{-2}L^0$

133. The dimensional formula for impulse is same as the dimensional formula for

a) Momentum b) Force

c) Rate of change of momentum d) Torque

134. Choose the incorrect statement out of the following

a) Every measurement by any measuring instrument has some error

b) Every calculated physical quantity that is based on measured values has some error

c) A measurement can have more accuracy but less precision and vice versa

d) The percentage error is different from relative error

135. Linear momentum and angular momentum have the same dimensions in

a) Mass and length b) Length and time

c) Mass and time d) Mass, length and time

136. The unit of nuclear dose given to a patient is

a) $Fermi$ b) Rutherford

c) Curie d) Roentgen

137. Dimensional formula of Stefan's constant is

a) $[MT^{-3}K^{-4}]$ b) $[ML^2T^{-2}K^{-4}]$

c) $[ML^2T^{-2}]$ d) $[MT^{-2}L^0]$

138. The unit of absolute permittivity is

a) $Fm\ \ (farad - metre)$ b) $Fm^{-1}\ (farad/metre)$

c) Fm^{-2} (farad/metre^2) d) F (farad)

139. Unit of moment of inertia in MKS system

a) $\text{kg} \times \text{cm}^2$ b) kg/cm^2

c) $\text{kg} \times \text{m}^2$ d) $\text{Joule} \times \text{m}$

140. $[\text{ML}^3\text{T}^{-1}\text{Q}^{-2}]$ is the dimensional formula of

a) Resistance b) Resistivity

c) Conductance d) Conductivity

141. Which physical quantities have same dimensions?

a) Force and power b) Torque and energy

c) Torque and power d) Force and torque

142. The dimensions of kinetic energy are

a) $[\text{M}^2\text{L}^2\text{T}]$ b) $[\text{ML}^2\text{T}]$

c) $[\text{ML}^2\text{T}^{-2}]$ d) $[\text{ML}^2\text{T}^{-1}]$

143. Pressure gradient has the same dimension as that of

a) Velocity gradient b) Potential gradient

c) Energy gradient d) None of these

: ANSWER KEY :

1)	b	2)	b	3)	a	4)	a	5)	d	6)	b	7)	c	8)	b
9)	d	10)	b	11)	a	12)	b	13)	b	14)	b	15)	d	16)	a
17)	b	18)	b	19)	c	20)	c	21)	b	22)	c	23)	c	24)	c
25)	c	26)	d	27)	a	28)	a	29)	b	30)	a	31)	d	32)	c
33)	a	34)	d	35)	b	36)	d	37)	b	38)	d	39)	c	40)	a
41)	d	42)	a	43)	a	44)	d	45)	c	46)	b	47)	b	48)	d
49)	c	50)	a	51)	d	52)	a	53)	a	54)	a	55)	a	56)	d
57)	a	58)	a	59)	c	60)	d	61)	b	62)	c	63)	a	64)	a
65)	d	66)	a	67)	b	68)	a	69)	b	70)	a	71)	a	72)	c
73)	d	74)	b	75)	c	76)	d	77)	d	78)	d	79)	c	80)	b
81)	c	82)	a	83)	a	84)	a	85)	c	86)	b	87)	a	88)	c
89)	d	90)	a	91)	a	92)	d	93)	a	94)	a	95)	d	96)	d
97)	a	98)	a	99)	d	100)	b	101)	a	102)	c	103)	c	104)	a
105)	a	106)	c	107)	a	108)	c	109)	d	110)	b	111)	b	112)	d
113)	c	114)	b	115)	b	116)	b	117)	c	118)	a	119)	d	120)	d
121)	c	122)	b	123)	a	124)	b	125)	b	126)	a	127)	b	128)	d
129)	d	130)	a	131)	a	132)	a	133)	a	134)	d	135)	c	136)	d
137)	b	138)	b	139)	c	140)	b	141)	b	142)	c	143)	d		

: HINTS AND SOLUTIONS :

2 **(b)**

Here, $S = (13.8 \pm 0.2)m$

and $t = (4.0 \pm 0.3)\ sec$

Expressing it in percentage error, we have,

$S = 13.8 \pm \frac{0.2}{13.8} \times 100\% = 13.8 \pm 1.4\%$

and $t = 4.0 \pm \frac{0.3}{4} \times 100\% = 4 \pm 7.5\%$

$\because V = \frac{s}{t} = \frac{13.8 \pm 1.4}{4 \pm 7.5} = (3.45 \pm 0.3)\ m/s$

3 **(a)**

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

4 **(a)**

$[\mathrm{B}]=\left[\frac{\text{force}\times\text{length}}{\text{mass}}\right] = \left[\frac{\text{energy}}{\text{mass}}\right]$ =[latent heat]

5 **(d)**

$[G] = [M^{-1}L^3T^{-2}]; [h] = [ML^2T^{-1}]$

Power $= \frac{1}{\text{focal length}} = [L^{-1}]$

All quantities have dimensions

6 **(b)**

$E = KF^aA^bT^c$

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

$[ML^2T^{-2}] = [M^aL^{a+b}T^{-2a-2b+c}]$

$\therefore a = 1, a + b = 2 \Rightarrow b = 1$

And $-2a - 2b + c = -2 \Rightarrow c = 2$

$\therefore E = KFAT^2$

7 **(c)**

Capacity $\times$ Resistance $= \frac{\text{Charge}}{\text{Potential}} \times \frac{\text{Volt}}{\text{amp}}$

$= \frac{\text{amp} \times \text{second} \times \text{Volt}}{\text{Volt} \times \text{amp}} = \text{Second}$

8 **(b)**

Angular momentum $= mvr$

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

10 **(b)**

$X = \mathrm{M}^a\mathrm{L}^b\mathrm{T}^{-c}$

$\therefore \frac{\Delta X}{X} = \pm\left[a\frac{\Delta M}{M} + b\frac{\Delta L}{L} + c\frac{\Delta T}{T}\right]$

$= \pm[a\alpha + \beta b + \gamma c]\%$

11 **(a)**

By principle of dimensional homogenity $\left[\frac{a}{V^2}\right] = [P]$

$\therefore [a] = [P][V^2] = [ML^{-1}T^{-2}] \times [L^6] = [ML^5T^{-2}]$

12 **(b)**

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

13 **(b)**

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

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

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

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

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

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

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

Hence, E_I is minimum.

14 **(b)**

Planck's constant $(h) = \mathrm{J-s} = [\mathrm{ML^2T^{-2}}][\mathrm{T}] = [\mathrm{ML^2T^{-1}}]$

Linear momentum $(p) = \mathrm{kg-ms^{-1}}$

$= [\mathrm{M}][\mathrm{L}][\mathrm{T}]^{-1} = [\mathrm{MLT^{-1}}]$

15 **(d)**

Relative density $= \frac{\text{Density of substance}}{\text{Density of water}} = [M^0L^0T^0]$

16 **(a)**

Let $m = KF^aL^bT^c$

Substituting the dimension of

$[F] = [MLT^{-2}], [C] = [L]$ and $[T] = [T]$

And comparing both sides, we get $m = FL^{-1}T^2$

17 **(b)**

Subtract 3.87 from 4.23 and then divide by 2.

18 **(b)**

$H = I^2Rt$

$\therefore \frac{\Delta H}{H} \times 100 = \left(\frac{2\Delta I}{I} + \frac{\Delta R}{R} + \frac{\Delta t}{t}\right) \times 100$

$= (2 \times 3 + 4 + 6)\% = 16\%$

19 **(c)**

Resistance, $R = \frac{V}{i} = \frac{W}{qi}$

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

$R = [\mathrm{ML^2T^{-3}A^{-2}}]$

$\left[\frac{h}{e^2}\right] = \frac{[\mathrm{ML^2T^{-1}}]}{[\mathrm{AT}]^2}$

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

20 **(c)**

Do not think in terms of I and ω. Remember; kinetic energy is fundamentally 'work'

W =Force × distance

$= [\mathrm{MLT^{-2}}] \times [\mathrm{L}]$

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

21 **(b)**

$$[B]=\frac{[F]}{[I][L]}=\frac{[MLT^{-2}]}{[CT^{-1}][L]}=[MT^{-1}C^{-1}]$$

22 **(c)**

Momentum $[MLT^{-1}]$, Plank's constant $[ML^2T^{-1}]$

23 **(c)**

The right hand side of the given relation is basically $\frac{k}{\text{metre}}$. But, since the left hand side is joule, therefore k should be J m.

24 **(c)**

$$\text{Angular acceleration } = \frac{\text{Angular velocity}}{\text{Time}}=\frac{rad}{sec^2}$$

25 **(c)**

$$PV=nRT \Rightarrow R=\frac{PV}{nT}=\frac{joule}{mole \times kelvin}=JK^{-1}mol^{-1}$$

26 **(d)**

$[\eta]=[\mathrm{ML^{-1}T^{-2}}]$or $[T]=\left[\frac{\mathrm{M}}{\mathrm{L}\eta}\right]^{1/2}$

Time period $=2\pi\sqrt{\frac{M}{L\eta}}$

28 **(a)**

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

29 **(b)**

From the principle of homogenity $\left(\frac{x}{v}\right)$ has dimensions of T

30 **(a)**

$$n_1u_1=n_2u_2$$
$$n_2=\frac{n_1u_1}{u_2}$$
$$=\frac{1450\text{mile/h}}{\text{m/s}}=\frac{1450\text{ s/mile}}{\text{mh}}$$
$$=\frac{1450\text{ s}\times 1.6\text{km}}{10^{-3}\text{km } 60\times 60\text{s}}=644.4$$

1450 mile/h=644.4m/s

31 **(d)**

Volume elasticity $=\frac{\text{Force/Area}}{\text{Volume strain}}$

Strain is dimensionless, so

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

32 **(c)**

$$[C]=[\mathrm{M^{-1}L^{-2}T^4A^2}]$$
$$[V]=[\mathrm{ML^2T^{-3}A^{-1}}]$$
$$\therefore [CV^2]=[\mathrm{M^{-1}L^{-2}T^4A^2}][\mathrm{ML^2T^{-3}A^{-1}}]^2$$
$$=[\mathrm{ML^2T^{-2}}]$$

34 **(a)**

$$n_1u_1=n_2u_2$$
$$n_2=\frac{1\text{ shake}}{1\text{ ns}}$$

$=\dfrac{10^{-8}\text{s}}{10^{-9}\text{s}}$

$\therefore\ n_2 = 10$

35 **(b)**

$1\ yard = 36\ inch = 36 \times 2.54\ cm = 0.9144m$

36 **(d)**

$Watt$ is a unit of power

37 **(b)**

Here, $[\text{M}^0\text{L}^0\text{T}^0] = [\text{M L}^{-1}\text{T}^{-2}]^a[\text{MT}^{-3}]^b[\text{LT}^{-1}]^c$

Or $\quad [\text{M}^0\text{L}^0\text{T}^0] = [\text{M}^{a+b}\text{L}^{-a+c}\text{T}^{-2a-3b-c}]$

Comparing powers of M, L and T, we get $a + b = 0, -a + c = 0, -2a - 3b = 0$

Solving $a = 1, b = -1, c = 1$

38 **(d)**

Acceleration $= \frac{\text{Distance}}{\text{time}^2} \Rightarrow A = LT^{-2} \Rightarrow L = AT^2$

39 **(c)**

We know, $\quad f = \frac{1}{2\pi\sqrt{LC}}$

Or $\quad \sqrt{LC} = \frac{1}{2\pi f} = \text{time}$

Thus, $\sqrt{LC}$ has the dimension of time.

40 **(a)**

$[E] = [ML^2T^{-2}], [m] = [M], [l] = [ML^2T^{-1}]$ and $[G] = [M^{-1}L^3T^{-2}]$ Substituting the dimensions of above quantities in the given formula:

$$\frac{El^2}{m^5G^2}\frac{[ML^2T^{-2}][ML^2T^{-1}]^2}{[M^5][M^{-1}L^3T^{-2}]^2} = \frac{M^3L^6T^{-4}}{M^3L^6T^{-4}} = [M^0L^0T^0]$$

41 **(d)**

Size of universe is about $10^{26}\text{m} = 10^6 \times (9.46 \times 10^{15})\text{m}$

$= 10^{10}\text{ly}$

42 **(a)**

$$\text{Least count} = \frac{\text{Value of main scale division}}{\text{No. of divisions on vernier scale}}$$

$$= \frac{1}{30}\ \text{MSD} = \frac{1}{30} \times \frac{1°}{2} = \frac{1°}{60} = 1\ \text{min}$$

43 **(a)**

Bxt is unitless. $\therefore$ Unit of B is $m^{-1}s^{-1}$

44 **(d)**

$$n_2 = n_1\left[\frac{m_1}{m_2}\right]\left[\frac{L_1}{L_2}\right]^{-3}$$

$$= 4\left[\frac{1\ gm}{100\ gm}\right]\left[\frac{cm}{10\ cm}\right]^{-3} = 4 \times \frac{1}{100} \times 10^3$$

$= 40$ units

45 **(c)**

$$[X] = \left[\frac{\text{M}^{-1}\text{L}^3\text{T}^{-2} \times \text{ML}^2\text{T}^{-1}}{\text{L}^3\text{T}^{-3}}\right]^{-1/2} = [\text{L}]$$

46 **(b)**

One femtometre is equivalent to 10^{-15} m

ie, $\quad 1\text{fm} = 10^{-15}$ m

47 **(b)**

We have to retain three significant figures in the result.

48 **(d)**

Dipole momen = (charge) × (distance)

Electric flux = (electric field) × (area)

50 **(a)**

1 C.G.S. unit of density = 1000 M.K.S. unit of density

$\Rightarrow 0.5\ gm/cc = 500\ kg/m^3$

51 **(d)**

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

52 **(a)**

$n_1 u_1 = n_2 u_2$

$$n_2 = \frac{n_1 u_1}{u_2}$$

$$= \frac{170.474L}{M^3}$$

$$= \frac{170.474 \times 10^{-3} M^3}{M^3}$$

$= 0.170474$

53 **(a)**

Here,

Mass of a body, $M = 5.00 \pm 0.05\ kg$

Volume of a body, $V = 1.00 \pm 0.05 m^3$

Density, $\rho = \frac{M}{V}$

Relative error in density is

$$\frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + \frac{\Delta V}{V}$$

Percentage error in density is

$$\frac{\Delta\rho}{\rho} \times 100 = \frac{\Delta M}{M} \times 100 + \frac{\Delta V}{V} \times 100$$

$$= \left(\frac{0.05}{5} \times 100\right) + \left(\frac{0.05}{1} \times 100\right) = 1\% + 5\% = 6\%$$

54 **(a)**

$$\frac{R}{L} = \frac{V/I}{V \times T/I} = \frac{1}{T} = \text{Frequency}$$

55 **(a)**

Area of rectangle

$A = lb$

$= 10.5 \times 2.1$

$= 22.05\ cm^2$

Minimum possible measurement of scale =0.1 cm

So, area measured by scale = $22.0 cm^2$

56 **(d)**

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

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

57 **(a)**

By submitting dimension of each quantity in R.H.S. of option (a) we get

$$\left[\frac{mg}{\eta r}\right] = \left[\frac{M \times LT^{-2}}{ML^{-1}T^{-1} \times L}\right] = [LT^{-1}]$$

This option gives the dimension of velocity

58 **(a)**

$$Y = \frac{\text{Stress}}{\text{Strain}} = \frac{\text{Force/Area}}{\text{Dimensionless}} \Rightarrow Y \equiv \text{Pressure}$$

60 **(d)**

Given, $U = \frac{A\sqrt{x}}{x+B}$ ... (i)

Dimensions of U = dimensions of potential energy

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

From Eq. (i),

Dimensions of B = dimensions of $x = [\mathrm{M^0LT^0}]$

∴ Dimensions of A

$$= \frac{\text{dimensions of } U \times \text{dimensions of } (x+B)}{\text{dimension of } \sqrt{x}}$$

$$= \frac{[\mathrm{ML^2T^{-2}}][\mathrm{M^0LT^0}]}{[\mathrm{M^0L^{1/2}T^0}]}$$

$$= [\mathrm{ML^{5/2}T^{-2}}]$$

Hence, dimensions of AB

$$= [\mathrm{ML^{5/2}T^{-2}}][\mathrm{M^0LT^0}]$$

$$= [\mathrm{ML^{7/2}T^{-2}}]$$

61 **(b)**

$$L = \frac{\emptyset}{I} = \frac{Wb}{A} = Henry$$

62 **(c)**

$1\ nm = 10^{-9}\ m = 10^{-7} cm$

63 **(a)**

The dimension of $y = \frac{e^2}{4\pi\varepsilon_0 hc}$

Putting the dimensions of

$$[e] = [Q] = [\mathrm{AT}]$$

$$[\varepsilon_0] = [\mathrm{M^{-1}L^{-3}T^4A^2}], h = [\mathrm{ML^2T^{-1}}], c = [\mathrm{LT^{-1}}]$$

$$y = \frac{[\mathrm{A^2T^2}]}{[\mathrm{M^{-1}L^{-3}T^4A^2}][\mathrm{ML^2T^{-1}}][\mathrm{LT^{-1}}]}$$

$$y = [\mathrm{M^0L^0T^0}]$$

64 **(a)**

The unit of $\frac{1}{2}\varepsilon E^2 = \frac{\mathrm{C^2}}{\mathrm{Nm^2}}\left(\frac{\mathrm{N}}{\mathrm{C}}\right)^2$

$$= \frac{\mathrm{C^2}}{\mathrm{Nm^2}}\frac{\mathrm{N^2}}{\mathrm{C^2}} = \frac{\mathrm{N}}{\mathrm{m^2}} = \frac{\mathrm{Nm}}{\mathrm{m^3}}$$

$= \frac{\mathrm{J}}{\mathrm{m^3}}$ =energy density

65 **(d)**

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

66 **(a)**

Time period

$T \propto p^a \rho^b E^c$

Or, $T = kp^a \rho^b E^c$

k, is a dimensionless constant.

According to homogeneity of dimensions,

LHS=RHS

$\therefore \quad [\mathrm{T}] = [\mathrm{ML^{-1}T^{-2}}]^a[\mathrm{ML^{-3}}]^b[\mathrm{ML^2T^{-2}}]^c$

$[\mathrm{T}] = [\mathrm{M}^{a+b+c}][\mathrm{L}^{-a-3b+2c}][\mathrm{T}^{-2a-2c}]$

Comparing the powers, we obtain

$a + b + c = 0$

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

$-2a - 2c = 1$

On solving, we get

$a = -\frac{5}{6}, b = \frac{1}{2}, c = \frac{1}{3}$

67 **(b)**

$f = \frac{1}{2\pi\sqrt{LC}} \Rightarrow LC = \frac{1}{f^2} = [M^0L^0T^2]$

68 **(a)**

The result has to be in one significant umber only.

69 **(b)**

Positions $x = ka^m t^n$

$[\mathrm{M^0LT^0}] = [\mathrm{LT^{-2}}]^m[\mathrm{T}]^n$

$= [\mathrm{M^0L^mT^{-2m+n}}]$

On comparing both sides

$m = 1$

$-2m + n = 0$

$n = 2m$

$n = 2 \times 1 = 2$

70 **(a)**

Couple of force $= |\vec{r} \times \vec{F}| = [ML^2T^{-2}]$

Work $= [\vec{F}.\vec{d}] = [ML^2T^{-2}]$

71 **(a)**

Electric potential $V = \frac{W}{q} = \frac{\text{joule}}{\text{coulomb}} = \frac{\text{newton}\times\text{metre}}{\text{coulomb}}$

$= \frac{(\mathrm{kg - ms^{-2}}) \times \mathrm{m}}{\text{coulomb}}$

$= \mathrm{kg - ms^{-2}} \times \mathrm{m} \times \mathrm{coulomb^{-1}}$

$\therefore \quad = [\mathrm{ML^2T^{-2}Q^{-1}}]$

72 **(c)**

1 fermi $= 10^{-15}$ *metre*

73 **(d)**

$R_1 = (6 \pm 0.3)\mathrm{k\Omega}, R_2 = (10 \pm 0.2)\mathrm{k\Omega}$

$$R_{parallel} = \frac{R_1R_2}{(R_1 + R_2)}$$

Let $(R_1 + R_2) = x$

$\Rightarrow \qquad R_P = \dfrac{R_1R_2}{x}$

Taking log of both sides

$$\ln R_P = \ln R_1 + \ln R_2 - \ln x$$

Differentiating,

$$\frac{\Delta R_P}{R_P} = \frac{\Delta R_1}{R_1} + \frac{\Delta R_2}{R_2} + \left(-\frac{\Delta x}{x}\right)$$

$$\Delta x_{\text{mean}} = \frac{0.3 + 0.2}{2} = 0.25\ \Omega$$

$$R_{\text{mean}} = \frac{6 + 10}{2} = 8\ \Omega$$

$\therefore \qquad x = \dfrac{6+10}{2} = 8\ \Omega$

$\Rightarrow \qquad \dfrac{\Delta x}{x} = \dfrac{0.25}{8}$

$\therefore$ Total error $= \dfrac{0.3}{6} + \dfrac{0.2}{10} + \dfrac{0.25}{8}$

$= 0.05 + 0.02 + 0.03125 = 0.10125$

$\therefore \qquad \dfrac{\Delta R_P}{R_P} = 10.125\%$

74 **(b)**

From Coulomb's law

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$$

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

$\therefore$ Units of ε_0 (permittivity)

$$= \frac{\mathrm{C}^2}{\mathrm{N - m}^2} = \mathrm{C^2N^{-1}m^{-2}}$$

75 **(c)**

Resistivity, $\rho = \frac{m}{ne^2\tau}$

$\therefore [\rho] = \dfrac{[\mathrm{M}]}{[\mathrm{L^{-3}}][\mathrm{AT}][\mathrm{T^2}]}$

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

So, electrical conductivity

$$\sigma = \frac{1}{\rho}$$

$\Rightarrow \qquad [\sigma] = \dfrac{1}{[\rho]} = [\mathrm{M^{-1}L^{-3}A^2T^3}]$

76 **(d)**

$n(x\mathrm{m})^2 = 1\mathrm{m}^2$ or $n = \frac{1}{x^2}$

77 **(d)**

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

Since, LHS is equal to velocity, so at and $\frac{b}{t+c}$ must have the dimensions of velocity.

$\therefore \quad at = v$

Or $\quad a = \frac{v}{t} = \frac{[\mathrm{LT^{-1}}]}{[\mathrm{T}]} = [\mathrm{LT^{-2}}]$

Now, $\quad c = $ time $\quad$ ($\because$ like quantities are added)

$\therefore \quad c = t = [\mathrm{T}]$

Now,

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

$\therefore \quad b = v \times \text{time} = [\mathrm{LT^{-1}}][\mathrm{T}] = [\mathrm{L}]$

78 **(d)**

The second is the duration of 9192631770 period of the radiation corresponding to the transition between the two hyperfine levels of the ground state of cesium-133 atom. Therefore, 1 ns is 10^{-9} s of Cs-clock of 9192631770 oscillations.

80 **(b)**

We know that kinetic energy $= \frac{1}{2}mv^2$

Required percentage error is 2%+2× 3% ie, 8%

81 **(c)**

$30\ VSD = 29\ MSD$

$$1\ VSD = \frac{29}{30}\ MSD$$

Least count of vernier $= 1\ M.S.D. - 1\ V.S.D.$

$$= 0.5° - \frac{29}{30} \times 0.5° = \frac{0.5°}{30}$$

Reading of vernier $=$ M.S. reading $+$ V.S. reading $\times\ L.C.$

$$= 58.5° + 9 \times \frac{0.5°}{30} = 58.65$$

82 **(a)**

We know that the dimensional formula of energy is $[\mathrm{ML^2T^{-2}}]$

$$n_2 = 1[\left[\frac{1\mathrm{kg}}{10\mathrm{kg}}\right]^1 \left[\frac{1\mathrm{m}}{1\mathrm{km}}\right] \left[\frac{1\mathrm{s}}{1\ \mathrm{min}}\right]^2$$

$$= \frac{1}{10} \times \frac{1}{10^6} \times \frac{1}{(60)^{-2}} = \frac{3600}{10^7} = 3.6 \times 10^{-4}$$

83 **(a)**

Let $h \propto G^x L^y E^z$

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

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

Comparing the powers, we get

$$1 = -x + y + z \quad \text{... (i)}$$

$$2 = 3x + 2y + 2z \quad \text{... (ii)}$$

$$-1 = -2x - y - 2z \quad \text{... (iii)}$$

On solving Eqs. (i), (ii) and (iii), we get

$$x = 0$$

∴ Gravitational constant has no dimensions

85 **(c)**

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

86 **(b)**

Unit of $\varepsilon_0 = C^2/N - m^2$ ∴ Unit of $K = Nm^2C^{-2}$

87 **(a)**

Let $n = k\rho^a a^b T^c$ where $[\rho] = [ML^{-3}]$, $[a] = [L]$ and $[T] = [MT^{-2}]$

Comparing dimensions both sides we get

$a = \frac{-1}{2}, b = \frac{-3}{2}$ and $c = \frac{1}{2}$ $\therefore \eta = k\rho^{-1/2}a^{-3/2}T^{-1/2}$

$$= \frac{K\sqrt{T}}{\rho^{1/2}a^{3/2}}$$

88 **(c)**

$$F = \frac{Gm_1m_2}{d^2};\ \therefore\ G = \frac{Fd^2}{m_1m_2} = Nm^2/kg^2$$

90 **(a)**

$X = [M^aL^bT^c]$

Maximum % error in $X = a\alpha + b\beta + c\gamma$

91 **(a)**

Angular velocity $= \frac{\theta}{t}, [\omega] = \frac{[M^0L^0T^0]}{[T]} = [T^{-1}]$

92 **(d)**

$$\text{Diameter} = \text{Main scale reading} + \text{Circular scale reading} \times \text{LC} + \text{Zero error}$$

$$= 3 + 35 \times \frac{1}{2 \times 50} + 0.03 = 3.38 \text{ mm}$$

93 **(a)**

Required relative error=power × relative error in x.

94 **(a)**

$30\ VSD = 29\ MSD$

$$1\ VSD = \frac{29}{30}\ MSD$$

$L.C. = 1\ MSD - 1\ VSD$

$= \left(1 - \frac{29}{30}\right)\ MSD = \frac{1}{30} \times 0.5° = 1 \text{ minute}$

95 **(d)**

The number of significant figures in 4.8000×10^4 is 5 (zeros on right after decimal are counted while zeros in powers of 10 are not counted).

The number of significant figures in 48000.50 is 7 (all the zeros between two non-zero digits are significant).

96 **(d)**

Unit of $e.m.f. = volt = joule/coulomb$

97 **(a)**

Dimensionally. $\left[\frac{b}{t}\right] = [v]$ or $[b] = [vt] = [\text{L}]$.

99 **(d)**

As $v = \frac{4}{3}\pi r^3$

$$\frac{dv}{v} = 3\left(\frac{dr}{r}\right)$$

∴ Percentage error in determination of volume = 3

(Percentage error in measurement of radius) = 3(2%) = 6%

100 **(b)**

Intensity of radiation $= \frac{\text{Radiation Energy}}{\text{Area} \times \text{time}}$

$$\Rightarrow I = \frac{[ML^2T^{-2}]}{[L^2 \times T]} = [ML^0T^{-3}]$$

102 **(c)**

Area of cross section $= \frac{22}{7} \times 0.24 \times 0.24\text{mm}^2 = 018\text{mm}^2$

103 **(c)**

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

104 **(a)**

Time defined in terms of the rotation of the earth is called universal time (UT).

105 **(a)**

Let $v \propto \sigma^a \rho^b \lambda^c$

Equating dimensions on both sides,

$[M^0L^1T^{-1}] \propto [MT^{-2}]^a[ML^{-3}]^b[L]^c$

$\propto [M]^{a+b}[L]^{-3b+c}[T]^{-2a}$

Equating the powers of M, L, T on both sides, we get

$a + b = 0$

$-3b + c = 1$

$-2a = -1$

Solving, we get

$a = \frac{1}{2}, b = -\frac{1}{2}, c = -\frac{1}{2}$

$\therefore\ v \propto \sigma^{1/2}\, \rho^{-1/2}\, \lambda^{-1/2}$

$\therefore\ v^2 \propto \frac{\sigma}{\rho\lambda}$

106 **(c)**

Quantity C has maximum power. So it brings maximum error in P

107 **(a)**

Let $v \propto \sigma^a \rho^b \lambda^c$

Equating dimensions on both sides.

$$[M^0LT^{-1}] \propto [MT^{-2}]^a[ML^{-3}]^b[L]^c$$
$$\propto [M]^{a+b}[L]^{-3b+c}[T]^{-2a}$$

Equating the powers of M, L, T on both sides, we get

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

Solving, we get

$$a = \frac{1}{2}, b = -\frac{1}{2}, c = -\frac{1}{2}$$

$\therefore$ $v \propto \sigma^{1/2}\rho^{-1/2}\lambda^{-1/2}$

$\therefore$ $v^2 \propto \frac{\sigma}{\rho\lambda}$

108 **(c)**

Einstein's mass-energy equivalence is $E = mc^2$.

109 **(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.

110 **(b)**

One light year

$= 3 \times 10^8$ m/s year

$= \frac{3\times10^8}{s} \times 365 \times 24 \times 60 \times 60s$

$= 3 \times 10^8 \times 365 \times 24 \times 60 \times 60\text{m}$
$= 9.461 \times 10^{15}\text{m}$

111 **(b)**
$(2.3 + 0.035 + 0.035)$g=2.37 g
But we have to retain only one decimal place.
So, the total mass is 2.4 g.

112 **(d)**
$P = \frac{F}{A} = \frac{F}{l^2}$, so maximum error in pressure (P)
$$\left(\frac{\Delta P}{P} \times 100\right)_{\text{max}} = \frac{\Delta F}{F} \times 100 + 2\frac{\Delta l}{l} \times 100$$
$= 4\% + 2 \times 2\% = 8\%$

113 **(c)**
Impulse = Force × time = $(kg - m/s^2) \times s = kg\text{-}m/s$

114 **(b)**
The action of impulse is to change the momentum of a body or particle and the impulse of force is equal to the change in momentum.
Thus, the dimensions of impulse are same as that of momentum.

115 **(b)**
Solar constant is energy received per unit area per unit time i.e. $\frac{[ML^2T^{-2}]}{[L^2][T]} = [M^1T^{-3}]$

116 **(b)**
$\frac{\text{Energy}}{\text{Volume}} = \frac{ML^2T^{-2}}{L^3} = [ML^{-1}T^{-2}] = \text{Pressure}$

117 **(c)**
S_{nth} represents the distance covered in nth sec.

118 **(a)**
$$\frac{h}{I} = \left[\frac{ML^2T^{-1}}{ML^2}\right] = [T^{-1}]$$

119 **(d)**
Volume $\times r^3$
So, error is $3 \times 2\% = 6\%$

120 **(d)**
$\because$ Density, $\rho = \frac{M}{V} = \frac{M}{\pi\gamma^2 L}$
$$\Rightarrow \frac{\Delta\rho}{\rho} = \frac{\Delta M}{M} + 2\frac{\Delta r}{r} + \frac{\Delta L}{L}$$
$$= \frac{0.003}{0.3} + 2 \times \frac{0.005}{0.5} + \frac{0.06}{6}$$
$= 0.01 + 0.02 + 0.01 = 0.04$
$$\therefore \text{Percentage error} = \frac{\Delta\rho}{\rho} \times 100 = 0.04 \times 100 = 4\%$$

121 **(c)**
$$x = \frac{1\text{gcms}^{-1}}{\text{T}^2} = \frac{1\text{gcms}^{-1}}{1\text{kg} \times 1\text{ms}^{-1} \times 1\text{s}}$$
$$= \frac{1\text{gcms}^{-1}}{10^3\text{g} \times 10^2\text{cms}^2 \times 1\text{s}} = 10^{-5}$$

122 **(b)**
$1\ kWh = 1 \times 10^3 \times 3600\ W \times \text{sec} = 36 \times 10^5\ J$

123 **(a)**

Percentage error in $X = a\alpha + b\beta + c\gamma$

124 **(b)**

By substituting the dimension of given quantities

$$[ML^{-1}T^{-2}]^x[MT^{-3}]^y[LT^{-1}]^z = [MLT]^0$$

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

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

$-x + z = 0$ ...(ii)

$-2x - 3y - z = 0$ ...(iii)

The only values of x, y, z satisfying (i), (ii) and (iii) corresponds to (b)

125 **(b)**

Let $m \propto E^x v^y F^z$

By substituting the following dimensions:

$E = [ML^2T^{-2}], [v] = [LT^{-1}], [F] = [MLT^{-2}]$

and by equating the both sides

$x = 1, y = -2, z = 0$. So $[m] = [Ev^{-2}]$

126 **(a)**

Given that,

Time period, $T \propto p^a d^b E^c$ ... (i)

The dimensions of these quantities are given as

$$p = [\mathrm{ML^{-1}T^{-2}}]$$
$$d = [\mathrm{ML^{-3}}]$$
$$E = [\mathrm{ML^2T^{-2}}]$$

In Eq. (i), on writing the dimensions on both sides.

$[\mathrm{M^0L^0T}] \propto [\mathrm{ML^{-1}T^{-2}}]^a[\mathrm{ML^{-3}}]^b[\mathrm{ML^2T^{-2}}]^c$

$\Rightarrow [\mathrm{M^0L^0T}] \propto [\mathrm{M}^{a+b+c}\mathrm{L}^{-a-3b+2c}\mathrm{T}^{-2a-2c}]$

On comparing the powers of M, L, T on both sides.

$\Rightarrow \quad a + b + c = 0$ ... (ii)

$-a - 3b + 2c = 0$ ... (iii)

$-2a - 2c = 1$ ... (iv)

Solving, we get value of a, b and c, $-\frac{5}{6}, \frac{1}{2}$ and $\frac{1}{3}$ repectively.

127 **(b)**

The difference in the sidereal year and solar year is about 1 day (or $24 \times 60 = 1440$ min)

$\therefore$ Difference in sidereal day and solar day is about $\frac{1440}{365} \cong 4$ min

i.e., sidereal day is 4 min smaller than the solar day

128 **(d)**

ct^2 must have dimensions of L

$\Rightarrow c$ must have dimensions of L/T^2 *i.e.* LT^{-2}

129 **(d)**

Angular momentum,

$$[J] = [I\omega] = [\mathrm{ML^2T^{-1}}]$$

Planck's constant, $[h] = \frac{[E]}{[v]} = [\mathrm{ML^2T^{-1}}]$

130 **(a)**

$F = \dfrac{dp}{dt} \Rightarrow dp = Fdt$

131 **(a)**

Angle of banking: $\tan\theta = \frac{v^2}{rg}$. i.e. $\frac{v^2}{rg}$ is dimensionless

132 **(a)**

Stefan's constant

$$\sigma = \frac{\text{Energy}}{\text{Area } \times \text{Time } \times (\text{Temperature})^4}$$

$$\therefore\ \sigma = \frac{[ML^2T^{-2}]}{[L^2][T][K]^4} = [ML^0T^{-3}K^{-4}] = [MT^{-3}K^{-4}]$$

133 **(a)**

Momentum $= mv = [MLT^{-1}]$

Impulse $=$ Force $\times$ Time $= [MLT^{-2}] \times [T] = [MLT^{-1}]$

135 **(c)**

Linear momentum $= [\text{MLT}^{-1}]$

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

137 **(b)**

By Stefan's law,

$$E = \sigma T^4$$

Where σ is the Stefan's constant

$$\sigma = \frac{E}{T^4}$$

$$[\sigma] = \frac{[E]}{T^4} = \frac{[\text{ML}^2\text{T}^{-2}]}{[\text{K}^4]}$$

$$= [\text{ML}^2\text{T}^{-2}\ \text{K}^{-4}]$$

139 **(c)**

As $I = MR^2 = kg - m^2$

141 **(b)**

Force $=$ Mass $\times$ acceleration

$\therefore$ Dimensions of force $= [\text{M}][\text{LT}^{-2}] = [\text{MLT}^{-2}]$

$$\text{Power} = \frac{\text{Work}}{\text{Time}}$$

$\therefore$ Dimensions of power $= \frac{[\text{ML}^2\text{T}^{-2}]}{[\text{T}]} = [\text{ML}^2\text{T}^{-3}]$

Torque $=$ Force $\times$ displacement

$\therefore$ Dimensions of torque

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

And dimensions of energy $= [\text{ML}^2\text{T}^{-2}]$

Hence, torque and energy have same dimensions.

142 **(c)**

$$\text{KE} = \frac{1}{2}mv^2$$

$\therefore$ $[\text{KE}] = [\text{M}][\text{LT}^{-1}]^2 = [\text{ML}^2\text{T}^{-2}]$

143 **(d)**

Velocity gradient $= \frac{v}{x} = \frac{[LT^{-1}]}{[L]} = [T^{-1}]$

Potential gradient $= \frac{V}{x} = \frac{[ML^2T^{-3}A^{-1}]}{[L]} = [MLT^{-3}A^{-1}]$

Energy gradient $= \frac{E}{x} = \frac{[ML^2T^2]}{[L]} = [MLT^{-2}]$

And pressure gradient $= \frac{P}{x} = \frac{[ML^{-1}T^{-2}]}{[L]} = [ML^{-2}T^{-2}]$

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 1 to 0. 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

1 **Statement 1:** The unit used for measuring nuclear cross section is 'barn'.
Statement 2: 1 barn $= 10^{-14}$ m^2.

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

3 **Statement 1:** In $y = A\sin(\omega t - kx)$, $(\omega t - kx)$ is dimensionless
Statement 2: Because dimension of $\omega = [M^0 L^0 T]$

4 **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

5 **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

6 **Statement 1:** Avogadro number is not a dimensionless constant.
Statement 2: It is number of atoms is one gram mole.

7 **Statement 1:** The light year and wavelength consist of dimensions of length.
Statement 2: Both light year and wavelength represent distances.

8 **Statement 1:** Mass, length and time are fundamental physical quantities
Statement 2: They are independent of each other

9 **Statement 1:** The unit used for measuring nuclear cross-section is barn.
Statement 2: 1 barn$=10^{-4}m^2$.

10 **Statement 1:** Linear mass density has the dimensions of $[M^1 L^{-1} T^0]$
Statement 2: Because density is always mass per unit per volume

11 **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

12 **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

13 **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

14 **Statement 1:** The size of the nucleus of an atom is not very small
Statement 2: One Fermi is equal to $10^{-12}\ m$.

15 **Statement 1:** Avogadro number is the number of atoms in one gram mole
Statement 2: Avogadro number is a dimensionless constant

16 **Statement 1:** Surface tension and surface energy have the same dimensions
Statement 2: Because both have the same S.I unit

17 **Statement 1:** AU is much bigger than Å.
Statement 2: 1 AU=1.5× $10^{11}\ m\ and$ 1 Å $= 10^{-10}\ m$.

18 **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.

19 **Statement 1:** A.U. is much bigger than Å
Statement 2: A.U. stands for astronomical unit and Å stands from *Angstrom*

20 **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

21 **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

22 **Statement 1:** Force cannot be added to pressure
Statement 2: Because their dimensions are different

23 **Statement 1:** 'Light year' and 'Wavelength' both measure distance
Statement 2: Both have dimensions of time

24 **Statement 1:** Impulse has the dimensions of force.
Statement 2: Impulse=force×time.

25 **Statement 1:** Dimensional constants are the quantities whose values are constant
Statement 2: Dimensional constants are dimensionless

26 **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 $\frac{\Delta A}{A} = \frac{4\Delta R}{r}$

27 **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 $= \frac{\text{distance}}{\text{time}}$

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

Statement 2: Rate of flow is velocity/sec.

29 **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

: ANSWER KEY :

1)	c	2)	a	3)	c	4)	a	5)	c	6)	a	7)	a	8)	a
9)	c	10)	c	11)	b	12)	a	13)	d	14)	d	15)	c	16)	c
17)	a	18)	c	19)	b	20)	b	21)	a	22)	a	23)	c	24)	d
25)	c	26)	c	27)	b	28)	c	29)	c						

: HINTS AND SOLUTIONS :

1 **(c)**

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

2 **(a)**

Both assertion and reason are true and the reason is correct explanation of the assertion.

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

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

3 **(c)**

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

5 **(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 $Q_1=n_1u_1=n_2u_2$, $nu=$ constant $\Rightarrow n\propto 1/u$ $i.e.$, smaller the unit of measurement, greater is its numerical value

6 **(a)**

Avogadro number has the unit per gram mole. So, it is not diamensionless.

7 **(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 $[\text{M}^{\circ}LT^{\circ}]$. So, both represent distances.

8 **(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

9 **(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.

10 **(c)**

Density is not always mass per unit volume

11 **(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

12 **(a)**

According to statement of reason, as the graph is a straight line, $P\propto Q$, or $P=\text{constant}\ \times$ Q

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

13 **(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

14 **(d)**

The radius of the nucleus of an atom is of the order of 1 fermi.

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

15 **(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}

16 **(c)**

As surface tension and surface energy both have different S.I. unit and same dimensional formula

17 **(a)**

Au is an astronomical unit. This is the mean distance between earth and sun

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

Å *is angstrom units 1* Å$=10^{-10}m$

18 **(c)**

From $n = \frac{1}{2l}\sqrt{\frac{T}{m}}, n^2 = \frac{T}{4l^2m}$

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

$=$ linear mass density

19 **(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.$= 1.5 \times 10^{-11}m$; $1\text{Å} = 10^{-10}m$

20 **(b)**

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

21 **(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

22 **(a)**

Addition and subtraction can be done between quantities having same dimensions

23 **(c)**

Light year and wavelength both represent the distance, so both have dimensions of length not of time

24 **(d)**

Impulse $=$ Force $\times$ time

$\therefore$ Impulse has no dimension of force

25 **(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

26 **(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

27 **(b)**

Both the assertion and reason are true. But reason is not the correct explanation of the assertion. In fact,

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

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

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

28 **(c)**

The assertion is true, but the reason is false.

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

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

29 **(c)**

Because representation of standard metre in terms of wavelength of light is most accurate

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**.

1. 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

2. 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) $(\text{metre})^3$ $(\text{second})^{-2}$
(C)	$\frac{F^2}{q^2B^2}$ $F -$ force, $q -$ charge, $B -$ magnetic field	(r)	$(\text{metre})^2$ $(\text{second})^{-2}$
(D)	$\frac{GM_e}{R_e}$ $G -$ universal gravitational constant, $M_e -$ mass of earth $R_e -$ radius of earth	(s)	$(\text{Farad})(\text{volt})^2(\text{kg})^{-1}$

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

3. 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

4. Match the following

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

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

5. 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

6. 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)	$\text{Coulomb}^2\text{-joule}^{-1}$
(C)	Magnetic induction	(r)	Coulomb $(\text{volt})^{-1}$

(s) Newton (ampere metre)$^{-1}$

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

CODES :

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

: ANSWER KEY :

1)	d	2)	b	3)	b	4)	b	5)	d	6)	a				

: HINTS AND SOLUTIONS :

1 **(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 $Wm^{-1}K^{-1}$

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

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

2 **(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) $\left.\frac{3RT}{M}\right\}\ \upsilon = \sqrt{\frac{3RT}{M}}$; $\therefore \frac{3RT}{M} = \upsilon^2$

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

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

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

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

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

Thus compare the dimension

5 **(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,

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

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

6 **(a)**

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

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

(C) Magnetic induction – Newton$(\text{ampere} - \text{metre})^{-1}$

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 $F = IlB \sin\theta$