Topicwise Questions

UNIT AND DIMENSIONS

Units, System of Units

1. A unit less quantity
(*a*) never has a nonzero dimension
(*b*) always has a nonzero dimension
(*c*) may have a nonzero dimension
(*d*) does not exit

2. Which of the following is not the name of a physical quantity?
(*a*) kilogram (*b*) impulse
(*c*) energy (*d*) density

3. PARSEC is a unit of
(*a*) Time (*b*) Angle
(*c*) Distance (*d*) Velocity

4. Which of the following system of units is NOT based on the unit of mass, length and time alone
(*a*) FPS (*b*) SI (*c*) CGS (*d*) MKS

5. In the S.I. system the unit of energy is-
(*a*) erg (*b*) calorie
(*c*) joule (*d*) electron volt

6. The SI unit of the universal gravitational constant G is
(*a*) $Nm\,kg^{-2}$ (*b*) Nm^2kg^{-2} (*c*) $Nm^2\,kg^{-1}$ (*d*) $Nmkg^{-1}$

7. Surface tension has unit of-
(*a*) $Joule.m^2$ (*b*) $Joule.m^{-2}$ (*c*) $Joule.m^{-1}$ (*d*) $Joule.m^3$

8. The specific resistance has the unit of-
(*a*) ohm/m (*b*) ohm/m^2 (*c*) $ohm.m^2$ (*d*) ohm.m

9. The unit of magnetic moment is-
(*a*) $amp\,m^2$ (*b*) $amp\,m^{-2}$ (*c*) amp m (*d*) $amp\,m^{-1}$

10. The SI unit of the universal gas constant R is:
(*a*) $erg\,K^{-1}\,mol^{-1}$ (*b*) $watt\,K^{-1}\,mol^{-1}$
(*c*) $newton\,K^{-1}\,mol^{-1}$ (*d*) $joule\,K^{-1}\,mol^{-1}$

11. The SI unit of Stefan's constant is:
(*a*) $Ws^{-1}\,m^{-2}\,K^{-4}$ (*b*) $J\,s\,m^{-1}\,K^{-1}$
(*c*) $J\,s^{-1}\,m^{-2}\,K^{-1}$ (*d*) $W\,m^{-2}\,K^{-4}$

Dimension, Finding Dimensional Formula

12. In SI unit the angular acceleration has unit of-
(*a*) $Nmkg^{-1}$ (*b*) ms^{-2}
(*c*) $rad.s^{-2}$ (*d*) Nkg^{-1}

13. The angular frequency is measured in rad s^{-1}. Its exponent in length are:
(*a*) – 2 (*b*) –1
(*c*) 0 (*d*) 2

14. $[M\,L\,T^{-1}]$ are the dimensions of-
(*a*) power (*b*) momentum
(*c*) force (*d*) couple

15. What are the dimensions of Boltzmann's constant?
(*a*) $MLT^{-2}K^{-1}$ (*b*) $ML^2T^{-2}K^{-1}$
(*c*) M^0LT^{-2} (*d*) $M^0L^2T^{-2}K^{-1}$

16. A pair of physical quantities having the same dimensional formula is:
(*a*) angular momentum and torque
(*b*) torque and energy
(*c*) force and power
(*d*) power and angular momentum

17. Which one of the following has the dimensions of $ML^{-1}T^{-2}$?
(*a*) torque (*b*) surface tension
(*c*) viscosity (*d*) stress

Principle of Homogeneity of Dimension

18. Force F is given in terms of time t and distance x by $F = A \sin C t + B \cos D x$ Then the dimensions of $\frac{A}{B}$ and $\frac{C}{D}$ are given by
(*a*) MLT^{-2}, $M^0L^0T^{-1}$
(*b*) MLT^{-2}, $M^0L^{-1}T^0$
(*c*) $M^0L^0T^0$, $M^0L^1T^{-1}$
(*d*) $M^0L^1T^{-1}$, $M^0L^0T^0$

19. $\int \frac{x dx}{\sqrt{2ax - x^2}} = a^n \sin^{-1}\left[\frac{x}{a} - 1\right]$. The value of n is:

You may use dimensional analysis to solve the problem.
(*a*) 0
(*b*) –1
(*c*) 1
(*d*) None of these

20. The equation for the velocity of sound in a gas states that $v = \sqrt{\gamma k_b \frac{T}{m}}$. Velocity v is measured in m/s. γ is a dimensionless constant, T is temperature in kelvin (K), and m is mass in kg. What are the units for the Boltzmann constant, k_b ?

(*a*) $kg \cdot m^2 \cdot s^{-2} \cdot K^{-1}$ (*b*) $kg \cdot m^2 \cdot s^2 \cdot K$
(*c*) $kg \cdot m/s \cdot K^{-2}$ (*d*) $kg \cdot m^2 \cdot s^{-2} \cdot K$

21. A wave is represented by
$y = a \sin(At - Bx + C)$
where A, B, C are constants and t is in seconds & x is in metre. The Dimensions of A, B, C are-

(*a*) $T^{-1}, L, M^0L^0T^0$ (*b*) $T^{-1}, L^{-1}, M^0L^0T^0$
(*c*) T, L, M (*d*) T^{-1}, L^{-1}, M^{-1}

22. If $v = \sqrt{\frac{\gamma p}{\rho}}$, then the dimensions of γ are (p is pressure, ρ is density and v is speed of sound has their usual dimension) -

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

23. Consider the equation $\frac{d}{dt}\left[\int \vec{F} \cdot d\vec{s}\right] = A\left[\vec{F} \cdot \vec{P}\right]$. Then dimension of A will be (where $\vec{F} \equiv$ force, $d\vec{s} \equiv$ small displacement, $t \equiv$ time and $\vec{P} \equiv$ linear momentum).

(*a*) $M^oL^oT^o$ (*b*) $M^1L^oT^o$
(*c*) $M^{-1}L^oT^o$ (*d*) $M^oL^oT^{-1}$

Application of Dimensional Analysis: Deriving New Relation

24. The velocity of water waves may depend on their wavelength λ, the density of water ρ and the acceleration due to gravity g. The method of dimensions gives the relation between these quantities aswhere k is a dimensionless constant

(*a*) $v^2 = k\lambda^{-1} g^{-1} \rho^{-1}$ (*b*) $v^2 = k g \lambda$
(*c*) $v^2 = k g \lambda \rho$ (*d*) $v^2 = k \lambda^3 g^{-1} \rho^{-1}$

25. Force applied by water stream depends on density of water (ρ), velocity of the stream (v) and cross–sectional area of the stream (*a*). The expression of the force should be

(*a*) $\rho A v$ (*b*) $\rho A v^2$ (*c*) $\rho^2 A v$ (*d*) $\rho A^2 v$

Application of Dimensional Analysis: To Convert from one System of Unit

26. One watt-hour is equivalent to

(*a*) 6.3×10^3 Joule (*b*) 6.3×10^{-7} Joule
(*c*) 3.6×10^3 Joule (*d*) 3.6×10^{-3} Joule

27. The pressure of 10^6 dyne/cm² is equivalent to

(*a*) 10^5 N/m² (*b*) 10^6 N/m² (*c*) 10^7 N/m² (*d*) 10^8 N/m²

28. $\rho = 2$ g/cm³ convert it into MKS system-

(*a*) $2 \times 10^{-3} \frac{kg}{m^3}$ (*b*) $2 \times 10^3 \frac{kg}{m^3}$
(*c*) $4 \times 10^3 \frac{kg}{m^3}$ (*d*) $2 \times 10^6 \frac{kg}{m^3}$

29. The density of mercury is 13600 kg m^{-3}. Its value of CGS system will be:

(*a*) 13.6 g cm^{-3} (*b*) 1360 g cm^{-3}
(*c*) 136 g cm^{-3} (*d*) 1.36 g cm^{-3}

ERRORS IN MEASUREMENT

30. Which of the following measurements is most accurate ?

(*a*) 9×10^{-2} m (*b*) 90×10^{-3} m
(*c*) 900×10^{-4} m (*d*) 0.090 m

31. A system takes 70.40 second to complete 20 oscillations. The time period of the system is–

(*a*) 3.52 s (*b*) 35.2 × 10 s
(*c*) 3.520 s (*d*) 3.5200 s

32. The percentage error in the measurement of mass and speed are 1% and 2% respectively. What is the percentage error in kinetic energy–

(*a*) 5% (*b*) 2.5% (*c*) 3% (*d*) 1.5%

33. Number 15462 when rounded off to numbers to three significant digits will be-

(*a*) 15500 (*b*) 155
(*c*) 1546 (*d*) 150

34. Value of expression $\frac{25.2 \times 1374}{33.3}$ will be.

(All the digits in this expression are significant.)

(*a*) 1040 (*b*) 1039 (*c*) 1038 (*d*) 1041

35. Value of 24.36 + 0.0623 + 256.2 will be-

(*a*) 280.6 (*b*) 280.8 (*c*) 280.7 (*d*) 280.6224

36. 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 the kinetic energy obtained by measuring mass and speed

(*a*) 11% (*b*) 8% (*c*) 5% (*d*) 1%

37. The random error in the arithmetic mean of 100 observations is x; then random error in the arithmetic mean of 400 observations would be

(*a*) $4x$ (*b*) $\frac{1}{4}x$

(*c*) $2x$ (*d*) $\frac{1}{2}x$

38. What is the number of significant figures in 0.310×10^3

(*a*) 2 (*b*) 3 (*c*) 4 (*d*) 6

39. Error in the measurement of radius of a sphere is 1%. The error in the calculated value of its volume is

(*a*) 1% (*b*) 3% (*c*) 5% (*d*) 7%

40. The mean time period of *second*'s pendulum is 2.00*s* and mean absolute error in the time period is 0.05*s*. To express maximum estimate of error, the time period should be written as

(*a*) $(2.00 \pm 0.01)\,s$ (*b*) $(2.00 + 0.025)\,s$

(*c*) $(2.00 \pm 0.05)\,s$ (*d*) $(2.00 \pm 0.10)\,s$

41. The unit of percentage error is

(*a*) Same as that of physical quantity

(*b*) Different from that of physical quantity

(*c*) Percentage error is unit less

(*d*) Errors have got their own units which are different from that of physical quantity measured

42. The decimal equivalent of 1/20 upto three significant figures is

(*a*) 0.0500 (*b*) 0.05000 (*c*) 0.0050 (*d*) 5.0×10^{-2}

43. Accuracy of measurement is determined by

(*a*) Absolute error (*b*) Percentage error

(*c*) Both (*a*) and (*b*) (*d*) None of these

44. A thin copper wire of length *l metre* increases in length by 2% when heated through 10ºC. What is the percentage increase in area when a square copper sheet of length *l metre* is heated through 10º*C*

(*a*) 4% (*b*) 8% (*c*) 16% (*d*) 32 %

45. In a vernier callipers, ten smallest divisions of the vernier scale are equal to nine smallest division on the main scale. If the smallest division on the main scale is half millimeter, then the vernier constant is–

(*a*) 0.5 mm (*b*) 0.1 mm (*c*) 0.05 mm (*d*) 0.005 mm

46. A vernier calliper has 20 divisions on the vernier scale, which coincide with 19 on the main scale. The least count of the instrument is 0.1 mm. The main scale divisions are of–

(*a*) 0.5 mm (*b*) 1 mm

(*c*) 2 mm (*d*) 1/4 mm

47. A vernier callipers having 1 main scale division = 0.1 cm is designed to have a least count of 0.02 cm. If n be the number of divisions on vernier scale and m be the length of vernier scale, then

(*a*) n = 10, m = 0.5 cm (*b*) n = 9, m = 0.4 cm

(*c*) n = 10, m = 0.8 cm (*d*) n = 10, m = 0.2 cm

Learning Plus

UNIT AND DIMENSIONS

1. Which of the following is not the unit of time

(*a*) solar day (*b*) parallactic second

(*c*) leap year (*d*) lunar month

2. The unit of impulse is the same as that of:

(*a*) moment force

(*b*) linear momentum

(*c*) rate of change of linear momentum

(*d*) force

3. Which of the following is not the unit of energy?

(*a*) watt-hour

(*b*) electron-volt

(*c*) N × m

(*d*) kg × m/sec^2

4. A dimensionless quantity:

(*a*) never has a unit

(*b*) always has a unit

(*c*) may have a unit

(*d*) does not exit

5. If a and b are two physical quantities having different dimensions then which of the following can denote a new physical quantity

(*a*) a + b

(*b*) a – b

(*c*) a/b

(*d*) $e^{a/b}$

6. The time dependence of a physical quantity ?
$P = P_0 exp(-\alpha t^2)$ where α is a constant and t is timeThe constant α
(*a*) will be dimensionless
(*b*) will have dimensions of T^{-2}
(*c*) will have dimensions as that of P
(*d*) will have dimensions equal to the dimension of P multiplied by T^{-2}

7. Which pair of following quantities has dimensions different from each other.
(*a*) Impulse and linear momentum
(*b*) Plank's constant and angular momentum
(*c*) Moment of inertia and moment of force
(*d*) Young's modulus and pressure

8. The product of energy and time is called action. The dimensional formula for action is same as that for
(*a*) power (*b*) angular energy
(*c*) force × velocity (*d*) impulse × distance

9. What is the physical quantity whose dimensions are $[M L^2 T^{-2}]$?
(*a*) kinetic energy (*b*) pressure
(*c*) momentum (*d*) power

10. If E, M, J and G denote energy, mass, angular momentum and gravitational constant respectively, then $\frac{EJ^2}{M^5G^2}$ has the dimensions of
(*a*) length (*b*) angle (*c*) mass (*d*) time

11. The position of a particle at time 't' is given by the relation $x(t) = \frac{V_0}{\alpha}[1 - e^{-\alpha t}]$ where V_0 is a constant and $\alpha > 0$. The dimensions of V_0 and α are respectively.
(*a*) $M^0L^1T^0$ and T^{-1} (*b*) $M^0L^1T^0$ and T^{-2}
(*c*) $M^0L^1T^{-1}$ and T^{-1} (*d*) $M^0L^1T^{-1}$ and T^{-2}

12. If force (F) is given by $F = Pt^{-1} + \alpha t$, where t is time. The unit of P is same as that of
(*a*) velocity (*b*) displacement
(*c*) acceleration (*d*) momentum

13. When a wave traverses a medium, the displacement of a particle located at x at time t is given by $y = a \sin (bt - cx)$ where a, b and c are constants of the wave. The dimensions of b are the same as those of
(*a*) wave velocity (*b*) amplitude
(*c*) wavelength (*d*) wave frequency

14. In a book, the answer for a particular question is expressed as $b = \frac{ma}{k}\left[\sqrt{1 + \frac{2kl}{ma}}\right]$ here m represents mass, a represents accelerations, *l* represents length. The unit of b should be
(*a*) m/s (*b*) m/s^2
(*c*) meter (*d*) /sec

15. $\alpha = \frac{F}{V^2}\sin(\beta t)$ (here V = velocity, F = force, t = time) :
Find the dimension of α and β -
(*a*) $\alpha = [M^1L^1T^0]$, $\beta = [T^{-1}]$
(*b*) $\alpha = [M^1L^1T^{-1}]$, $\beta = [T^1]$
(*c*) $\alpha = [M^1L^1T^{-1}]$, $\beta = [T^{-1}]$
(*d*) $\alpha = [M^1L^{-1}T^0]$, $\beta = [T^{-1}]$

16. If force, acceleration and time are taken as fundamental quantities, then the dimensions of length will be:
(*a*) FT^2 (*b*) $F^{-1} A^2 T^{-1}$ (*c*) FA^2T (*d*) AT^2

17. If area (*A*) velocity (v) and density (ρ) are base units, then the dimensional formula of force can be represented as
(*a*) $Av\rho$ (*b*) $Av^2\rho$
(*c*) $Av\rho^2$ (*d*) $A^2v\rho$

18. The velocity of a freely falling body changes as $g^p h^q$ where g is acceleration due to gravity and h is the height. The values of p and q are:
(*a*) $1, \frac{1}{2}$ (*b*) $\frac{1}{2}, \frac{1}{2}$
(*c*) $\frac{1}{2}, 1$ (*d*) 1, 1

19. If the unit of length is micrometer and the unit of time is microsecond, the unit of velcoity will be:
(*a*) 100 m/s (*b*) 10 m/s
(*c*) micrometers (*d*) m/s

20. In a certain system of units, 1 unit of time is 5 sec, 1 unit of mass is 20 kg and unit of length is 10m. In this system, one unit of power will correspond to
(*a*) 16 watts (*b*) 1/16 watts
(*c*) 25 watts (*d*) none of these

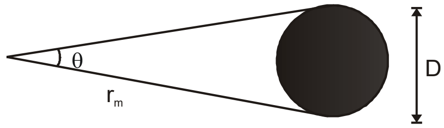
21. If the unit of force is 1 kilonewton, the length is 1 km and time is 100 second, what will be the unit of mass:
(*a*) 1000 kg (*b*) 10 kg
(*c*) 10000 kg (*d*) 100 kg

22. The units of length, velocity and force are doubled. Which of the following is the correct change in the other units?
(*a*) unit of time is doubled
(*b*) unit of mass is doubled
(*c*) unit of momentum is doubled
(*d*) unit of energy is doubled

23. If the units of force and that of length are doubled, the unit of energy will be:
(*a*) 1/4 times (*b*) 1/2 times
(*c*) 2 times (*d*) 4 times

24. If the units of M, L are doubled then the unit of kinetic energy will become
(*a*) 2 times (*b*) 4 times
(*c*) 8 times (*d*) 16 times

25. The angle subtended by the moon's diameter at a point on the earth is about 0.50°. Use this and the act that the moon is about 384000 km away to find the approximate diameter of the moon.



(*a*) 192000 km (*b*) 3350 km
(*c*) 1600 km (*d*) 1920 km

ERRORS IN MEASUREMENT

26. The length of a rectangular plate is measured by a meter scale and is found to be 10.0 cm. Its width is measured by vernier callipers as 1.00 cm. The least count of the meter scale and vernier callipers are 0.1 cm and 0.01 cm respectively (Obviously). Maximum permissible error in area measurement is -
(*a*) ± 0.2 cm^2 (*b*) ± 0.1 cm^2
(*c*) ± 0.3 cm^2 (*d*) Zero

27. For a cubical block, error in measurement of sides is ____ $\pm$ 1% and error in measurement of mass is $\pm$2%, then maximum possible error in density is -
(*a*) 1% (*b*) 5%
(*c*) 3% (*d*) 7%

28. To estimate 'g' (from $g = 4\pi^2 \dfrac{L}{T^2}$), error in measurement of L is $\pm$2% and error in measurement of T is $\pm$3%. The error in estimated 'g' will be -
(*a*) $\pm$8% (*b*) $\pm$6%
(*c*) $\pm$3% (*d*) $\pm$5%

29. The least count of a stop watch is 0.2 second. The time of 20 oscillations of a pendulum is measured to be 25 seconds. The percentage error in the time period is
(*a*) 16% (*b*) 0.8 %
(*c*) 1.8 % (*d*) 8 %

30. The dimensions of a rectangular block measured with a vernier callipers having least count of 0.1 mm is 5 mm × 10 mm × 5 mm. The maximum percentage error in measurement of volume of the block is
(*a*) 5 % (*b*) 10 %
(*c*) 15 % (*d*) 20 %

31. An experiment measures quantities x, y, z and then t is calculated from the data as $t = \dfrac{xy^2}{z^3}$. If percentage errors in x, y and z are respectively 1%, 3%, 2%, then percentage error in t is :
(*a*) 10 % (*b*) 4 %
(*c*) 7 % (*d*) 13 %

32. The external and internal diameters of a hollow cylinder are measured to be (4.23 ± 0.01) cm and (3.89 ± 0.01) cm. The thickness of the wall of the cylinder is
(*a*) (0.34 ± 0.02) cm
(*b*) (0.17 ± 0.02) cm
(*c*) (0.17 ± 0.01) cm
(*d*) (0.34 ± 0.01) cm

33. The mass of a ball is 1.76 kg. The mass of 25 such balls is
(*a*) 0.44×10^3 kg (*b*) 44.0 kg
(*c*) 44 kg (*d*) 44.00 kg

34. Two resistors R_1 (24 ± 0.5) Ω and R_2 (8 ± 0.3) Ω are joined in series. The equivalent resistance is
(*a*) 32 ± 0.33 Ω (*b*) 32 ± 0.8 Ω
(*c*) 32 ± 0.2 Ω (*d*) 32 ± 0.5 Ω

35. The pitch of a screw gauge is 0.5 mm and there are 100 divisions on its circular scale. The instrument reads +2 divisions when nothing is put in-between its jaws. In measuring the diameter of a wire, there are 8 divisions on the main scale and 83rd division coincides with the reference line. Then the diameter of the wire is
(*a*) 4.05 mm (*b*) 4.405 mm
(*c*) 3.05 mm (*d*) 1.25 mm

36. The pitch of a screw gauge having 50 divisions on its circular scale is 1 mm. When the two jaws of the screw gauge are in contact with each other, the zero of the circular scale lies 6 division below the line of graduation. When a wire is placed between the jaws, 3 linear scale divisions are clearly visible while 31st division on the circular scale coincide with the reference line. The diameter of the wire is:
(*a*) 3.62 mm (*b*) 3.50 mm
(*c*) 3.5 mm (*d*) 3.74 mm

37. The smallest division on the main scale of a vernier callipers is 1 mm, and 10 vernier divisions coincide with 9 main scale divisions. While measuring the diameter of a sphere, the zero mark of the vernier scale lies between 2.0 and 2.1 cm and the fifth division of the vernier scale coincide with a scale division. Then diameter of the sphere is
(*a*) 2.05 cm (*b*) 3.05 cm
(*c*) 2.50 cm (*d*) None of these

Advanced Level Multiconcept Questions

JEE-ADVANCED
MCQ/COMPREHENSION/MATCHING/NUMERICAL

1. Choose the correct statement(s):
(*a*) All quantities may be represented dimensionally in terms of the base quantities.
(*b*) A base quantity cannot be represented dimensionally in terms of the rest of the base quantities.
(*c*) The dimension of a base quantity in other base quantities is always zero.
(*d*) The dimension of a derived quantity is never zero in any base quantity.

2. Choose the correct statement(s):
(*a*) A dimensionally correct equation may be correct.
(*b*) A dimensionally correct equation may be incorrect.
(*c*) A dimensionally incorrect equation may be correct.
(*d*) A dimensionally incorrect equation must be incorrect.

3. The dimensions $ML^{-1}T^{-2}$ may correspond to
(*a*) work done by a force
(*b*) linear momentum
(*c*) pressure
(*d*) energy per unit volume

Comprehension Type Questions – 1 (No. 4 to 6)

Let us consider a particle P where is moving straight on the X-axis. We also know that the rate of change of its position is given by $\frac{dx}{dt}$; where x is its separation from the origin and t is time. This term $\frac{dx}{dt}$ is called the velocity of particle (v). Further the second derivation of x, w.r.t. time is called acceleration (*a*) or rate of change of velocity and represented by $\frac{d^2x}{dt^2}$ or $\frac{dv}{dt}$. If the acceleration of this particle is found to depend upon time as follows

$a = At + Bt^2 + \frac{Ct}{D + t^2}$ then-

4. The dimensions of A are -
(*a*) LT^{-2} (*b*) LT^{-3}
(*c*) LT^3 (*d*) L^2T^3

5. The dimensions of B are -
(*a*) LT^{-4} (*b*) L^2T^{-3}
(*c*) LT^4 (*d*) LT^{-2}

6. The dimensions of C are -
(*a*) L^2T^{-2} (*b*) LT^{-2}
(*c*) LT^{-1} (*d*) T^2

Comprehension Type Questions – 2 (No. 7 to 9)

According to coulombs law of electrostatics there is a force between two charged particles q_1 & q_2 separated by a distance r such that $F \propto q_1$, $F \propto q_2$ & $F \propto \frac{1}{r^2}$; combining all three we get $F \propto \frac{q_1q_2}{r^2}$ or $F = \frac{kq_1q_2}{r^2}$, where k is a constant which depends on the medium and is given by $1/4\pi\varepsilon_0\varepsilon_r$ where ε_0 is absolute permittivity & ε_r is relative permittivity.

But in case of protons of a nucleus there exists another force called nuclear force; which is much higher in magnitude in comparison to electrostatic force and is given by $F = \frac{Ce^{-kr}}{r^2}$.

7. What are the dimensions of C -
(*a*) $M^2L^3T^{-1}$ (*b*) ML^3T^{-3}
(*c*) ML^3T^{-2} (*d*) ML^2T^{-3}

8. What are the dimensions of k –
(*a*) L (*b*) L^2
(*c*) L^{-3} (*d*) L^{-1}

9. What are the SI units of C -
(*a*) Nm^{-2} (*b*) Nm^2
(*c*) Nm^{-3} (*d*) Nm

10. Match the following columns

Physical quantity	**Dimension**	**Unit**
(*a*) Gravitational constant 'G'	(P) $M^1L^1T^{-1}$	(*a*) N.m
(*b*) Torque	(Q) $M^{-1}L^3T^{-2}$	(*b*) N.s
(*c*) Momentum	(R) $M^1L^{-1}T^{-2}$	(*c*) Nm^2/kg^2
(*d*) Pressure	(S) $M^1L^2T^{-2}$	(*d*) pascal

11. **Match the following:**

Physical quantity	Dimension	Unit
(i) Stefan's constant 'σ'	(P) $M^1L^1T^{-2}A^{-2}$	(*a*) W/m^2
(ii) Wien's constant 'b'	(Q) $M^1L^oT^{-3}K^{-4}$	(*b*) K.m.
(iii) Coefficient of viscosity 'η'	(R) $M^1L^oT^{-3}$	(*c*) tesla .m/A
(iv) Emissive power of radiation (Intensity emitted)	(S) $M^oL^1T^oK^1$	(*d*) W/m^2.K^4
(v) Mutual inductance 'M'	(T) $M^1L^2T^{-2}A^{-2}$	(e) poise
(vi) Magnetic permeability 'μ_0'	(U) $M^1L^{-1}T^{-1}$	(f) henry

NUMERICAL VALUE BASED

12. Number of significant figures in 0.007 m^2 .

13. Number of significant figures in 2.64×10^{24} kg

14. Number of significant figures in 6.032 N m^{-2}

15. The velocity of sound in a gas depends on its pressure and density. The relation between velocity, pressure and density is given by $V = Kp^a D^b$ then (a + b) is

16. A gas bubble, from an explosion under water, oscillates with a period proportional to $P^ad^bE^c$. Where P is the static pressure, d is the density and E is the total energy of the explosion. Find the values of a + b + c

17. The pitch of a screw gauge is 1 mm and there are 100 divisions on the circular scale. While measuring the diameter of a wire, the linear scale reads 1 mm and 47th division on the circular scale coincides with the reference line. The length of the wire is 5.6 cm. Find the curved surface area (in cm^2) of the wire in two number of significant figures.

18. The density of a cube is measured by measuring its mass and the length of its sides. If the maximum errors in the measurement of mass and length are 3% and 2% respectively, then the maximum error in the measurement of density is.

19. The length of the string of a simple pendulum is measured with a metre scale to be 90.0 cm. The radius of the bob plus the length of the hook is calculated to be 2.13 cm using measurements with a slide callipers. What is the effective length of the pendulum? (This effective length is defined as the distance between the point of suspension and the center of the bob).

Topicwise Questions

1. (*a*) It is obvious.
2. (*a*) Kilogram is not a physical quantity, its a unit.
3. (*c*) PARSEC is a unit of distance.
   It is used in astronomical science.
4. (*b*) System is NOT based on unit of mass, length and time alone,
   This system is based on all 7 Fundamental physical quantities and 2 supplementary physical quantities.
5. (*c*) S.I. unit of energy is Joule.
6. (*b*) SI unit of universal gravitational constant G is -

   We know $F = \frac{GM_1M_2}{R^2}$

   Here M_1 and M_2 are mass
   R = Distance between them M_1 and M_2
   F = Force

   $$G = \frac{FR^2}{M_1M_2} = \frac{N-m^2}{kg^2}$$

   So, Unit of G = $N\text{–}m^2\ kg^{-2}$
7. (*b*) Surface Tension (T) :-

   $$T = \frac{J}{A} = \frac{J}{m^2}$$

   So S.I. unit of surface tension is joule/m^{+2}
8. (*d*) Here ρ is specific resistance.

   $$R = \frac{\rho l}{A} \Rightarrow ohm = \frac{\rho m}{m^2} \qquad \Rightarrow \rho = ohm \times m$$
9. (*a*) Here i = current
   A = crossectional Area
   M = iA
   = Amp. m^2
10. (*d*) Unit of universal gas constant (R)
    PV = nRT P → Pressure
    V → Volume

    $$R = \frac{PV}{nT} \quad T \rightarrow \text{Temperature}$$

    $$= \frac{N/m^2 \times m^3}{mol. \times K} \quad R \rightarrow \text{Univ. Gas. Const.}$$

    n → No. of male

    $$= \frac{N-m}{mol. \times K} = \text{Joule}\ K^{-1} mol^{-1}$$

    {n – m = joule}
11. (*d*) Stefan-Constant(σ)
    Unit → $w/m^2\text{-}k^4 = wm^{-2}k^{-4}$
12. (*c*) S.I. unit of the angular acceleration is rad/s^2.
    α = angular velocity/time = rad/s^2 = rad.s^{-2}
13. (*c*) Angular Frequency (f) $= \frac{1}{T} = M^oL^oT^{-1}$

    So, here dimension in length is zero
14. (*b*) P = mvm → mass
    v → velocity
    Dimesion of [P] = [MLT^{-1}]
15. (*b*) Boltz mann's const. (k) → J → Joule
    K → Kelvin
    Unit → J/k

    Dimension $= \frac{M^1L^2T^{-2}}{K^1} = M^1L^2T^{-2}K^{-1}$
16. (*b*) Find out Dimension of each physical quantity in all options.
    AM = $Mvr^2 = ML^2T^{-1}$

    Dimension of Torque (τ)= $\vec{r} \times \vec{F}$ →Force = MLT^{-2}
    (τ) = $L^1 \times M^1L^1T^{-2}$
    It is also a dimension of Energy. = ML^2T^{-2}
    Power = W/t = $ML^2T^{-2}/T = ML^2T^{-3}$

17. (*d*) Find dimension in all options.

Here stress = Force/Area

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

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

18. (*c*) All the terms in the equation must have the dimension of force

$\therefore$ $[A \sin C t] = MLT^{-2}$

$\Rightarrow$ $[A][M^0L^0T^0] = MLT^{-2}$

$\Rightarrow$ $[A] = MLT^{-2}$

Similarly, $[B] = MLT^{-2}$

$$\therefore \frac{[A]}{[B]} = M^oL^oT^o$$

Again $[Ct] = M^oL^oT^o \Rightarrow [C] = T^{-1}$

$[Dx] = MLT^o \Rightarrow [D] = L^{-1}$

$$\Rightarrow \frac{[C]}{[D]} = M^oL^1T^{-1}.$$

19. (*c*) $\int \frac{dx}{\sqrt{2ax - x^2}} = a^n \sin^{-1}\left[\frac{x}{a} - 1\right].$

L.H.S. is the dimensionless as denominator $2ax - x^2$ must have the dimension of $[x]^2$ ($\because$ we can add or substract only if quantities have same dimension)

$$\therefore \left[\sqrt{2ax - x^2}\right] = [x]$$

Also, dx has the dimension of $[x]$

$\therefore$ $\frac{x\,dx}{\sqrt{2ax - x^2}}$ is having dimension L

Equating the dimension of L.H.S. & R.H.S. we have

$[a^n] = M^0L^1T^0$ { $\therefore$ $\sin^{-1}\left(\frac{x}{a} - 1\right)$ must be dimensionless

$\therefore$ n = 1

20. (*a*)

21. (*b*) $y = a \sin(At - Bx + C)$

Angle has no dimensions so

Dimensions of At = $M^0L^0T^0$

$\Rightarrow$ $A = T^{-1}$

Dimensions of Bx = $M^0L^0T^0$

$\Rightarrow$ $B = L^{-1}$

Dimensions of C = $M^0L^0T^0$

22. (*a*) Dimensions of $\sqrt{\frac{\gamma p}{\rho}}$ = Dimensions of v

$\gamma L^2T^{-2} = L^2T^{-2}$

$\gamma = M^0L^0T^0$

23. (*c*) $A = \frac{d\ work}{dt}\ \frac{1}{F}P$

$$[A] = \frac{[work]}{[time]\frac{[work]}{[displacement]} \times [P]}$$

$$= \frac{L}{T} MLT^{-1} = \frac{1}{M}$$

24. (*b*) $[v] = [k][\lambda^a \rho^b g^c] \Rightarrow LT^{-1} = L^a M^b L^{-3b} L^c T^{-2c}$

$\Rightarrow$ $LT^{-1} = M^b L^{a-3b+c}\ T^{-2c}$

$\Rightarrow$ $a = ½, b = 0, c = ½$

so, $v^2 = kg\lambda$

25. (*b*) It is obvious

26. (*c*) $P = \frac{W}{t}$

Watt = Joule/sec.

Joule = Watt-sec.

One watt-hour = 1 watt×60×60 sec

1 Hour=60×60sec. = 3600 watt-sec

= 3600 Joule

= 3.6×10^3 Joule

27. (*a*) Given

$P = 10^6$ dyne/cm^2

$n_1u_1 = n_2u_2$

$$n_1\left[M_1^1L_1^{-1}T_1^{-2}\right] = 10^6\left[M_2^1L_2^{-1}T_2^{-2}\right]$$

$$n_1 = 10^6\left[\frac{M_2}{M_1}\right]^1\left[\frac{L_2}{L_1}\right]^{-1}\left[\frac{T_2}{T_1}\right]^{-2}$$

$$= 10^6\left[\frac{1}{1000}\right]^1\left[\frac{1}{100}\right]^{-1}$$

$$\Rightarrow 10^6 \times \frac{10^2}{10^3} = 10^5\ N/m^2$$

28. (*b*) $\rho = 2g/cm^3$

$n_1u_1 = n_2u_2$

$$n_1\left[M_1^1L_1^{-3}\right] = 2\left[M_2^1L_2^{-3}\right]$$

$$n_1 = 2\left[\frac{M_2}{M_1}\right]^1\left[\frac{L_2}{L_1}\right]^{-3}$$

$$= 2\left[\frac{10^{-3}}{1}\right]^1\left[\frac{10^{-2}}{1}\right]^{-3}$$

$= 2 \times 10^{-3} \times 10^6$

$= 2 \times 10^3$ Kg/m^3

29. (*a*) $n_2 = 13600\left[\frac{M_1}{M_2}\right]^1\left[\frac{L_1}{L_2}\right]^{-3}$

$= 13600\left[\frac{1000}{1}\right]^1\left[\frac{100}{1}\right]^{-3}$

$n_2 = 13.6\ gcm^{-3}$

30. (*c*) Measurement 900 × 10^{-4} m is most accurate as significant figure is 3,

31. (*c*) 70.40s four significant figures.
Time period = 3.520 sec. (4 significant figure)

32. (*a*) $KE = \frac{1}{2}mv^2$

$\frac{\Delta k}{k}\times 100 = 1\% + 2\times 2\% = 5\%$

33. (*a*) The third significant digit is 4. This digit is to be rounded. The digit next to it is 6 which is greater than 5. The third digit should, therefore , be increased by 1. The digits to be dropped should be replaced by zeros because they appear to the left of the decimal. Thus, 15462 becomes 15500 on rounding to three significant digits.

34. (*a*) We have $\frac{25.2\ \times\ 1374}{33.3} = 1039.7838$ .....

Out of the three numbers given in the expression 25.2 and 33.3 have 3 significant digits and 1374 has four. The answer should have three significant digits. Rounded 1039.7838 .... to three significant digits, it becomes 1040.
Thus , we write.

$\frac{25.2\ \times\ 1374}{33.3} = 1040.$

35. (*c*) 24.36
0.0623
256.2
Now the first column where a doubtful digit occurs is the one just next to the decimal point (256.2). All digits right to this column must be dropped after proper rounding. The table is rewritten and added below
24.4
0.1
256.2
———
280.7 The sum is 280.7

36. (*b*) $\therefore E = \frac{1}{2}mv^2$

$\therefore$ % Error in K.E.
= % error in mass + 2 × % error in velocity
= 2 + 2 × 3 = 8 %

37. (*b*)

38. (*b*) Number of significant figures are 3, because 10^3 is decimal multiplier.

39. (*b*)

$\because V = \frac{4}{3}\pi r^3$

$\therefore$ % error is volume $= 3\times\%$ error in radius $= 3\times 1 = 3\%$

40. (*c*) Mean time period $T = 2.00$ *sec*
& Mean absolute error = $\Delta T = 0.05$ *sec.*
To express maximum estimate of error, the time period should be written as (2.00 ± 0.05) *sec*

41. (*c*)

42. (*a*) $\frac{1}{20} = 0.05$

$\therefore$ Decimal equivalent upto 3 significant figures is 0.0500

43. (*b*)

44. (*a*) Since percentage increase in length = 2 %
Hence, percentage increase in area of square sheet
$= 2\times 2\% = 4\%$

45. (*c*) 1 main scale div = 0.5 mm
10V = 9S

$V = \frac{9}{10}S$

$S - V = S - \frac{9}{10}S = \frac{1}{10}S.$

$\therefore$ Vernier constant $= \frac{0.5\ mm}{10} = 0.05$ mm

46. (c) $20V = 19s., V = \frac{19}{20}S$

$S - V = S - \frac{19}{20}S \Rightarrow$ vernier $= \frac{S}{20}$

$0.1\ mm = \frac{S}{20}$

$\therefore$ 1s = 20 × 0.1 mm = 2 mm.

47. (*c*) 1 VC = 1 MSD – VSD

$1VC = 0.1\ cm - \frac{n}{m}$

$0.02\ cm = \frac{1}{10} - \frac{n}{m}$

$\frac{n}{m} = \frac{1}{10} - \frac{2}{100}$

n = 10, m = 0.8 cm

Learning Plus

1. (*b*) Solar day $\rightarrow$ Time far Earth to wake a complete rotation on its axis
Parallactic second [1 Parsec] $\rightarrow$ It is a distance corresponding to a parallex of one second of arc.
Leap year $\rightarrow$ A leap year is year (time) Containing one extra day.
Lunar Month $\rightarrow$ A lunar month is the time between two identical view moons of full moons.
1 Lunar month = 29.53059 days.

2. (*b*) Unit of impulse = $\Rightarrow$ Impulse = Force × time
$$= kg\frac{m}{sec^2}sec = kg\frac{m}{sec} = mv$$
The unit is same as the unit of linear momentum.

3. (*d*) Energy W = f × d = Nm
W = eV = electron-volt
W = p × t = Watt hour
So, kg × m/sec^2 is not the unit of energy.

4. (*c*) Dimensionless quantity may have a unit
Ex. Angle Unit $\rightarrow$ Radian
Dimension $\rightarrow M^oL^oT^o$

5. (*c*) Only same physical quantities can be added or substracted,
It's only multiply and divided only.
So, a/b denote a new physical quantity.

6. (*c*) $P = P_o\,Exp(-\alpha t^2)$
Here Exp $(-\alpha t^2)$ is a dimensionless
So, dimension of $[\alpha t^2] = M^oL^oT^o$
$$So,\ [\alpha] = \frac{M^oL^oT^o}{T^2}$$
$[\alpha] = M^oL^oT^{-2}$

7. (*c*) By Checking the dimension in all options
(*c*) Moment of Inertia = Mr^2
$= M^1L^2T^o$
Moment of force = r × F
$= L^1 \times M^1L^1T^{-2}$
$= M^1L^2T^{-2}$

8. (*d*) Action = Energy × Time = $M^1L^2T^{-2} \times T^1$
$= M^1L^2T^{-1}$
It is same as dimension of Impulse × distance
$= MLT^{-1} \times L^1 = M^1L^2T^{-1}$

9. (*a*) $M^1L^2T^{-2}$ is a dimension of kinetic energy.

10. (*b*) $\frac{EJ^2}{M^5G^2}$ J=mvr, J = $[ML^2T^{-1}]$
$= [M^0L^0T^0]$
Dimension of Angle = $[M^0L^0T^0]$

11. (*c*) $x(t) = \frac{v_o}{\alpha}[1 - e^{-\alpha t}]$
Dimension of v_o and α
Here $e^{-\alpha t}$ is dimensionless so,
$[\alpha]\,[t] = M^oL^oT^o$
$$[\alpha] = \frac{M^oL^oT^o}{T^1} = T^{-1}$$
$[\alpha] = M^oL^oT^{-1}$
Here $1\text{-}e^{-\alpha t}$ is a number
$$[x(t)] = \frac{V_o}{\alpha}$$
$[V_o] = [L^1]\,[T^{-1}]$
$[V_o] = M^oL^1T^{-1}$

12. (*d*) $F = Pt^{-1} + \alpha t$
Here F and Pt^{-1} is a same
Physical quantity
$[F] = [Pt^{-1}]$
$$[P] = \frac{[F]}{[t^-]} = [F \times t] = ML\,T^{-2} \times T = MLT^{-1}$$
We find it is same as dimension of momentum $= MLT^{-1}$

13. (*d*) Y = a sin (bt – cx)
Dimension of b
Here bt is dimensionless
$[bt] = M^oL^oT^o$
$$[b] = \frac{M^oL^oT^o}{[T^1]} = M^oL^oT^{-1}$$
It is a dimension of wave frequency.

14. (*c*) Here $\sqrt{1 + \frac{2k\ell}{ma}}$ is a number.
It's a dimensionless quantity.
$$\left[\frac{2k\ell}{ma}\right] = [M^oL^oT^o]$$
$$[K] = \frac{[m][a]}{[\ell]}$$

$$= \frac{M^1L^1T^{-2}}{L^1} = M^1L^oT^{-2}$$

So dimession of [b] is

$$[b] = \left[\frac{ma}{K}\right] = \left[\frac{MLT^{-2}}{MT^{-2}}\right]$$

$[b] = L$

unit of b is metre

15. (*d*) $\alpha = \frac{F}{V^2}\sin(\beta t)$

Here sin (βt) is dimensionless.

$[\beta t] = M^oL^oT^o$

$$\beta = \frac{M^oL^oT^o}{T^1} = \left[T^{-1}\right]$$

$$[\alpha] = \left[\frac{F}{V^2}\right]$$

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

$[\alpha] = [M^1L^{-1}T^o]$

16. (*d*) L α FAT

$L = K\,F^aA^bT^c$ .... (*a*)

$M^oL^1T^o = K[M^1L^1T^{-2}]\,[L^1T^{-2}]^b[T]^c$

$M^oL^1T^o = K[M^a]\,[L^{a+b}]\,[T^{-2a-2b+c}]$

By comparesion and solving we find

$[a = 0]\ [b = 1]\ [c = 2]$

Put these value in Equa. (*a*)

$[L = F^oA^1T^2]$

17. (*b*) F α Avρ

$F = KA^a\,v^b\,\rho^c$

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

$F = K[M^cL^{2a+b-3c}\,T^{-b}]$

$M^1L^1T^{-2} = K[M^c\,L^{2a+b-3c}T^{-b}]$

$c = 1$

$-2 = -b \Rightarrow b = 2$

and

$2a + b - 3c = 1$

$2a + 2 - 3 = 1 \Rightarrow a = 1$

So $F = A^1\,v^2\,q^1$

$\therefore\ F = Av^2\rho$

18. (*b*) $V = g^p\,h^q$

$V = Kg^ph^q$

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

$L^1T^{-1} = L^{p+q}\,T^{-2p}$

By comparing both sides

$p + q = 1, -2p = -1$

$p = 1/2,\ q = 1/2$

19. (*d*) Unit of length is micrometer

Unit of time is microsecond

$$\because \text{ Velocity } = \frac{\text{Displacement}}{\text{Time taken}}$$

$$= \frac{10^{-6}\,m}{10^{-6}\,sec} = m/sec$$

20. (*a*) $n_1u_1 = n_1u_1$

$$n_1\left[M_1^1L_1^2T_1^{-3}\right] = 1\left[M_2^1L_2^2T_2^{-3}\right]$$

$$n_1 = \left[\frac{M_2}{M_1}\right]^1\left[\frac{L_2}{L_1}\right]^2\left[\frac{T_2}{T_1}\right]^{-3}$$

$$= \left[\frac{20}{1}\right]^1\left[\frac{10}{1}\right]^2\left[\frac{5}{1}\right]^{-3}$$

$$= \frac{20\times100}{5\times5\times5} = 16$$

$n_1 = 16$

Unit of power in new system = 16 Watt.

21. (*c*) $10^3(N) = M^1L^1T^{-2}$

$10^3 = [M]^1\,[10^3]^1\,[100]^{-2}$

$$M = \frac{10^3}{10^3\times(100)^{-2}} = 10000\text{ kg}$$

22. (*c*) In new system

Length $\rightarrow$ m 2m

Velocity $\rightarrow$ m/sec. 2m/sec

Force $\rightarrow$ kgm/sec^2 2kgm/sec^2

$\therefore$ Momentum (P) = mv = kg m/sec.

$$P = kg\frac{m}{sec}\times\frac{m}{m}\times\frac{sec}{sec}$$

$$P = kg\frac{m}{sec^2}\times\frac{m}{(m/sec)}$$

In new system

$$P^1 = \left(2kg\frac{m}{sec^2}\right)\times\frac{(2m)}{(2m/sec)}$$

$$P^1 = (2kg\,m/sec) = 2P$$

So, Here unit of momentum is doubled.

23. (*d*) Unit of Energy $= \text{kg}\dfrac{\text{m}^2}{\text{sec}^2}$

$$= \left(\text{kg}\frac{\text{m}}{\text{sec}^2}\right)\times(\text{m})$$

Now unit of force and length are doubled.

$$= \left(2\text{kg}\frac{\text{m}}{\text{sec}^2}\right)(2\text{m}) = 4\text{kg}\frac{\text{m}^2}{\text{sec}^2}$$

So, Unit of Energy is 4 times.

24. (*c*) $\text{K.E.} = \dfrac{1}{2}mv^2$

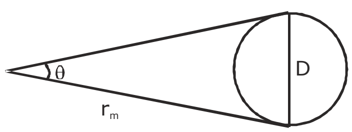
Dimension $= M^1L^2T^{-2}$

Now M.L are doubled

$= (2M)^1\,(2L)^2\,(T^{-2}) = 8\,M^1L^2T^{-2}$

So, K.E. will become 8 times.

25. (*b*) Take small angle approximation



$$\text{Sin}\,\theta = \frac{D}{r_m}$$

$$\text{Sin}\,0.50° = \frac{D}{r_m}$$

$$0.50\times\frac{\pi}{180} = \frac{D}{384000}$$

$$D = 0.50\times\frac{\pi}{180}\times 384000$$

$D = 3349.33 \Rightarrow D \approx 3350\,\text{km}.$

26. (*a*) $A = \ell b = 10.0\times 1.00 = 10.00$

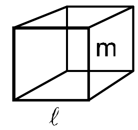
$$\frac{\Delta A}{A} = \frac{\Delta\ell}{\ell} + \frac{\Delta b}{b}$$

$$\frac{\Delta A}{10.00} = \frac{0.1}{10.0} + \frac{0.01}{1.00}$$

$$\Rightarrow \Delta A = 10.00\left(\frac{1}{100}+\frac{1}{100}\right)$$

$$= 10.00\left(\frac{2}{100}\right) = \pm 0.2\,\text{cm}^2.$$

27. (*b*)



$$\rho = \frac{m}{V} = \frac{m}{\ell^3}$$

Given : $\dfrac{\Delta m}{m} = \pm\ 2\% = \pm 2\times 10^{-2}\ \dfrac{\Delta\ell}{\ell}$

$= \pm 1\% = \pm 1\times 10^{-2}$

$$\frac{\Delta\rho}{\rho} = \frac{\Delta m}{m} + 3\frac{\Delta\ell}{\ell}$$

$= 2\times 10^{-2} + 3\times 10^{-2}$

$= 5\times 10^{-2} = 5\%$

28. (*a*) $g = 4\pi^2\dfrac{\ell}{T^2}$

$$\frac{\Delta\ell}{\ell} = 2\% = \pm 2\times 10^{-2}$$

$$\frac{\Delta T}{T} = \pm 3\% = \pm 3\times 10^{-2}$$

$$\Rightarrow \frac{\Delta g}{g} = \frac{\Delta\ell}{\ell} + \frac{2\Delta T}{T}$$

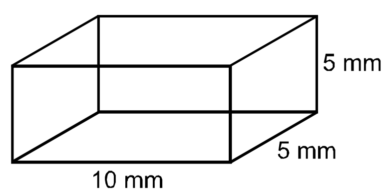
$= 2\times 10^{-2} + 2\times 3\times 10^{-2} = 8\times 10^{-2} = \pm 8\,\%$

29. (*b*) $\Delta t = 0.2$ s.

$t = 25$ s

$$T = \frac{t}{N} \Rightarrow \frac{\Delta T}{T} = \frac{\Delta t}{t} = \frac{0.2}{25} = 0.8\,\%$$

30. (*a*)



$v = \ell bh$

$$\frac{\Delta v}{v} = \frac{\Delta\ell}{\ell} + \frac{\Delta b}{b} + \frac{\Delta h}{h}$$

$$= \frac{0.1}{10} + \frac{0.1}{5} + \frac{0.1}{5} = \frac{0.5}{10} = \pm 5\%$$

31. (*d*) $\dfrac{\Delta x}{x} = 1\% = 10^{-2}$

$$\frac{\Delta y}{y} = 3\% = 3\times 10^{-2}$$

$$\frac{\Delta z}{z} = 2\% = 2\times 10^{-2}$$

$$t = \frac{xy^2}{z^3}$$

$$\frac{\Delta t}{t}=\frac{\Delta x}{x}+\frac{2\Delta y}{y}+\frac{3\Delta z}{z}$$
$$=10^{-2}+2\times 3\times 10^{-2}+3\times 2\times 10^{-2}$$
$$=13\times 10^{-2}\ \therefore \%\text{ error in t }=\frac{\Delta t}{t}\times 100=13\%$$

32. (*c*) $D=(4.23\pm 0.01)$ cm
$d=(3.89\pm 0.01)$ cm
$\Delta t=(D-d)/2$
$$=\frac{(4.23\pm 0.01)-(3.89\pm 0.01)}{2}$$
$$=\frac{(4.23-3.89)\pm(0.01+0.01)}{2}$$
$=(0.34\pm 0.02)/2$ cm
$=(0.17\pm 0.01)$cm

33. (*b*) $m=1.76$ kg
$M=25$ m
$=25\times 1.76$
$=44.0$ kg
Note: Mass of one unit has three significant figures and it is just multiplied by a pure number (magnified). So result should also have three significant figures.

34. (*b*) $R_1=(24\pm 0.5)\,\Omega$
$R_2=(8\pm 0.3)\,\Omega$
$R_S=R_1+R_2$
$=(32\pm 0.8)\,\Omega$

35. (*b*) $\Delta\ell=0.5$ mm
N = 100 divisions
zero correction = 2 divisions
Reading = Measured value + zero correction
$$=(8\times 0.5)\text{ mm}+(83-2)\times\frac{0.5}{100}.$$
$$=4\text{ mm}+81\times\frac{0.5}{100}\text{ mm}$$
$=4.405$ mm

36. (*d*) $\Delta\ell=1$ mm
N = 50 division
zero error = –6 Divisions
= – 0.12 mm
Diameter = Measured value + zero correction
$$=3\times 1+(6+31)\times\frac{1}{50}$$
$=3+0.74=3.74$ mm

37. (*a*) $D=2\times 1+5\times\frac{10-9}{100}=2.05$ cm

Advanced Level Multiconcept Questions

1. (*a*), (*b*), (*c*), (*d*)
All A,B & C are obvious.
(d) Derived quantity may have zero dimension in certain base quantity.
For example acceleration which is derived quantity, has zero dimensions in mass which is base quantity.

2. (*a*), (*c*), (*d*)
It is obvious

3. (*c*), (*d*)
By checking dimension in each option
$$\text{Pressure }=\frac{F}{A}=\frac{[M^1L^1T^{-2}]}{[L^2]}=[M^1L^{-1}T^{-2}]$$
$$\text{Energy per unit volume }=\frac{\text{Energy}}{\text{Volume}}$$
$$=\frac{[M^1L^2T^{-2}]}{[L^3]}=[M^1L^{-1}T^{-2}]$$

4. (*b*) $A=\frac{a}{t}=LT^{-3}$

5. (*a*) LT^{-4}

6. (*c*) $c=at=[LT^{-1}]$

7. (*c*) $F=\frac{[c]}{r^2}\Rightarrow[c]=Fr^2=[MLT^{-2}]L^2$

8. (*d*) Kr = constant
$$K=\frac{\text{constant}}{r}=\frac{1}{L}=L^{-1}$$

9. (*b*) $F=\frac{C}{r^2}\Rightarrow C=Fr^2=Nm^2$

10. (*a*) $\to$ (Q) $\to$ (*c*), (*b*) $\to$ (S) $\to$ (*a*), (*c*) $\to$ (P) $\to$ (*b*), (*d*) $\to$ (R) $\to$ (*d*)
$$F=G\frac{m_1m_2}{r^2}\Rightarrow[G]=\frac{[F][r^2]}{[m_1m_2]}=\frac{MLT^{-2}L^2}{M^2}=M^{-1}L^3T^{-2}$$
$[\text{Torque}]=[f]\,[d]=MLT^{-2}L=ML^2T^{-2}$
$[\text{Momentum}]=[m]\,[v]=MLT^{-1}$
$$[p]=\frac{[F]}{[A]}=\frac{MLT^{-2}}{L^2}=ML^{-1}T^{-2}.$$

11. (i) $\rightarrow$ (Q) $\rightarrow$ (*d*), (ii) $\rightarrow$ (S) $\rightarrow$ (*b*), (iii) $\rightarrow$ (U) $\rightarrow$ (e), (iv) $\rightarrow$ (R) $\rightarrow$ (*a*), (v) $\rightarrow$ (T) $\rightarrow$ (f)
(vi) $\rightarrow$ (P) $\rightarrow$ (*c*)

(i) $U = \sigma AT^4 \Rightarrow [\sigma] = \frac{[U]}{[A][T^4]} = \frac{ML^2T^{-3}}{L^2K^4} = MT^{-3}K^{-4}$

(ii) $\lambda T = b \Rightarrow [b] = [\lambda][T] = LK$

(iii) $F = 6\pi\eta rv \Rightarrow [\eta] = \frac{[F]}{[r][v]} = \frac{MLT^{-2}}{L.\ LT^{-1}} = ML^{-1}T^{-1}$

(iv) $I = \frac{P}{A} = \frac{ML^2T^{-3}}{L^2} = ML^oT^{-3}$

(v) Energy $= \frac{1}{2}Mi^2 \Rightarrow [M] = \frac{[E]}{[i^2]} = ML^2T^{-2}A^{-2}$

(vi) $\frac{[U]}{[V]} = \frac{[B^2]}{[2\mu_0]}$

$= [\mu_0] = \frac{[B^2][V]}{[U]}$

Also, $F = qVB \Rightarrow B = \frac{F}{qv}$

$[\mu_0] = \frac{(F)^2[V]}{[q^2v^2][U]} = MLT^{-2}A^{-2}$

12. [1] **13.** [3] **14.** [4] **15.** [1] **16.** [0]
17. 2.6 cm^2 (in two significant figures)
18. [9%]
19. [92.1 cm]
Least count of slide calliper is 1 mm. Hence effective length of Pendulum = 90 + 2.1 = 92.1 cm