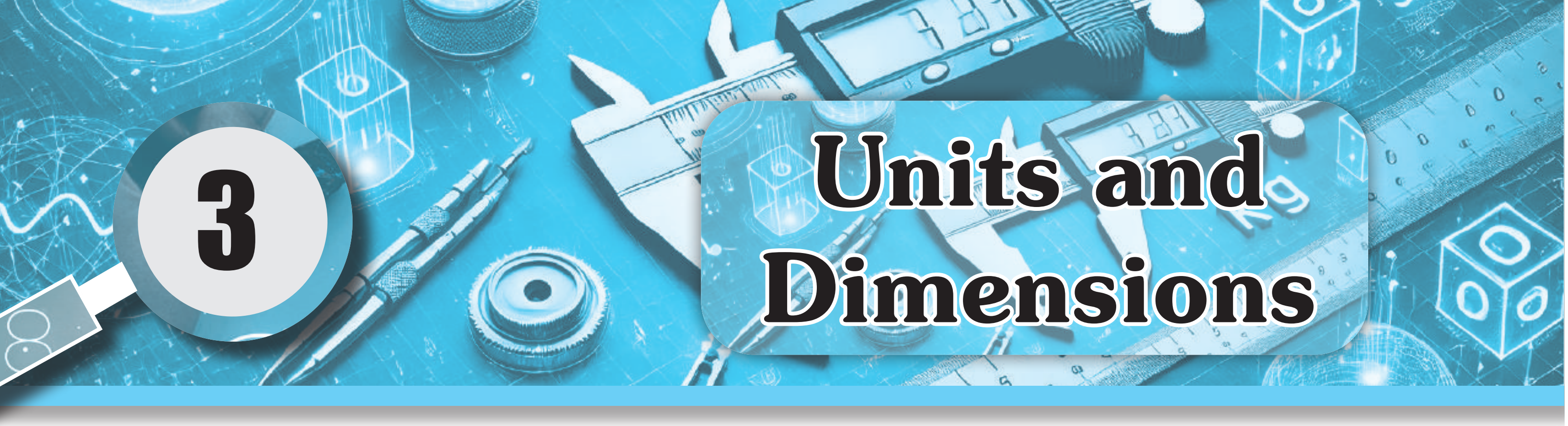
MR Physics

Question Solving Med Easy

Complete 11th & 12th Syllabus For NEET and JEE Aspirants

Contents



3 Units and Dimensions

Physical Quantity

1. Which of the following group of physical quantity can be considered as a group of fundamental physical quantity.
   (*a*) Force, mass time
   (*b*) Mass, force, acceleration
   (*c*) Velocity, time, displacement
   (*d*) Velocity, momentum, mass
   (*e*) None of the above
2. Which does not have same unit as other:-
   (*a*) watt - sec (*b*) kilowatt - hour
   (*c*) eV (*d*) Joule - sec
3. Unit of distance is :
   (*a*) Femtometer (*b*) Angstrom
   (*c*) Parsec (*d*) Light year
   (*e*) All of these
4. **Assertion (A):** Astronomical unit, light year and parsec measures distance
   Reason (R): Each has dimension of distance.
   (*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).
   (*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).
   (*c*) If Assertion (A) is True but the Reason (R) is False.
   (*d*) If both Assertion (A) & Reason (R) are false.
5. Which of the following is a characteristic of unit?
   (*a*) The unit must be universally accepted
   (*b*) It must be invariable and well defined
   (*c*) It must be of suitable size and easily available
   (*d*) All the above
6. Ratio of two similar physical quantity has units.
   (*a*) True (*b*) False

Unit Conversion

7. The magnitude of physical quantity and units are directly proportional to each other.
   (*a*) True (*b*) False
8. If Area of object is $5m^2$ then find its value in C.G.S unit?
   (*a*) 5×10^4 cm^2 (*b*) 3×10^4 m^2
   (*c*) 2×10^4 cm^2 (*d*) 1×10^4 m^2
9. Convert 25 m/s in C.G.S unit
10. If unit of length becomes double then value of area $5m^2$ in new unit will be :-
    (*a*) $\frac{1}{4}$ (*b*) $\frac{3}{2}$ (*c*) $\frac{5}{4}$ (*d*) $\frac{5}{2}$
11. Convert 1 newton into Dyne.
    (*a*) 10^4 (*b*) 10^5 (*c*) 10^3 (*d*) 10^7
12. Convert values of 10 joule in CGS unit?
    (*a*) 10×10^7 (*b*) 1×10^7 (*c*) 1×10^5 (*d*) 3×10^5
13. In a new system of units, unit of mass is *x* kg, unit of length is *y* metre and unit of time is *z* second. Now if 1 newton = *F* new units then F =
    (*a*) $\frac{z}{xy}$ (*b*) $\frac{z^2}{xy}$ (*c*) $\frac{z}{xy^2}$ (*d*) $\frac{z}{x^2y}$
14. In new system of unit, unit of length is 10 m, unit of time is 2s, unit of mass is 5 kg, then find unit of torque in new system of unit.
    (*a*) 125 Nm (*b*) 0.125 Nm
    (*c*) 8 Nm (*d*) 8×10^{-3} Nm
15. If unit of length 10 m and unit of mass is 5 kg and unit of time is 2 sec then, find value of 10 Joule energy in new system of unit.
    (*a*) $\frac{2}{25}$ (*b*) $\frac{3}{8}$ (*c*) $\frac{1}{16}$ (*d*) $\frac{2}{3}$
16. The density of a material in CGS system of units is 4 g cm^{-3} In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be
    (*a*) 0.04 (*b*) 0.4 (*c*) 40 (*d*) 400
17. In a new system of units, unit of mass is α kg unit of length is β m and unit of time is γ s. In this symstem, 10J will be represented as.
    (*a*) $10\alpha^{-1}\beta^2\gamma^2$ (*b*) $10\alpha^{-2}\beta^{-1}\gamma^{-2}$
    (*c*) $10\alpha^{-1}\beta^{-2}\gamma^2$ (*d*) $10\alpha\beta^2\gamma^{-2}$

18. Given below are two statements:

Statement I: Two physical quantities having same dimensions, may have different units.

Statement II: Shake and light year, both measure time.

In the light of the above statements, choose the most appropriate answer from the options given below:

(*a*) Both statement I and statement II are correct.
(*b*) Statement I is correct and statement II is incorrect
(*c*) Statement I is incorrect and statement II is correct
(*d*) Both statements I and statements II are incorrect

19. Light year is used to measure:

(*a*) distance between stars
(*b*) distance between atoms
(*c*) revolution time of earth around sun
(*d*) none of these

20. The wrong unit conversion among the following is :

(*a*) 1 angstrom = 10^{-10} m
(*b*) 1 fermi = 10^{-15} m
(*c*) 1 light year = 9.46×10^{15} m
(*d*) 1 astronomical unit = 1.496×10^{-11} m

21. Which of the following is not the unit of time ?

(*a*) microsecond (*b*) leap year
(*c*) lunar months (*d*) parallactic second
(*e*) Solar day

22. The unit of Stefan's constant σ is :

(If rate of heat radiation is given by σAT^4 where *A* is Area and T is temperature)

(*a*) $Wm^{-2}K^{-1}$ (*b*) $Wm^2 K^{-4}$
(*c*) $Wm^{-2}K^{-4}$ (*d*) $Wm^{-2} K^4$

23. Match Column-I with Column-II and select correct option.

Column-I		Column-II	
(A)	Mega	(P)	10^{-9}
(B)	Nano	(Q)	10^{-15}
(C)	Micro	(R)	10^{6}
(D)	Femto	(S)	10^{-6}
(E)	Pico	(T)	10^{-12}

	A	B	C	D	E
(*a*)	R	P	S	T	Q
(*b*)	S	P	R	Q	T
(*c*)	R	P	S	Q	T
(*d*)	S	P	R	T	Q

24. Which of the following ratios express pressure ?

(i) Force/Area
(ii) Energy/Volume
(iii) Energy/Area
(iv) Force/Volume

(*a*) Only (i) is correct. (*b*) Only (ii) is correct.
(*c*) Only (iii) is correct. (*d*) Both (i) and (ii) are correct.

25. The unit of thermal conductivity is :

(*a*) $Wm^{-1}K^{-1}$ (*b*) $Hm\ K^{-1}$
(*c*) $Jm^{-1} K^{-1}$ (*d*) $Wm\ K^{-1}$

Dimension

26. The dimension of mutual inductance is:

(*a*) $[ML^2T^{-2} A^{-1}]$ (*b*) $[ML^2T^{-3} A^{-1}]$
(*c*) $[ML^2T^{-2} A^{-2}]$ (*d*) $[ML^2T^{-3} A^{-2}]$

27. The SI unit of a physical quantity is pascal-second. The dimensional formula of this quantity will be

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

28. Dimension of Stress

29. Dimension of electric resistance

30. Dimension of Self Induction

31. Dimension of Permeability

32. Dimension of Magnetic field and magnetic flux

33. Dimension of Coefficient of viscosity

34. Dimension of $\dfrac{1}{\mu_0 \epsilon_0}$ should be equal to

(*a*) T^2/L^2 (*b*) T/L
(*c*) L^2/T^2 (*d*) L/T

35. If the dimensions of a physical quantity are given by $M^aL^bT^c$, then the physical quantity will be

(*a*) Velocity if $a = 1, b = 0, c = -1$
(*b*) Acceleration if $a = 1, b = 0, c = -2$
(*c*) Force if $a = 0, b = -1, c = -2$
(*d*) Pressure if $a = 1, b = -1, c = -2$

36. If E, L, M and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of *P* in the formula $P = EL^2M^{-5}G^{-2}$ are:

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

37. A quantity *f* is given by $f = \sqrt{\dfrac{hc^5}{G}}$ where c is speed of light, G universal gravitational constant and *h* is the Planck's constant. Dimension of *f* is that of

(*a*) Energy (*b*) Momentum
(*c*) Area (*d*) Volume

38. Which two of the following five physical parameters have the same dimensions?

1. Energy density 2. Refractive index
3. Dielectric constant 4. Young's modulus
5. Magnetic field

(*a*) 1 and 4 (*b*) 1 and 5
(*c*) 2 and 4 (*d*) 3 and 5

39. Which of the following pairs have same dimensional formula?

(*a*) Bulk modulus and energy density

(*b*) Latent heat and velocity

(*c*) Specific heat and latent heat

(*d*) Both (*a*) and (*b*)

40. The unit of electric flux is

(*a*) $\frac{Vm^2}{C}$ (*b*) volt-second

(*c*) $\frac{Nm^2}{C}$ (*d*) $\frac{N}{C^2\ m}$

41. Match List-I with List-II:

List-I		List-II	
A.	Surface tension	I.	kg $m^{+1}s^{-1}$
B.	Pressure	II.	kg $m^{-1}s^{-2}$
C.	Viscosity	III.	kg $m^{-1}s^{-2}$
D.	Impulse	IV.	kg s^{-2}

Choose the correct answer from the options given below:

(*a*) A-IV, B-III, C-II, D-I (*b*) A-IV, B-III, C-I, D-II

(*c*) A-III, B-IV, C-I, D-II (*d*) A-II, B-I, C-III, D-IV

42. Match List-I with List-II:

List-I		List-II	
A.	Torque	I.	kg $m^{-1}s^{-2}$
B.	Energy density	II.	kg ms^{-1}
C.	Pressure gradient	III.	kg $m^{-2}s^{-2}$
D.	Impulse	IV.	kg $m^2\ s^{-2}$

Choose the correct answer from the options given below:

(*a*) A-IV, B-III, C-I, D-II (*b*) A-I, B-IV, C-III, D-II

(*c*) A-IV, B-I, C-II, D-III (*d*) A-IV, B-I, C-III, D-II

43. Match List-I with List-II:

List-I		List-II	
A.	Planck's constat (h)	I.	$[M^1L^2T^{-2}]$
B.	Stopping potential (Vs)	II.	$[M^1L^1T^{-1}]$
C.	Work function (ϕ)	III.	$[M^1L^2T^{-1}]$
D.	Momentum (p)	IV.	$[M^1L^2T^{-3}A^{-1}]$

(*a*) A-III, B-I, C-II, D-IV (*b*) A-III, B-IV, C-I, D-II

(*c*) A-II, B-IV, C-III, D-I (*d*) A-I, B-III, C-IV, D-II

44. Match List-I with List-II:

List-I		List-II	
A.	Young's Modulus (Y)	I.	$[M L^{-1}T^{-1}]$
B.	Co-efficient of Viscosity (η)	II.	$[M L^2T^{-1}]$
C.	Planck's Constant (h)	III.	$[M L^{-1}T^{-2}]$
D.	Work Function (ϕ)	IV.	$[M L^2T^{-2}]$

Choose the correct answer from the options given below:

(*a*) A-II, B-III, C-IV, D-I (*b*) A-III, B-I, C-II, D-IV

(*c*) A-I, B-III, C-IV, D-II (*d*) A-I, B-II, C-III, D-IV

45. Match List-I with List-II:

List-I (Quantity)		List-II (Dimensional Formula)	
A.	Pressure gradient	I.	$[M^0L^2\ T^{-2}]$
B.	Energy density	II.	$[ML^{-1}T^{-2}]$
C.	Electric field	III.	$[M^1\ L^{-2}T^{-2}]$
D.	Latent heat	IV.	$[M^1\ L^1\ T^{-3}\ A^{-1}]$

Choose the correct answer from the options given below:

(*a*) A-III, B-II, C-I, D-IV (*b*) A.-II, B-III, C-IV, D-I

(*c*) A-III, B-II, C-IV, D-I (*d*) A-II, B-III, C-I, D-IV

46. Match List-I with List-II:

List-I		List-II	
A.	Angular momentum	I.	$[M\ L^2\ T^{-2}]$
B.	Torque	II.	$[ML^{-2}T^{-2}]$
C.	Stress	III.	$[ML^2T^{-1}]$
D.	Pressure gradient	IV.	$[ML^{-1}\ T^{-2}]$

Choose the correct answer from the options given below:

(*a*) A-I, B-IV, C-III, D-II (*b*) A-III, B-I, C-IV, D-II

(*c*) A-II, B-III, C-IV, D-I (*d*) A-IV, B-II, C-I, D-III

47. If L, C and R are the self inductance, capacitance and resistance respectively, which of the following does not have the dimension of time?

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

48. **Assertion (A):** The dimensional formula for product of resistance and conductance is same as for dielectric constant.

Reason (R): Both have dimensions of time constant

(*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).

(*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).

(*c*) If Assertion (A) is True but the Reason (R) is False.

(*d*) If both Assertion (A) & Reason (R) are false.

49. The pair of quantities having same dimensions is

(*a*) Impulse and Surface Tension

(*b*) Angular momentum and Work

(*c*) Work and Torque

(*d*) Young's modulus and Energy

50. Which two of the following five physical parameters have the same dimensions ?

(A) energy density (B) refractive index

(C) dielectric constant (D) Young's modulus

(E) magnetic field

(*a*) A and D (*b*) A and E

(*c*) B and D (*d*) C and E

51. Choose the incorrect statement

(*a*) Solid angle has a unit but no dimensions

(*b*) Relative density has neither unit nor dimensions

(*c*) Universal gravitational constant (G) has a SI unit $Nm^2 kg^{-2}$

(*d*) Reynolds number is having a unit

52. If y = force and x = velocity then dimension of $\frac{dy}{dx}$

(*a*) $[MT^{-1}]$ (*b*) $[LT^{-2}]$

(*c*) $[ML^2T^2]$ (*d*) $[MLT^{-1}]$

53. **Assertion (A):** If x and y are the distances along x and y axes respectively then the dimensions of $\frac{d^3y}{dx^3}$ is $M^0 L^{-2} T^0$.

Reason (R): Dimensions of $\int_a^b y dx$ is $M^0 L^2 T^0$

(*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).

(*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).

(*c*) If Assertion (A) is True but the Reason (R) is False.

(*d*) If both Assertion (A) & Reason (R) are false.

54. Fill in the blanks with correct statement, according to given statement

Dimension	(1) ______	(2) ______	(*c*) A physical quantity have dimension	(*d*) A physical quantity does not have dimension
Unit	(*a*) A physical quantity have unit	(*b*) A physical quantity does not have unit	(3) ______	(4) ______

55. A unitless physical quantity may have dimension

(*a*) True (*b*) False

56. A dimensionless physical quantity may be unitless

(*a*) True (*b*) False

57. A physical quantity have unit must have dimension

(*a*) True (*b*) False

58. A physical quantity have dimension may have unit

(*a*) True (*b*) False

59. Select correct options

(*a*) Two physical quantities of different dimensions may have same unit

(*b*) Two physical quantities of different units may have same dimensions

(*c*) Unit less quantities must be dimensionless /

(*d*) Both (*b*) & (*c*)

60. **Assertion (A):** The unit vectors $\hat{i}, \hat{j}$ and $\hat{k}$ have units of distance and dimensions $[M^0L^1T^0]$

Reason (R): The product of a scalar and a vector is a new scalar.

(*a*) If both Assertion (A) & Reason (R) are True & the Reason (R) is a correct explanation of the Assertion (A).

(*b*) If both Assertion (A) & Reason (R) are True but Reason (R) is not a correct explanation of the Assertion (A).

(*c*) If Assertion (A) is True but the Reason (R) is False.

(*d*) If both Assertion (A) & Reason (R) are false.

61. Which of the following is a dimensional constant?

(*a*) Relative density (*b*) Gravitational constant

(*c*) Refractive inbox (*d*) Poisson's ratio

62. The relation between [E] and [B] is

(*a*) [E] = [B][L][T] (*b*) $[E] = [B][L]^{-1}[T]$

(*c*) $[E] = [B][L][T]^{-1}$ (*d*) $[E] = [B][L]^{-1}[T]^{-1}$

63. In the expression $P = El^2m^{-5}G^{-2}$, where E, m, l and G denote energy, mass, angular momentum and gravitational constant, respectively.

The dimensions of P are

(*a*) $[MLT^0]$ (*b*) $[M^2LT^{-1}]$

(*c*) $[M^0L^0T^0]$ (*d*) $[M^0 LT^{-2}]$

64. The pairs of physical quantities that have the same dimensions is/are

I. Volumetric strain and coefficient of friction.

II. Disintegration constant of a radioactive substance and frequency of light wave.

III. Heat capacity and gravitational potential.

IV. Stefan's constant and Wien's constant.

(*a*) I, II and IV (*b*) I, III and IV

(*c*) I, II and III (*d*) I and II

65. Match the following columns.

	Column-I		Column-II
(A)	A physical quantity which has a unit but no dimensions	1.	Gravitational constant
(B)	A physical quantity which has neither unit nor dimensions	2.	Reynold number
(C)	A constant which has a unit	3.	Strain
(D)	A constant which has no unit	4.	Plane angle

(*a*) 4 3 1 2 (*b*) 3 4 2 1

(*c*) 1 2 3 4 (*d*) 1 4 2 3

66. Which of the following physical quantities have the same dimensions?

(*a*) Electric displacement ($\vec{D}$) and surface charge density

(*b*) Displacement current and electric field

(*c*) Current density and surface charge density

(*d*) Electric potential and energy

Units and Dimensions

85. $Y = \log e^{\alpha t}$ then find dimension of α?

86. F = 2V – 6t. Find dimension of '2' & '6' Where F is force, V = velocity, t = time

(*a*) Both are dimensionless (*b*) MT^{-1}, MLT^{-3}

(*c*) $ML^{-1}T^{-2}$, MLT^{-3} (*d*) MTT^{-3}, MT^{-1}

87. Force (F) and density (*d*) are related as $F = \frac{\alpha}{\beta + \sqrt{d}}$ Then, the dimensions of α and β are

(*a*) $[M^{3/2} L^{-1/2} T^{-2}]$, $[ML^{-3} T^0]$

(*b*) $[M^{3/2} L^{-1/2} T^{-2}]$, $[M^{1/2} L^{-3/2} T^0]$

(*c*) $[M^2 L^2 T^{-1}]$, $[ML^{-1} T^{-3/2}]$

(*d*) $[MLT^{-2}]$, $[ML^{-2} T^{-2/3}]$

88. The force is given in terms of time *t* and displacement *x* by the equation $F = A \cos Bx + C \sin Dt$

The dimensional formula of $\frac{AD}{B}$ is

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

Dimensional Analysis

89. If force (F), acceleration (*a*) and time *t* is used as a fundamental P.Q. then find dimension of length in terms of them :-

(*a*) $F^0a^1T^2$ (*b*) Fa^2T^2 (*c*) $F a^2 T^0$ (*d*) $F^0 a T$

90. If time (*t*), energy (*E*) and momentum (*P*) taken as base quantities then dimension of mass (*m*), is

(*a*) $m = k t^0 P^2 E^{-1}$ (*b*) $m = k t^0 P^{-1} E^2$

(*c*) $m = k t P^2 E$ (*d*) $m = k t^0 P^2 E$

91. If mass (M), velocity (V) and time (T) are taken as fundamental units, then the dimensions of force (F) are

(*a*) [M V T] (*b*) $[M V T^{-1}]$

(*c*) $[M^2 V T]$ (*d*) $[M^{-1}V^{-1}T]$

92. The frequency of vibrations *f* of a mass m suspended from a spring of spring constant K is given by a relation of type $f = cm^x K^y$, where *c* is a dimensionless constant. The values of *x* and *y* are

(*a*) $x = \frac{1}{2}, y = \frac{1}{2}$ (*b*) $x = \frac{-1}{2}, y = \frac{-1}{2}$

(*c*) $x = \frac{1}{2}, y = \frac{-1}{2}$ (*d*) $x = \frac{-1}{2}, y = \frac{1}{2}$

93. If force acceleration and time are basic fundamental P.Q. then find dimension of energy

(*a*) $F^2A^{-1}T$ (*b*) $F A T^2$

(*c*) $F A T^{-2}$ (*d*) $F A^{-1}T$

94. If surface tension (S), moment of inertia (I) and Planck's constant (*h*), were to be taken as the fundamental units, the dimensional formula for linear momentum would be

(*a*) $S^{3/2}[I^{1/2}h^0]$ (*b*) $S^{1/2}[I^{1/2}h^0]$

(*c*) $S^{1/2}[I^{1/2}h^{-1}]$ (*d*) $S^{1/2}[I^{3/2}h^{-1}]$

95. The frequency (v) of an oscillating liquid drop may depend upon radius (*r*) of the drop, density (ρ) of liquid and the surface tension (s) of the liquid as: $v = r^a \rho^b s^c$. The values of *a,b* and *c* respectively are

(*a*) $\left(-\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$ (*b*) $\left(\frac{3}{2}, -\frac{1}{2}, \frac{1}{2}\right)$

(*c*) $\left(\frac{3}{2}, \frac{1}{2}, -\frac{1}{2}\right)$ (*d*) $\left(-\frac{3}{2}, \frac{1}{2}, \frac{1}{2}\right)$

96. The speed of a wave produced in H_2O is given by $v = \lambda^a g^b \rho^c$, where λ, g, ρ pare wavelength of wave, acceleration due to gravity & density of water respectively. The value of a, b & c respectively are :

(*a*) $\frac{1}{2}, 0, \frac{1}{2}$ (*b*) 1, 1, 0

(*c*) 1, –1, 0 (*d*) $\frac{1}{2}, \frac{1}{2}, 0$

97. If force F, area A and density D are taken as the fundamental units, the representation of Young's modulus 'Y' will be:

(*a*) $[F^{-1}A^{-1}D^{-1}]$ (*b*) $[FA^{-2}D^2]$

(*c*) $[FA^{-1}D]$ (*d*) $[FA^{-1}D^0]$

98. If maximum acceleration of oscillating particle is α and maximum velocity is β, then find time period

(*a*) $2\pi\frac{\alpha}{\beta}$ (*b*) $2\pi\alpha\beta$ (*c*) $2\pi\frac{\beta}{\alpha}$ (*d*) $\frac{2\pi\alpha^2}{\beta^2}$

99. Plank's constant (*h*), speed of light in vacuum (*c*) and Newton's gravitational constant (*G*) are three fundamental constants, Which of the following combinations of these has the dimension of length?

(*a*) $\frac{\sqrt{hG}}{c^{3/2}}$ (*b*) $\frac{\sqrt{hG}}{c^{5/2}}$ (*c*) $\sqrt{\frac{hc}{G}}$ (*d*) $\frac{\sqrt{Gc}}{h^{3/2}}$

100. If dimensions of critical velocity v_c of a liquid flowing through a tube are expressed as $\eta^x \rho^y r^z$ where η ρ r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of *x,y* and *z* are given by

(*a*) 1,1,1 (*b*) 1, –1,–1

(*c*) –1,–1,1 (*d*) –1,–1,–1

101. If momentum [P], area [A] and time [T] are taken as fundamental quantities, then the dimensional formula for coefficient of viscosity is:

(*a*) $[PA^{-1}T^0]$ (*b*) $[PAT^{-1}]$

(*c*) $[PA^{-1}T]$ (*d*) $[PA^{-1}T^{-1}]$

102. A spherical ball is moving through a viscous medium. If the viscous force acting on the ball is proportional to speed of the ball, then the dimensions of proportionality constant is

(*a*) $[M L^{-1} T^{-1}]$ (*b*) $[M L^{-2} T^{-1}]$

(*c*) $[M L T^{-2}]$ (*d*) $[M L^0 T^{-1}]$

103. Force acting on object is proportional to squre of velocity then find dimensions of proportional constant.

MR* CORNER

Direction: In the questions given below, the first statement is given as Assertion(A) and other as Reason(R). for each questions, choose correct option from the following

(*a*) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(*b*) If both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).
(*c*) If Assertion (A) is true but Reason (R) is false.
(*d*) If both Assertion (A) and Reason (R) are false.

1. **Assertion (A):** Force can be added to pressure.
Reason (R): Force and pressure have same dimensions.

2. **Assertion (A):** Both velocity and speed have same dimensions.
Reason (R): Velocity cannot be added to speed.

3. **Assertion (A):** The given equation $x = x_0 + u_0t + 1/2\ at^2$ is dimensionally correct, where x is the distance travelled by a particle in time t, initial position x_0 initial velocity u_0 and uniform acceleration a is along the direction of motion.
Reason (R): Dimensional analysis can be used for checking the dimensional consistency or homogeneity of the equation.

4. **Assertion (A):** Mass, length and time are fundamental physical quantities.
Reason (R): They are independent of each other.

5. **Assertion (A):** Density is a derived physical quantity.
Reason (R): Density cannot be derived from the fundamental physical quantities.

6. **Assertion (A):** When we change the unit of measurement of a quantity, its numerical value changes.
Reason (R): Smaller the unit of measurement, smaller is its numerical value.

7. **Assertion (A):** L/R and CR both have the same dimensions.
Reason (R): L/R and CR both have the dimension of time.

8. **Assertion (A):** A screw gauge having a smaller value of pitch has greater accuracy.
Reason (R): The least count of screw gauge is directly propor- tional to the number of divisions on circular scale.

9. **Assertion (A):** All unitless quantities are dimensionless.
Reason (R): Dimensions are exponent raised to fundamental units in derived units.

10. **Assertion (A):** Power of an engine depends on mass, angular speed, torque and angular momentum, so the formula of power is not derived with the help of dimensional method.
Reason (R): In mechanics, if a particular quantity depends on more than three quantities, then we cannot derive the formula of the quantity by the help of dimensional method.

11. **Assertion (A):** Temperature cannot be expressed as a derived quantity in terms of length and mass.
Reason (R): Temperature is a fundamental quantity.

12. **Assertion (A):** Quality factor is dimensionless.
Reason (R): Quality factor depends on resistance, inductance and capacitance of LCR series circuit.

13. **Assertion (A):** The unit of EMF is Joule/Coulomb.
Reason (R): EMF is an electromagnetic force.

14. **Assertion (A):** A physical quantity is measured and its value is always found to be nu; where n is the numerical value and u is the unit.
Reason (R): $n \propto \frac{1}{u}$.

15. **Assertion (A):** The random error in the arithmetic mean of 100 observations is x; then random error in the arithmetic mean of 400 observations would be $x/4$.
Reason (R): Arithmetic mean of the magnitudes of absolute errors in n measurements of the quantity is represented by $\overline{\Delta a} = \frac{|\Delta a_1| + |\Delta a_2| + ... + |\Delta a_n|}{n}$

16. **Assertion (A):** Systematic error can be minimised.
Reason (R): Systematic error can be calculated.

17. **Assertion (A):** The period of oscillation of a simple pendulum in the experiment is recorded as 2.63 s, 2.56 s, 2.42 s, 2.71 s and 2.80 s, respectively. The average absolute error is 0.11 s.
Reason (R): Mean absolute error $= \frac{\text{Sum of absolute errors}}{\text{Numbers of observations}}$

18. **Assertion (A):** Measurement's precision is determined by least count of measuring instrument.
Reason (R): Smaller the least count, more is the precision

19. **Assertion (A):** Specific gravity of liquid is dimensionless.
Reason (R): It is the ratio of density of liquid to density of water.

20. **Assertion (A):** Methods of dimensions cannot be used for deriving formula containing trigonometric ratios.
Reason (R): Trigonometric ratios have no dimensions.

21. **Assertion (A):** Both plane and solid angles are fundamental units.
Reason (R): Both have the same units.

22. **Assertion (A):** Astronomical unit is a unit for measuring large distances.
Reason (R): It is the distance covered by light in one year.

Answer Key

1. (*a*) **2.** (*d*) **3.** (*e*) **4.** (*a*) **5.** (*d*) **6.** (*b*) **7.** (*b*) **8.** (*a*) **9.** 2500 m/s

10. (*c*) **11.** (*b*) **12.** (*a*) **13.** (*b*) **14.** (*a*) **15.** (*a*) **16.** (*c*) **17.** (*c*) **18.** (*b*) **19.** (*a*)

20. (*d*) **21.** (*d*) **22.** (*c*) **23.** (*c*) **24.** (*d*) **25.** (*a*) **26.** (*c*) **27.** (*a*) **28.** $ML^{-1}T^{-2}$ **29.** $ML^2T^{-3}A^{-2}$

30. $ML^2T^{-2}A^{-2}$ **31.** $MLT^{-2}A^{-2}$ **32.** $MT^{-2}A^{-1}$, $ML^2T^{-2}A^{-1}$ **33.** $ML^{-1}T^{-1}$ **34.** (*c*) **35.** (*d*)

36. (*a*) **37.** (*a*) **38.** (*a*) **39.** (*a*) **40.** (*c*) **41.** (*a*) **42.** (*d*) **43.** (*b*) **44.** (*b*) **45.** (*c*)

46. (*b*) **47.** (*d*) **48.** (*c*) **49.** (*c*) **50.** (*a*) **51.** (*d*) **52.** (*a*) **53.** (*b*) **54.** (1) May have dimension/may be dimensionless, (2) Must be dimensionless/does not have dimension, (3) Must have unit, (4) May or may not have unit

55. (*b*) **56.** (*a*) **57.** (*b*) **58.** (*b*) **59.** (*d*) **60.** (*d*) **61.** (*b*) **62.** (*c*) **63.** (*c*) **64.** (*d*)

65. (*a*) **66.** (*a*) **67.** (*d*) **68.** (*b*) **69.** $a = MLT^{-3}$, $b = MLT^{-4}$ **70.** $A = LT^{-1}$, $B = T^{-1}$ **71.** (*b*)

72. (*c*) **73.** (*b*) **74.** (*b*) **75.** (*b*) **76.** (*a*) **77.** $\beta = L^{-1}$, $\alpha = T^{-1}$ **78.** (*a*) **79.** (*d*)

80. $\alpha = [MLT^{-2}]$, $\beta = [M^0L^0T^0]$, $\gamma = [L^{-1}]$ **81.** (*b*) **82.** $A = L^1$, $k = L^{-1}$, $\omega = T^{-1}$ **83.** (*b*) **84.** (*a*)

85. $\alpha = T^{-1}$ **86.** (*b*) **87.** (*b*) **88.** (*c*) **89.** (*a*) **90.** (*a*) **91.** (*b*) **92.** (*d*) **93.** (*b*) **94.** (*b*)

95. (*a*) **96.** (*d*) **97.** (*d*) **98.** (*c*) **99.** (*a*) **100.** (*b*) **101.** (*a*) **102.** (*d*) **103.** (*d*) **104.** (*a*)

105. (*a*) **106.** (*b*) **107.** (*a,b,d*) **108.** (*a*) **109.** (*a*) **110.** (*d*) **111.** (*c*) **112.** (*b, d*) **113.** (*a*) **114.** (*a*)

115. (*d*) **116.** (*d*) **117.** (*a*) **118.** (*d*) **119.** (*d*) **120.** (*d*) **121.** (*a*) **122.** (1) Must be physically wrong, (2) May or amy not physically correct, (3) May or may be dimensionally correct (4)Must be dimensionally correct $S_n = u + \frac{a}{2}(2n-1)$ (S_nth → dimensionally correct becouse it is displacement in one sec.) **123.** (*d*) **124.** (*c*)

125. (i) 3, (ii) 4, (iii) 4, (iv) infinite. **126.** (*b*) **127.** (*d*) **128.** I-B, II-A, III-D, IV-C **129.** (*b*) **130.** (*b*)

131. (*b*) **132.** (*b*) **133.** (*a*) **134.** (i) 119.9 (ii) 201.87 **135.** (*b*) **136.** (*d*) **137.** (*d*) **138.** (*a*) **139.** (*a*)

140. (*a*) **141.** (*a*) **142.** (*a*) **143.** (*a*) **144.** (i) 2.62, (ii) 0.01, 0.06, 0.2, 0.09, 0.18, (iii) 0.11, (iv) 0.042, (iv) 4.2%

145. (*a*) **146.** 1% **147.** (*a*)

148. (*d*) **149.** (*c*) **150.** 5% **151.** (*b*) **152.** (i) $\frac{\Delta x}{x} = \frac{0.6}{30}$, (ii) $\frac{\Delta y}{y} = \frac{0.6}{10}$, (iii) $\frac{\Delta z}{z} = \left(\frac{0.5}{20} + \frac{0.1}{10}\right)$, (iv) $\frac{\Delta m}{m} = \frac{7}{200}$

153. (*a*) **154.** (*c*) **155.** (*a*) **156.** sum = (50 ± 0.7)°C, Difference = (30 ± 0.7)°C **157.** (*c*) **158.** (*d*) **159.** (*d*)

160. (*d*) **161.** (*d*) **162.** (*b*) **163.** (*b*) **164.** (*b*) **165.** (*d*) **166.** 10.1% **167.** (*b*) **168.** (*c*) **169.** (*a*)

170. $\frac{\pi}{\sqrt{3}}\%$ **171.** 45° **172.** 10% **173.** 125% **174.** (I) (150 ± 6) Ω, (II) (33.1 ± 3.1) Ω **175.** (*b*)

176. (1) Vernier Calliper, (2) screw gauge, (3) metre scale, (4) Vernier Calliper, (5) Vernier Calliper, (6) screw gauge, (7) screw gauge 14

177. (*d*) **178.** (*c*) **179.** (*a*) **180.** (*a*) **181.** (*c*) **182.** (*c*) **183.** 12/20 **184.** (*c*) **185.** 15.6 mm

186. (*b*) **187.** (*b*) **188.** (*c*) **189.** (*c*) **190.** (*a*) **191.** (*d*) **192.** (*d*) **193.** (*d*) **194.** (*b*)

195. (*a*) **196.** (*b*) **197.** 12% **198.** 3% **199.** (*d*)

MR* CORNER

1. (*d*) **2.** (*b*) **3.** (*a*) **4.** (*a*) **5.** (*c*) **6.** (*c*) **7.** (*a*) **8.** (*c*) **9.** (*b*) **10.** (*a*)

11. (*a*) **12.** (*b*) **13.** (*b*) **14.** (*a*) **15.** (*b*) **16.** (*d*) **17.** (*a*) **18.** (*a*) **19.** (*a*) **20.** (*a*)

21. (*d*) **22.** (*d*)

PHYSICS WALLAH

YAKEEN NEET

- Units and Measurements
- Mathematical Tools
- Motion in a Straight Line
- Motion in a Plane
- Newton's Laws of Motion

Physics

MODULE 1

3P PROGRESSOR

PLANNER

CHAPTER NAMES	Start Date of Module	End Date of Module	Solve More **PYQs**	Revision Period	Re-revision Period (**Before Test Series**)
Units and Measurements					
Mathematical Tools					
Motion in a Straight Line					
Motion in a Plane					
Newton's Laws of Motion					

PROGRESS TRACKING

CHAPTER NAMES	Solved Examples	Topicwise	Learning Plus	Multi Concept	PYQs
Units and Measurements					
Mathematical Tools					
Motion in a Straight Line					
Motion in a Plane					
Newton's Laws of Motion					

PREP POINTERS

Note down the topic you want to revise or section you want to re attempt while your preparation.

The Power of Gratitude: Transforming Challenges into Opportunities

Gratitude is about recognizing and appreciating the good, even amid challenges. For a NEET aspirant, it means being thankful for opportunities to learn, support from teachers and family, and every bit of progress made. It's more than just saying "thank you"—it's developing a mindset that helps you focus on the positives, manage stress, boost motivation, and stay resilient throughout your preparation.

> *"When we focus on our gratitude, the tide of disappointment goes out and the tide of love rushes in."*
> **— Kristin Armstrong**

Without Gratitude

- Lack of gratitude may lead to frustration and a focus on shortcomings, draining motivation and joy.
- A negative mindset without gratitude amplifies stress, making it harder to maintain focus and resilience in challenging times.

With Gratitude

- Gratitude cultivates a positive mindset, helping students appreciate their efforts and small achievements, boosting morale.
- Gratitude enhances emotional well-being, reducing stress and keeping students motivated throughout their preparation journey.

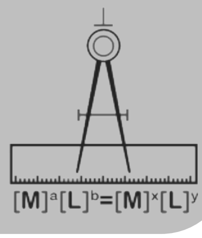
SCENARIOS

Without Gratitude	Scenario	*With Gratitude*
Feel frustrated, focusing only on mistakes and failures.	After a Difficult Mock Test	Appreciate the opportunity to learn and grow from the experience.
View feedback as criticism, leading to resentment.	Feedback from a Teacher	Feel thankful for the teacher's effort to guide and improve performance.
Feel burdened and complain about the workload.	Studying Long Hours	Be grateful for the resources, time, and opportunity to work toward goals.
Feel irritated and give up, thinking "Why is this so hard for me?"	Facing a Tough Concept	Appreciate the challenge as a chance to expand knowledge and skills.
Feel envious and dissatisfied, focusing on what others have achieved.	Comparing Scores with Friends	Feel thankful for personal progress and the journey of self-improvement.
Feel regretful, thinking "I'm missing out on so much fun."	Missing a Social Event for Study	Be grateful for the chance to invest in future success and fulfillment.
Feel defeated and think "Why do things always go wrong for me?"	Unexpected Challenges During Preparation	Appreciate the strength and resilience developed through overcoming obstacles.
Feel bored and complain about the monotony.	Daily Study Routine	Be grateful for the discipline, structure, and consistency driving progress.

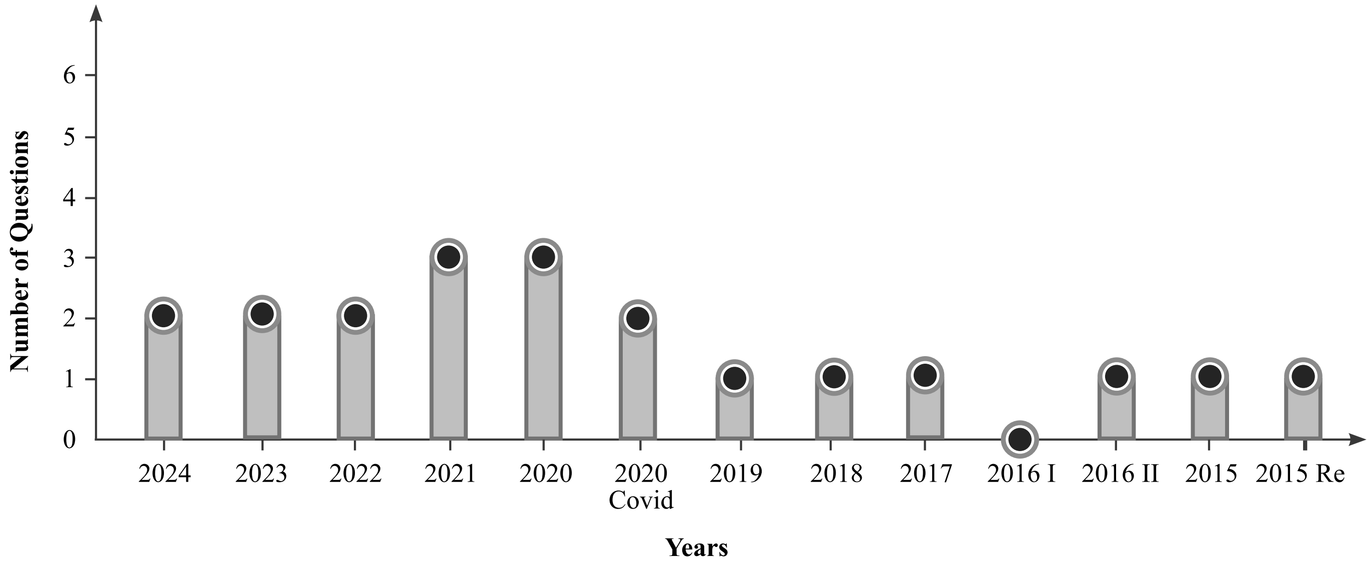
This demonstrates how adopting a mindset of **Gratitude** can help students navigate the stresses and challenges of exam preparation with more resilience and positivity. It highlights how a shift in perspective can transform obstacles into opportunities for growth and improvement.

CHAPTER 1

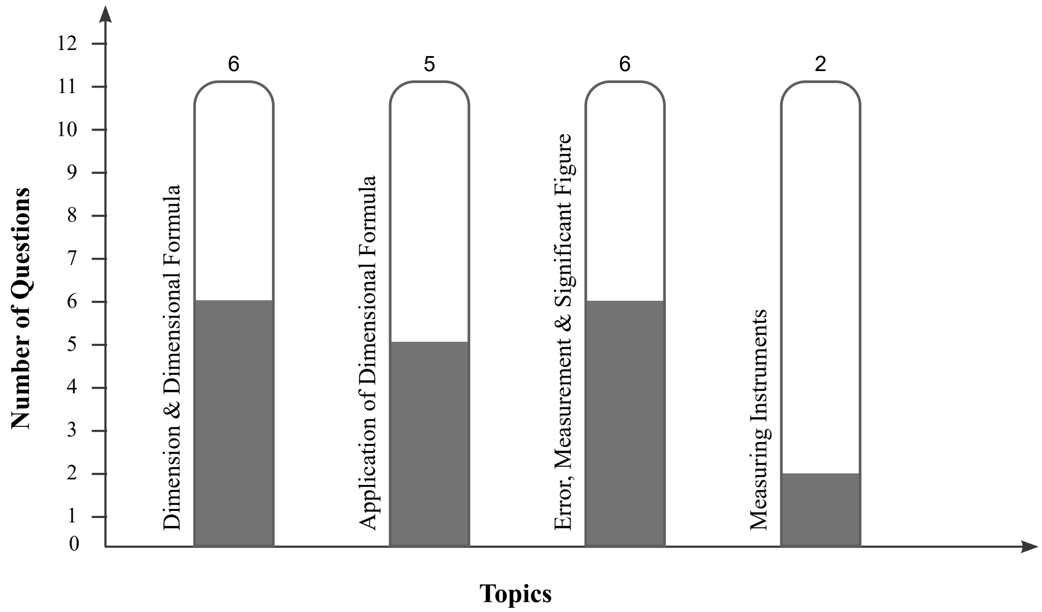
Units and Measurements



Year Wise Number of Questions Analysis (2024-2015)



Topicwise Number of Questions Analysis (2024-2015)



PHYSICAL WORLD

What is Science?

- Science is a systematic attempt to understand natural phenomena in as much detail and depth as possible, and use the knowledge so gained to **Predict**, **Modify** and **Control phenomena**.
- The word **'Science'** originates from the latin verb **'Scientia'** meaning **'to know'**.
- The Sanskrit word **'Vijnan'** and the Arabic word **'Ilm'** convey same meaning, namely 'Knowledge'.

What is Physics?

- Physics is a study of the basic laws of nature and its manifestation in different natural phenomena.
- Physics comes from a Greek word **"Fusis"** signifies **'nature'**.
- The Sanskrit word **'Bhautiki'** convey similar meaning **'to the study of physical world'**.

Fundamental Forces in Nature

There are four fundamental forces in nature.

Gravitational Force

- Gravitational force is weakest force and conservative in nature.
- It is the force of mutual attraction between any two objects by virtue of their masses.
- It is a universal force and always attractive in nature.
- It plays a key role in the large scale phenomena of universe such as formation and evolution of stars, galaxies and galactic clusters.
- The gravitational force is appreciable only when at least one of the two bodies has a large mass.

Electromagnetic Force

- Electromagnetic force is the force between charge particles.
- They are attractive as well as repulsive in nature.
- It is quite strong compared to gravity.
- Electric and magnetic effects are in general inseparable; hence the name electromagnetic force.
- Like the gravitational force, electromagnetic force act over large distances and does not need any intervening medium.
- For example electric force between two protons is 10^{36} times the gravitational force between them, for a certain distance.

Strong Nuclear Force

- It is independent of charge.
- The strong nuclear force binds protons and neutrons in a nucleus. It is evident that without some attractive force, a nucleus will be unstable due to electric repulsion between protons.
- The strong nuclear force is the strongest of all fundamental forces.
- Recent developments have however indicated that protons and neutrons are composed of still more elementary constituents called quarks.
- It's range is extremely small of the order nuclear dimensions (10^{-15}m).
- It is responsible for the stability of nuclei.

Weak Nuclear Force

- The weak nuclear force is not as weak as the gravitational force but much weaker than strong nuclear force.
- The weak nuclear force appears only in certain nuclear processes β-decay of a nucleus.
- The range of weak nuclear force is exceedingly small of the order 10^{-16}m.

Key Note

- Range of gravitational Force > Range of Electromagnetic Force > Range of Nculear force.
- Strength of Nuclear Force > Strength of Electromagnetic Force > Strength of Gravitational Force.

Table: Fundamental Force of Nature

Name	Relative Strength	Range	Operatres Among	Mediating Particle
Gravitational Force	10^{-39}	Infinite	All objects in the universe	Graviton
Weak Nuclear Force	10^{-13}	Very short, Sub-nuclear size (~10^{-16}m)	Some elementary particles, Particularly electron and antineutrino	Boson
Electromagnetic	10^{-2}	Infinite	Charges Particles	Photon
Strong Nuclear Force	1	Short Nuclear size (~10^{-15}m)	Nucleons, Havier elementary Particles	Gluon

PHYSICAL QUANTITIES

All quantities that can be measured are called physical quantities. *e.g.*, length, mass, force, work done, etc. In physics we study about physical quantities and their inter relationship.

There are two types of physical quantities

1. **Fundamental Quantity:** Physical quantities that are independent of all other quantities and do not require the help of any other physical quantity for their definition are known as fundamental quantities. There are seven fundamental quantities. Mass, Length, Time, Temperature, Current, Luminous Intensity, Amount of Substance.
2. **Derived Quantity:** Physical Quantities which are derived from fundamental quantities are called derived quantities. *e.g.*, Area, density, force etc.

MEASUREMENT

Measurement is the comparison of a physical quantity with a standard of the same physical quantity.

Different countries followed different standards.

Units of Measurement of Physical Quantity

A fixed measurement chosen as a standard of measurement to measure a physical quantity is called a Unit.

To measure a physical quantity means to determine the number of times its standard unit is contained in that physical quantity.

A standard unit is necessary for the sake of;

1. Accuracy,
2. Convenience,
3. Uniformity and
4. Equal justice to all.

The standard unit chosen should have the following characteristics;

1. Consistency or invariability
2. Availability
3. Imperishability Permanency
4. Convenience and acceptability.
5. Reproducibility

Based on the dependency units are classified in two types:

1. **Fundamental unit:** The unit used to measure the fundamental quantity is called fundamental unit.
   e.g., Metre for length, kilogram for mass etc.
2. **Derived unit:** The unit used to measure the derived quantity is called derived unit.
   e.g., Metre^2 for area, gram Centimeter^{-3} for density etc.

Systems of Units

There are four systems of units

1. **FPS or British Engineering system:** In this system length, mass and time are taken as fundamental quantities and their base units are foot (ft), pound (lb) and second (s) respectively.
2. **CGS or Gaussian system:** In this system the fundamental quantities are length, mass and time and their respective units are centimetre (cm), gram (g) and second (s).
3. **MKS system:** In this system also the fundamental quantities are length, mass and time but their fundamental units are metre (m), kilogram (kg) and second (s) respectively.

Units of some fundamental physical quantities in different systems

Type of physical Quantity	Physical Quantity	System		
		CGS	MKS	FPS
Fundamental	Length	cm	m	ft
	Mass	g	kg	lb
	Time	s	s	s

4. **International system (SI) of units:** This system is modification over the MKS system. Besides the three base units of MKS system four fundamental and two supplementary units are also included in this system.

Based on SI there are three categories of physical quantities:

1. 7 Fundamental quantities
2. 2 Supplementary quantities
3. Derived quantities

FUNDAMENTAL QUANTITIES AND THEIR S.I. UNITS

There are seven fundamental quantities and two supplementary quantities in S.I. system. The names and units with symbols are given below:

Classification	Physical Quantity	Unit	Symbol	Definition
Fundamental Quantity	Length	metre	m	The metre, symbol m, is the SI unit of length. It is defined by taking the fixed numerical value of the speed of light in vacuum *c* to be 299792458 when expressed in the unit m s^{-1}, where the second is defined in terms of the caesium frequency $\Delta\nu_{Cs}$.
	Mass	kilogram	kg	The kilogram, symbol kg, is the SI unit of mass. It is defined by taking the fixed numerical value of the Planck constant *h* to be $6.62607015 \times 10^{-34}$ when expressed in the unit J s, which is equal to kg m^2 s^{-1}, where the metre and the second are defined in terms of *c* and $\Delta\nu_{Cs}$.
	Time	second	s	The second, symbol s, is the SI unit of time. It is defined by taking the fixed numerical value of the caesium frequency $\Delta\nu_{Cs}$, the unperturbed ground state hyperfine transition frequency of the caesium-133 atom, to be 9192631770 when expressed in the unit Hz, which is equal to s^{-1}.
	Electric	ampere	A	The ampere, symbol A, is the SI unit of electric current. It is defined by taking the fixed numerical value of the elementary charge *e* to be $1.602176634 \times 10^{-19}$ when expressed in the unit *C*, which is equal to A s, where the second is defined in terms of $\Delta\nu_{Cs}$.
	Thermo dynamic Temperature	kelvin	K	The kelvin, symbol K, is the SI unit of thermodynamic temperature. It is defined by taking the fixed numerical value of the Boltzmann constant k to be 1.380649×10^{-23} when expressed in the unit J K^{-1}, which is equal to kg m^2 s^{-2} k^{-1}, where the kilogram, metre and second are defined in terms of *h*, *c* and $\Delta\nu_{Cs}$.
	Amount of substance	mole	mol	The mole, symbol mol, is the SI unit of amount of substance. One mole contains exactly $6.02214076 \times 10^{23}$ elementary entities. This number is the fixed numerical value of the Avogadro constant, N_A, when expressed in the unit mol^{-1} and is called the Avogadro number. The amount of substance, symbol *n*, of a system is a measure of the number of specified elementary entities. An elementary entity may be an atom, a molecule, an ion, an electron, any other particle or specified group of particles.
	Luminous intensity	candela	cd	The candela, symbol cd, is the SI unit of luminous intensity in given direction. It is defined by taking the fixed numerical value of the luminous efficacy of monochromatic radiation of frequency 540×10^{12} Hz, K_{cd}, to be 683 when expressed in the unit lm W^{-1}, which is equal to cd sr W^{-1}, or cd sr $kg^{-1}m^{-2}s^3$, where the kilogram, metre and second are defined in terms of *h*, *c* and $\Delta\nu_{Cs}$.
Supplementary Quantity	1. Plane angle (radian) 2. Solid Angle (steradian)	Radian Steradian	Rad sr	Angle = arc/radius, $\theta = l/r$ $\Omega = \text{Area}/(\text{Radius})^2$

Some Special Units for Length

Angstrom (Å) = 10^{-10} m = 10^{-8} cm
Nanometre (nm) = 10^{-9} m = 10 Å
Fermi = 10^{-15} m
Micron = 10^{-6} m
X-ray unit = 10^{-13} m
1 Astonomical Unit (A.U.) = Mean distance between sun & earth
= 1.496×10^{11} m
1 Light year = Distance travelled by light in one year in vacuum or air having speed 3×10^8 m/s.
= 9.46×10^{15} m
Bohr radius = 0.5×10^{-10} m
Mile = 1.6 km

Some Special Units for Mass

Quintal = 100 kg
Metric ton = 1000 kg
Atomic mass unit (a.m.u) = 1.67×10^{-27} kg

Some Special Units for Time

Shake = 10^{-8} second

Abbreviations for Multiples and Sub Multiples

Macro Prefixes:

Multiplier	Symbol	Name
10^1	da	Deca
10^2	h	Hecto
10^3	K	Kilo
10^6	M	Mega
10^9	G	Giga
10^{12}	T	Tera
10^{15}	P	Peta

Micro Prefixes:

Multiplier	Symbol	Name
10^{-1}	d	deci
10^{-2}	c	centi
10^{-3}	m	milli
10^{-6}	μ	micro
10^{-9}	n	nano
10^{-12}	p	pico
10^{-15}	f	femto

Some Important Conversions

$$1 \text{ km/h} = \frac{1000\text{m}}{3600\text{s}} = \frac{5}{18}\text{ms}^{-1}$$

1 newton = 10^5 dyne
1 joule = 10^7erg
1 calorie = 4.18 Joule
1 electron Volt = 1.6×10^{-19} Joule
1 gcm^{-3} = 1000 kgm^{-3}
1 L = 1000 cm^3 = 10^{-3} m^3
1kWh = 36×10^5 J
1 HP = 746 W

$$1 \text{ degree} = \frac{\pi}{180}\text{rad.}$$

1 kg-wt = 9.8 N

Some Physical Constants and their Values

1 amu = 1.67×10^{-27} kg = 931 MeV
1 atm = 76 cm of Hg = 1.013×10^5 Pa
Avagadro number (N) = 6.023×10^{23}
Permittivity of free space (ε_0) = 8.854×10^{-12} F–m^{-1}
Permeability of free space (μ_0) = $4\pi \times 10^{-7}$ H–m^{-1}
Joule's constant (J) = 4.186 J Cal^{-1}
Planck's constant (h) = 6.62×10^{-34} Js
Rydberg's constant (R) = 1.0974×10^7 m^{-1}
Boltzmann's constant (K) = 1.38×10^{-23} JK^{-1}
Stefan's constant (σ) = 5.67×10^{-8} Wm^{-2} K^{-4}
Universal gas constant (R) = 8.314 J mol^{-1} K^{-1}
= 1.98 cal mol^{-1} K^{-1}
Wien's constant (b) = 2.93×10^{-3} mK

DIMENSIONS AND DIMENSIONAL FORMULA

All the physical quantities of interest can be derived from the base quantities. The power (exponent) of base quantity that enters into the expression of a physical quantity, is called the dimension of the quantity in that base. To make it clear, consider the physical quantity force.

Force = mass × acceleration

$$= \text{mass} \times \frac{\text{velocity}}{\text{time}} = \text{mass} \times \frac{\text{length/time}}{\text{time}}$$

$$= \text{mass} \times \text{length} \times (\text{time})^{-2}$$

So the dimensions of force are 1 in mass, 1 in length and –2 in time.

Such an expression for a physical quantity in terms of base quantities is called dimensional formula.

Based on dimensions Physical quantity can be further divided in to four types:

1. **Dimensional Constants:** The physical quantities which have dimensions and have a fixed value are called dimensional constants.
   e.g., Gravitational Constant (G), Planck's Constant (h), Universal gas constant (R), Velocity of light in vacuum (c) etc.,
2. **Dimensionless Quantities:** Dimensionless quantities are those which do not have dimensions but have a fixed value.
   (*i*) Dimensionless quantities without units.
   e.g., Pure numbers, angle etc.
   (*ii*) Dimensionless quantities with units.
   e.g., Angular displacement (radian), Joule's constant (joule/calorie) etc.
3. **Dimensional Variables:** Dimensional variables are those physical quantities which have dimensions and do not have fixed value.
   e.g., velocity, acceleration, force, work, power... etc.

4. **Dimensionless Variables:** Dimensionless variables are those physical quantities which do not have dimensions and do not have fixed value.
e.g., Specific gravity, refractive index, Coefficient of friction, Poisson's Ratio etc.

DIMENSIONAL EQUATION

Whenever the dimension of a physical quantity is equated with its dimensional formula, we get a dimensional equation.
e.g., Force (F) = $[M^1L^1T^{-2}]$, Pressure (P) = $ML^{-1}T^{-2}$

Dimension

Dimensions of a physical quantity are the powers to which the fundamental units are to be raised to obtain one unit of that quantity.

Dimensional Formula

An expression showing the powers to which the fundamental units are to be raised to obtain one unit of the derived quantity is called Dimensional formula of that quantity.
In general the dimensional formula of a quantity can be written as $[M^xL^yT^z]$. Here x, y, z are dimensions of mass, length and time respectively.

Principle of Homogeneity of Dimension

This principle states that the dimensions of all the terms in a physical expression should be same. For example, in the physical expression $s = ut + \frac{1}{2}at^2$, the dimensions of s, ut and $\frac{1}{2}at^2$ all are same.
Note: The physical quantities separated by the symbols +,–, =, >,< etc., have the same dimensions.

USES OF DIMENSIONAL ANALYSIS

(*i*) Dimensional formulae help us to understand the physical behaviour of a quantity. Two different Physical quantities having different dimensions can not be added or subtracted. Thus we cannot add or subtract displacement to the velocity. Thus we must remember that

- If A + B and A – B are meaning full then and A and B must have same dimension and same nature.
- If A = B, then A and B have same dimension and same nature.

(*ii*) **To check the dimensional correctness of a given physical relation:** It is based on principle of homogeneity, which states that a given physical relation is dimensionally correct if the dimensions of the various terms on either side of the relation are the same.

Ex: The distance x travelled by a body in time t which starts from the position x_0 with initial velocity v_0 and has uniform acceleration a, is given by:

$$x = x_0 + v_0t + \frac{1}{2}at^2$$

Check the dimensional consistency of this equation.

Sol. The dimension of the various terms are

$[x] = [L]$

$[x_0] = [L]$

$[v_0t] = [LT^{-1}][T] = [L]$

$\left[\frac{1}{2}at^2\right] = [LT^{-2}][T^2] = [L]$

Since the dimensions of all the terms are same. Hence the given equation is dimensionally correct.

Train Your Brain

Example 1: Check the accuracy of the relation $T = 2\pi\sqrt{\frac{L}{g}}$ for a simple pendulum using dimensional analysis.

Sol. The dimensions of LHS = the dimension of $T = [M^0L^0T^1]$

The dimensions of $\text{RHS} = \left(\frac{\text{dim. of length}}{\text{dim. of acc}^n}\right)^{1/2}$

($\because$ 2π is a dimensionless const.)

$= \left(\frac{L}{LT^{-2}}\right)^{1/2} = (T^2)^{1/2} = (T) = [M^0L^0T^1]$

So Dimensions of LHS = Dimensions of RHS

Example 2: Find dimensions of constant a and b in equation

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

where P is pressure and V is volume, R is universal gas constant and T is temperature.

Sol. We can add and subtract only like quantities.

So, Dimensions of P = Dimension of $\frac{a}{V^2}$

$\therefore$ Dimensions of a = Dimension of P × Dimension of V^2

Dimension of a $= [ML^{-1}T^{-2}]\ [L^3]^2$

Dimension of $a = [M^1L^5T^{-2}]$

and Dimensions of b = Dimension of V

So, Dimension of $b = [L^3]$

Example 3: Find the dimension of (a/b) in the equation:

$$\text{P} = \frac{\text{a} - \text{t}^2}{\text{bx}}$$

where P is pressure, x is distance and t is time.

Sol. Using principle of Homogeneity,

$\therefore$ Dimension of P = $\frac{\text{Dimension of a}}{\text{Dimension of b} \times \text{Dimension of x}}$

$\frac{\text{Dimension of a}}{\text{Dimension of b}}$ = Dimension of P × Dimension of x

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

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

Concept Application

1. Which of the following physical quantities has derived unit?
   (1) Acceleration (2) Mass
   (3) Current (4) Amount of substances
2. The dimension of physical quantity X in the equations, $\text{Force} = \frac{X}{\text{Density}}$.
   (1) $M^2L^2T^{-1}$ (2) $M^2L^{-2}T^{-2}$
   (3) $M^1L^{-2}T^{-1}$ (4) $M^1L^4T^{-2}$
3. 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 then the dimension of b should be.
   (1) LT^{-1} (2) LT^{-2}
   (3) L (4) T^{-1}

1. **To establish a relation between different physical quantities:** If we know the various factors on which a physical quantity depends, then we can find a relation among different factors by using principle of homogeneity.

Ex: Let us find an expression for the time period T of a simple pendulum. The time period T may possibly depend upon

(*i*) Mass m of the bob of the pendulum
(*ii*) Length l of pendulum
(*iii*) Acceleration due to gravity g at the place where the pendulum is suspended.

Sol. Let (*i*) $T \propto m^a$ (*ii*) $T \propto l^b$ (*iii*) $T \propto g^c$

Combining all the three factors, we get

$T \propto m^a l^b g^c$

or $T = Km^a l^b g^c$

Where K is a dimensionless constant of proportionality.

Writing down the dimensions on either side of equation, we get

$[M^0L^0T^1] = [M^a][L^b][LT^{-2}]^c = [M^aL^{b+c}T^{-2c}]$

Comparing power of M, L and T

$a = 0, b + c = 0,$

$-2c = 1$

$\Rightarrow c = -\frac{1}{2}$

$\Rightarrow b = -c = \frac{1}{2}$

So, $T = K\sqrt{\frac{l}{g}}$

2. **To Convert the physical quantity from one system of unit to another system of unit:** According to this magnitude of physical quantity remains same whatever system is used for measure

i.e., magnitude = numerical value × unit = constant

$\therefore$ nu = Constant

So, for two unit systems.

$n_1u_1 = n_2u_2$

If a quantity in represented by $[M^aL^bT^c]$

Then, $n_1 [M_1^aL_1^bT_1^c] = n_2 [M_2^aL_2^bT_2^c]$

Where n_1 and n_2 are numerical values in both systems.

M_1 and M_2 are units of mass in system 1 and 2 respectively.

L_1 and L_2 are units of Length in system 1 and 2 respectively.

T_1 and T_2 are units of Time in system 1 and 2 respectively.

Train Your Brain

Example 4: If P is the pressure of a gas and ρ is its density, then find the dimension of velocity in term of pressure and density.

Sol. **Method-I**

$[P] = [ML^{-1}T^{-2}]$ ...(*i*)

$[\rho] = [ML^{-3}]$ ...(*ii*)

Dividing eq. (*i*) by (*ii*)

$[P\rho^{-1}] = [L^2T^{-2}]$

$\Rightarrow [LT^{-1}] = [P^{1/2}\rho^{-1/2}]$

$\Rightarrow [V] = [P^{1/2}\rho^{-1/2}]$

Method-II

$v \propto P^a \rho^b$

$v = kP^a \rho^b$

$[LT^{-1}] = [ML^{-1}T^{-2}]^a [ML^{-3}]^b$

Comparing both side

$a = \frac{1}{2}, b = -\frac{1}{2} \Rightarrow [V] = [P^{1/2}\rho^{-1/2}]$

Example 5: Find the value of 60J per min on a system that has 100g, 100cm and 1min as the fundamental units.

Sol. Here, $P = \frac{60\text{ joule}}{\text{min}} = \frac{60\text{ joule}}{60\text{ sec}} = 1\text{watt}$

The SI units of Power = $[M^1 L^2 T^{-3}]$

SI	New System of unit
$n_1 = 1$	$n_2 = ?$
M_1 = 1 Kg = 1000 g	M_2 = 100 g
L_1 = 1 m = 100 cm	L_2 = 100 cm
T_1 = 1 sec	T_2 = 1 min = 60 sec

Key Note

- Full names of the units, even when they are named after a scientist should not be written with a capital letter.
  e.g., newton, watt, ampere, metre.
- Units do not take plural form.
  e.g., 10 kg but not 10 kgs, 20 W but not 20 Ws, 2A but not 2 As
- No full stop or punctuation mark should be used within or at the end of symbols for units.
  e.g., 10 W but not 10 W.
- Powers are dimensionless
- sin θ, e^{θ}, cos θ, log θ gives dimensionless value and in above expression θ is dimensionless.

Dimensions of some Mathematical functions

- $\left[\frac{d^n y}{dx^n}\right] = \left[\frac{y}{x^n}\right]$ ∵ [$d^n y$ treated as y only]
- $\left[\int yds\right] = [y\ x]$
- All trigonometric exponential and logarithmic functions are dimensions.

The Following is the list of some Physical Quantities with their Formula and Dimensional Formula				
S. No.	**Physical Quantity**	**Explanation or Formulae**	**Dimensional Formulae**	**S.I.Unit**
1.	Distance, Displacement, Wave Length, Radius of gyration, Circumference, Perimeter, Light year, Par-sec.		$[M^0 L^1 T^0]$	m
2.	Mass		$[M^1 L^0 T^0]$	kg
3.	Period of oscillation, Time, time constant	$T = \frac{\text{total time}}{\text{No. of oscillations}}$ T = Capacitance × Resistance	$[M^0 L^0 T^1]$	s
4.	Frequency	Reciprocal of time period $n = \frac{1}{T}$	$[M^0 L^0 T^{-1}]$	Hertz (Hz)
5.	Area	A = length × breadth	$[M^0 L^2 T^0]$	m^2
6.	Volume	V = Length × breadth × height	$[M^0 L^3 T^0]$	m^3
7.	Density	$D = \frac{\text{Mass}}{\text{Volume}}$	$[M^1 L^{-3} T^0]$	kgm^{-3}
8.	Speed, Velocity	$v = \frac{\text{displacement}}{\text{time}}$	$[M^0 L^1 T^{-1}]$	ms^{-1}
9.	Acceleration	$a = \frac{\text{Change in Velocity}}{\text{time}}$	$[M^0 L^1 T^{-2}]$	ms^{-2}
10.	Linear Momentum	P = mass × velocity	$[M^1 L^1 T^{-1}]$	$kgms^{-1}$
11.	Impulse	J = Force × time	$[M^1 L^1 T^{-1}]$	Ns
12.	Force	F = Mass × acceleration	$[M^1 L^1 T^{-2}]$	N
13.	Work, Energy, PE, KE, Strain Energy	W = Force × displacement P.E = mgh; KE = $\frac{1}{2}MV^2$ $SE = \frac{1}{2}$ × Stress × Strain × Volume	$[M^1 L^2 T^{-2}]$	J(or) N.m

The Following is the list of some Physical Quantities with their Formula and Dimensional Formula				
S. No.	**Physical Quantity**	**Explanation or Formulae**	**Dimensional Formulae**	**S.I.Unit**
14.	Power	$P = \frac{\text{Work}}{\text{time}}$	$[M^1 L^2 T^{-3}]$	Js^{-1} (or) watt
15.	Pressure, Stress, Modulus of Elasticity (Y, n, k)	$\text{pressure} = \frac{\text{Force}}{\text{Area}}$ $Y = \frac{\text{Stress}}{\text{Strain}}$	$[M^1 L^{-1} T^{-2}]$	Nm^{-2} (or) Pascal
16.	Strain	$\frac{\text{Change in dimension}}{\text{Original dimensions}}$	$[M^0 L^0 T^0]$	No units
17.	Angular displacement	$\theta = \frac{\text{length of arc}}{\text{radius}}$	$[M^0 L^0 T^0]$	rad
18.	Angular Velocity	$\omega = \frac{\text{angular displacement}}{\text{time}}$	$[M^0 L^0 T^{-1}]$	$rads^{-1}$
19.	Angular acceleration	$\alpha = \frac{\text{Change in angular velocity}}{\text{time}}$	$[M^0 L^0 T^{-2}]$	$rads^{-2}$
20.	Angular momentum	L = Linear momentum × arm	$[M^1 L^2 T^{-1}]$	Js
21.	Torque	τ = force × ⊥ distance	$[M^1 L^2 T^{-2}]$	Nm
22.	Acceleration due to gravity (g) = gravitational field strength	$g = \frac{\text{weight}}{\text{mass}}$	$[M^0 L T^{-2}]$	ms^{-2} or Nkg^{-1}
23.	Universal gravitational Constant	$G = \frac{F.d^2}{M_1.M_2}$	$[M^{-1} L^3 T^{-2}]$	$Nm^2\ kg^{-2}$
24.	Moment of inertia	$I = MK^2$	$[M^1 L^2 T^0]$	kgm^2
25.	Surface Tension, Spring Constant	$S = \frac{\text{surface energy}}{\text{change in area}} = \frac{\text{force}}{\text{length}}$ $K = \frac{\text{force}}{\text{elongation}}$	$[M^1 L^0 T^{-2}]$	Nm^{-1} or Jm^{-2}
26.	Temperature	θ	$[M^0 L^0 T^0 . \theta^1]$	Kelvin (K)
27.	Electric current	I	$[M^0 L^0 T^0 A]$	A
28.	Charge	Q = Current × time	$[M^0 L^0 T .A]$	C
29.	Electrical resistance	$R = \frac{\text{Pot.diff}}{\text{Current}}$	$[M^1 L^2 T^{-3} A^{-2}]$	Ω

The following is the List of Some Physical Quantities Having Same Dimensional Formulas

S. No.	Physical Quantities	Dimensional Formulas
1.	Distance, Displacement, radius, light year wavelength, radius of gyration	[L]
2.	Speed, Velocity, Velocity of light (c), Relative velocity	$[L T^{-1}]$
3.	Acceleration, acceleration due to gravity, intensity of gravitational field, centripetal acceleration	$[L T^{-2}]$
4.	Impulse, Momentum, Change in momentum	$[M L T^{-1}]$
5.	Force, Weight, Tension, Thrust	$[M L T^{-2}]$
6.	Work, Energy, Moment of force or Torque, Moment of couple, heat	$[M L^2 T^{-2}]$
7.	Force constant, Surface Tension, Spring constant, Energy per unit area, Force gradient	$[M T^{-2}]$
8.	Angular momentum, Angular impulse, Planck's constant	$[M L^2 T^{-1}]$

LIMITATIONS OF DIMENSIONAL ANALYSIS METHOD

There are some limitations of Dimensional Analysis, which are given below:

1. Dimensionless quantities cannot be determined by this method. Constant of proportionality cannot be determined by this method. They can be found either by experiment (or) by theory. (*e.g.*, universal gravitational constan *G*, Planck's constant *h, etc.*)
2. This method is not applicable to trigonometric, logarthmic and exponential functions. (*e.g.*, $y = A \sin(\omega t - kx)$)
3. In the case of physical quantities which are dependent upon more than three physical quantities, this method will be difficult.
4. In some cases, the constant of proportionality also possesses dimensions. In such cases we cannot use this system.
5. If one side of equation contains addition or subtraction of physical quantities, we cannot use this method.

   (*e.g.*, $s = ut + \frac{1}{2}at^2, v = u + at$)
6. Same or may example dimensional quantities may not be unique. for work, energy and torque all have the same dimensional formula ML^2T^{-2}.
7. It gives no information whether a physical quantity is scalar or vector.

Key Note

- A dimensionless quantity may have units, (*e.g.*, radian, steradian) but a unit-less quantity has to be dimensionless.

Order of Magnitude

The order of Magnitude of a physical quantity is the power of 10 which is required to represent the physical quantity. It gives an idea about how big or how small a given physical quantity is:

To determine the order of magnitude of a number *Z*, we first express it as

$$Z = Y \times 10^x$$

If $0.5 < Y \leq 5$ then *x* will be the order of magnitude of *Z*.

Some Examples are given below:

Measure No. Z	Expressed Nearest power of 10	Order of Magnitude
7	0.7×10^1	1
48	4.8×10^1	1
51	0.51×10^2	2
554	0.554×10^3	3
997	0.997×10^3	3
1003	1.003×10^3	3
756000	0.756×10^6	6
0.136	1.36×10^{-1}	–1
0.05	5×10^{-2}	–2
0.92	0.92×10^0	0

Significant Figures

A significant figure is defined as the figure, which is considered reasonably, trust worthy in number.

e.g., π = 3.141592654 (upto 10 digits)

= 3.14 (with 3 figures)

= 3.1416 (upto 5 digits)

Larger the number of significant figures obtained in the measurement, grater will be the accuracy.

Rules for Determining the Number of Significant Figures

Rule 1: All Non-zero digit in a given no. are significant without any regard to its place.

e.g., 42.3 has three significant figures.

243.4 has four significant figures.

Rule 2: A zero becomes a significant figure if it appears between two non-zero digits.

e.g., 5.03 has three significant figures.

5.604 has four significant figures.

Rule 3: Leading zeros or the zeros placed to the left of the number are never significant.

e.g.,0.543 has three significant figures.

0.006 has one significant figure.

Rule 4: Trailing zeros or the zeros placed to the right of the number with decimal point are significant.

e.g.,4.330 has four significant figures.

433.00 has five significant figures.

Rule 5: In exponential notation, the numerical portion gives the number of significant figures.

e.g., 1.32×10^{-2} has three significant figures.

1.32×10^{4} has three significant figures.

Rule 6: The trailing zeros in a number without a decimal point will not be significant.

e.g., 500 – has one significant figures

101 has three significant figures.

Rule 7: When the number is expressed in exponential form, the exponential term does not affect the number of S.F. For example in $x = 12.3 = 1.23 \times 10^1 = .123 \times 10^2 = 0.0123 \times 10^3 = 123 \times 10^{-1}$, each term has 3 SF only.

S. No.	Number	Significant figures
1.	2.003	4
2.	0.002	1
3.	0.0020	2
4.	2.4001	5
5.	1000	1
6.	1000 kg	4
7.	1.0×10^6	2
8.	1.00×10^6	3

Rounding off Numbers

The process of omitting the non significant digits and retaining only the desired number of significant digits, incorporating the required modifications to the last significant digit is called rounding off the number.

Rules for Rounding off Numbers

Rule 1: If the digit to be dropped is less than 5, then the preceding digit is left unchanged.

e.g., (*i*) $x = 7.82$ is rounded off upto two S. F. 7.8

e.g., (*ii*) x = 3.94 is rounded off upto two S. F. 3.9.

Rule 2: If the digit to be dropped is more than 5, then the preceding digit is raised by 1.

e.g., (*i*) x = 6.87 is rounded off upto two S.F. 6.9.

e.g., (*ii*) x = 12.78 is rounded off upto three S.F. 12.8.

Rule 3: If the digit to be dropped is 5 followed by digits other than zero, then the preceding digit is raised by 1.

e.g., (*i*) x = 16.351 is rounded off upto three S.F. 16.4.

e.g., (*ii*) x = 6.758 is rounded off upto two S.F. 6.8.

Rule 4: If the digit to be dropped is 5 or 5 followed by zeros, then the preceding digit is left unchanged, if it is even.

e.g., (*i*) x = 3.250 becomes 3.2 on rounding off upto two S.F.

e.g., (*ii*) x = 12.650 becomes 12.6 on rounding off upto three S.F.

Rule 5: If the digit to be dropped is 5 or 5 followed by zeros, then the preceding digit is raised by 1, if it is odd.

e.g., (*i*) x = 3.750 is rounded off upto two S.F. 3.8.

e.g., (*ii*) x = 16.150 is rounded off upto three S.F. 16.2.

Rules for Arithmetic Operations with Significant Figures

1. In addition and subtraction the number of decimal places in the result should be equal to the least decimal place that the given number have. The rule is illustrated by the following examples:

(*a*)
```
   33.3          (has only one decimal place)
    3.11
 + 0.313
 -------
  36.723         (answer should be rounded off one decimal place)
```

Answer = 36.7

(*b*)
```
   3.1421
   0.241
 + 0.09          (has 2 decimal place)
 -------
   3.4731        (answer should be rounded off 2 decimal places)
```

Answer = 3.47

(*c*)
```
   62.831        (has 3 decimal place)
 – 24.5492
 ---------
   38.2818       (answer should be rounded off 3 decimal places)
```

Answer = 38.282

2. In multiplication or division the number of significant figure in result is equal to the smallest significant figure that the given number have. The rule is illustrated by the following examples:

(*a*)
```
   142.06
 ×   0.23        (two significant figures)
 --------
   32.6738       (answer should have two significant figures)
```

Answer = 33

(*b*)
```
   51.028
 × 1.31          (three significant figures)
 --------
   66.84668
```

Answer = 66.8

(*c*) $\dfrac{0.90}{4.26} = 0.2112676$

Answer = 0.21

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Example 8: The number of significant figures in 0.06900 is

(1) 5 (2) 4 (3) 2 (4) 3

Sol. If the number is less than 1, the zero (s) on the right of decimal point and before the first non-zero digit are not significant. In 0.06900, the underlined zeroes are not significant. Hence, number of significant figures are four.

So option (2) is correct.

Example 9: Each side of a cube is measured to be 7.203 m. Find the volume of the cube up to appropriate significant figures.

Sol. Volume = $a^3 = (7.023)^3 = 373.715\ m^3$

By rounding off it to 4 significant figure, we get,

$V = 373.7\ m^3$

So, correct answer is 373.7

Example 10: The mass of a box is 2.3 kg. Two marbles of masses 2.15 g and 12.39 g are added to it. Find the total mass of the box to the correct number of significant figures.

Sol. Total mass = 2.3 + 0.00215 + 0.01239 = 2.31 kg

The total mass in appropriate significant figures will be 2.3 kg.

Example 11: What is the number of significant figures in 0.310×10^3?

(1) 2 (2) 6 (3) 3 (4) 4

Sol. As we know power of 10 is not considered as significant figures and for decimal points the zero present between two significant digits and final or trailing zero in decimal portion is considered as significant figures. Hence, in this case the significant figures are 3.

So, option (3) is correct.

Concept Application

11. Number of significant digits in 0.01230 is:

(1) 3 (2) 4 (3) 5 (4) 6

12. After rounding off the number 4621 to 2 significant digits the value becomes:

(1) 4600 (2) 4620 (3) 4700 (4) 4720

13. Round off the number 4.996×10^5 to 3 significant digits:

(1) 4.89×10^5 (2) 5.00×10^5

(3) 5.10×10^5 (4) 4.98×10^5

14. The number of significant figures in 0.0006032 is

(1) 7 (2) 4 (3) 3 (4) 5

15. The radius of disc is 1.2 cm, its area according to idea of significant figures is _______ .

(1) $4.5216\ cm^2$ (2) $4.521\ cm^2$

(3) $4.52\ cm^2$ (4) $4.5\ cm^2$

16. The order of magnitude of the number 1013 is:

(1) 1 (2) 2 (3) 3 (4) 4

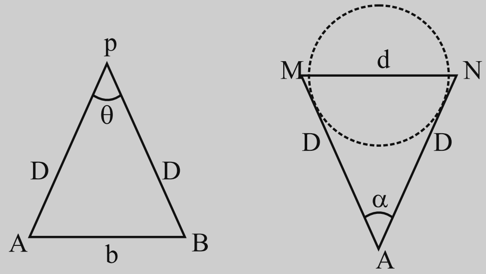
EXTENDED LEARNING

MEASUREMENT OF LARGE DISTANCES

Larger distances such as the distance of a planet or a star from the earth cannot be measured directly with a metre scale. An important method in such cases is the parallax method.

When an object located against a specific point on a wall is viewed with only one eye, say first with left eye and next with right eye, then the position of the object seems to change with respect to the point on the wall. This is called Parallax. The distance between the two points of observation is called the Basis.

The distance D of a far away planet 'P' is measured by observing it from two different places on earth say A and B separated by distance $AB = b$ as shown in the figure.



The angle θ between the two directions along which the planet is viewed at the two points is measured, which is called parallax angle or parallactic angle. Since θ is small, AB can be considered as an arc of length of a circle with center at P and the distance D as radius

$$\therefore b = D\theta \Rightarrow D = \frac{b}{\theta}$$

Once the distance 'D' of a planet is determined, the diameter 'd' and angular size of planet can be estimated by same method. Two diametrically opposite points M & N of planet are viewed through telescope from a point A on earth. The angle α between the two directions viewed is measured. Then by considering MN as arc of length of a circle with centre at A and the distance D as radius, we can write

$$d = D\alpha\,(\text{or})\,\alpha = \frac{d}{D}$$

Accuracy and Precision

The numerical values obtained on measuring physical quantities depend upon the measuring instruments and methods of measurement.

A unit of measurement of a physical quantity is the standard reference of the same physical quantity which is used for comparison of the given physical quantity.

Accuracy refers to how closely a measured value agrees with the true values.

Precision refers to what limit or resolution the given physical quantity can be measured

Accuracy refers to the closeness of observed values to its true value of the quantity while precision refes to closeness between the different observed values of the same quantity. High precision does not mean high accuracy. The difference between accuracy and precision can be understand by the following example: Suppose three students are asked to find the length of a rod whose length is known to be 2.250 cm. The observations are given in the table.

Short Notes

Fundamental Quantity	Derived Quantity
The physical quantities which do not depend on any other physical quantities for their measurements. *e.g.*, Mass, Length, Time Temperature, current, luminous Intensity & mole	Those quantities which can be expressed in terms of fundamental/base quantities. *e.g.*, Angle, speed or velocity Acceleration, force etc.

System of Units

(*a*) **FPS System:** Here length is measured in foot, mass in pounds and time in second.

(*b*) **CGS System:** In this system, L is measured in cm, M is measured in g and T is measured in sec.

(*c*) **MKS System:** In this system, L is measured in metre, M is measured in kg and T is measured in sec.

Principle of Homogeneity

According to this, the physical quantities having same dimension can be added or subtracted with each other and for a given equation, dimensions of both sides must be same.

For eg, in equation $F = A\sqrt{m} + \frac{B}{v} + C$,

all the three parts of R.H.S have same dimension as force on L.H.S.

Dimensions

The fundamental or base quantities along with their powers needed to express a physical quantity is called dimensions
e.g., $[F] = [MLT^{-2}]$ is dimension of force.

Usage of Dimensional Analysis

(*i*) To check the correctness of a given formula.

(*ii*) To establish relation between quantities dimensionally.

(*iii*) To convert the value of a quantity from one system of units to other system.

Limitations of Dimensional Analysis

(*i*) It does not predict the numerical value or number associated with a physical quantity in a relation

e.g., $v = \frac{u}{3} + \frac{1}{5}at$ & $v = u + at$

Both are dimensionally valid.

(*ii*) It does not derive any relations involving trigonometric, logarithmic and exponential functions

e.g., $P = P_0 e^{-bt^2}$ cannot be derived dimensionally.

(*iii*) It does not give any information about dimensionally constants or nature of a quantity (vector/scalar) associated with a relation.

Significant Figure or Digits

Rules to find out the number of significant figures:

1. **Rule:** All the non-zero digits are significant *e.g.*, 1984 has 4 SF.
2. **Rule:** All the zeros between two non-zero digits are significant. *e.g.*, 10806 has 5 SF.
3. **Rule:** All the zeros to the left of first non-zero digit are not significant. *e.g.*, 00108 has 3 SF.
4. **Rule:** If the number is less than 1, zeros on the right of the decimal point but to the left of the first non-zero digit are not significant. *e.g.*, 0.002308 has 4 SF.
5. **Rule:** The trailing zeros (zeros to the right of the last non-zero digit) in a number with a decimal point are significant. *e.g.*, 01.080 has 4 SF.
6. **Rule:** The trailing zeros in a number without a decimal point are not significant *e.g.*, 010100 has 3 SF. But if the number comes from some actual measurement then the trailing zeros become significant. *e.g.*, m = 100 kg has 3 SF.
7. **Rule:** When the number is expressed in exponential form, the exponential term does not affect the number of S.F. For example in $x = 12.3 = 1.23 \times 10^1 = .123 \times 10^2 = 0.0123 \times 10^3 = 123 \times 10^{-1}$, each term has 3 SF only.

Rules for arithmetical operations with significant figures:

1. **Rule:** In addition or subtraction the number of decimal places in the result should be equal to the number of decimal places of that term in the operation which contain lesser number of decimal places. *e.g.*, 12.587 – 12.5 = 0.087 = 0.1 (∵ second term contain lesser i.e., one decimal place)
2. **Rule:** In multiplication or division, the number of SF in the product or quotient is same as the smallest number of SF in any of the factors. *e.g.*, 5.0 × 0.125 = 0.625 = 0.62.

Rounding Off

Rules for rounding off the numbers:

1. **Rule:** If the digit to be rounded off is more than 5, then the preceding digit is increased by one. *e.g.*, 6.87≈ 6.9
2. **Rule:** If the digit to be rounded off is less than 5, than the preceding digit is unaffected and is left unchanged. *e.g.*, 3.94 ≈ 3.9
3. **Rule:** If the digit to be rounded off is 5 then the preceding digit is increased by one if it is odd and is left unchanged if it is even. *e.g.*, 14.35 ≈ 14.4 and 14.45 ≈ 14.4

Representation of Errors

1. Mean absolute error is defined as

$$\overline{\Delta a} = \frac{|\Delta a_1| + |\Delta a_2| + ... + |\Delta a_n|}{n} = \sum_{i=1}^{n} \frac{\Delta a_i}{n}$$

Final result of measurement may be written as:

$$a = a_m \pm \overline{\Delta a}$$

Aarambh (Solved Examples)

Directions for Exercise Questions: Please refer the table at Page No. 8 for the dimensions of physical quantities.

1. The dimension of Planck's constant equals to that of:

(1) Energy (2) Momentum

(3) Angular momentum (4) Power

Sol. Dimensions of Planck's constant, $h = \frac{\text{Energy}}{\text{Frequency}}$

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

Dimensions of angular momentum L

= Moment of inertia I × Angular velocity = $[ML^2][T^{-1}]$

Therefore, option (3) is the correct answer.

2. In the following dimensionally correct equations, we have $F = \frac{X}{\text{Linear density}} + Y$, where F = force. The dimensional formula of X are Y are:

(1) $[M\,L\,T^{-2}]$, $[M^2\,L^0\,T^{-2}]$

(2) $[M^2\,L^0\,T^{-2}]$, $[M\,L\,T^{-2}]$

(3) $[M\,L^2\,T^{-4}]$, $[M^2\,L^{-2}\,T^{-2}]$

(4) $[M\,L\,T^{-2}]$, $[M^2\,L^0\,T^{-2}]$

Sol. $[F] = \left[\frac{X}{L.D}\right] + [Y]$

$\therefore [Y] = [F] = [MLT^{-2}]$

$\left[MLT^{-2}\right] = \left[\frac{X}{ML^{-1}}\right] \Rightarrow X = \left[M^2L^0T^{-2}\right]$

Therefore, option (2) is the correct answer.

3. Given that $y = A\sin\left[\left(\frac{2\pi}{\lambda}(ct - x)\right)\right]$ where y and x are measured in meter. Which of the following statements are true?

(1) The unit of λ is same as that of x and A

(2) The unit of λ is same as of x but not of A

(3) The unit of c is same as that of $\frac{2\pi}{\lambda}$

(4) The unit of (ct – x) is same as that of $\frac{2\pi}{\lambda}$

Sol. $f = A\sin\left[\left(\frac{2\pi}{\lambda}\right)\right][ct - x]$. Since Angle has $[M^oL^oT^o]$ dimensions. $\therefore \left[\frac{2\pi}{\lambda}(ct - x)\right]$ needs to be dimensionless

$\therefore \frac{c}{\lambda}t = [M^\circ L^\circ T^\circ], \lambda = ct = [M^\circ L^1 T^\circ]$

$x = \lambda = [M^0\,L^1\,T^0]$, $A = [M^0\,L^1\,T^0]$

Therefore, option (1) is the correct answer.

4. $S_t = u + \frac{1}{2}a(2t - 1)$ is:

(1) Only numerically correct

(2) Only dimensionally correct

(3) Both numerically and dimensionally correct

(4) Neither numerically nor dimensionally correct

Sol. Displacement in t^{th} second = Displacement in t sec – Displacement in $(t - 1)$ sec

$= \left(ut + \frac{1}{2}at^2\right) - \left[u(t-1) + \frac{1}{2}a(t-1)^2\right]$

$= ut + \frac{1}{2}at^2 - ut + u(1) - \frac{1}{2}a\left[t^2 - 2t(1) + (1)^2\right]$

$= ut + \frac{1}{2}at^2 - ut + u(1) - \frac{1}{2}at^2 + at(1) - \frac{a}{2}(1)^2$

$= u(1) + at(1) - \frac{a}{2}(1)^2$

$= u(1) + \frac{a}{2}(1)\,(2t - (1))$

This (1) also have dimension of time

$u(t) = LT^{-1} \times T = L$

$= \frac{a}{2}(1)(2t - a) = LT^{-2} \times T \times T = L$

Therefore, option (3) is the correct answer.

5. Dimensions of resistance in an electrical circuit, in terms of dimension of mass M, length L, time T and current I, would be:

(1) $[ML^2T^{-2}]$

(2) $[ML^2T^{-1}A^{-1}]$

(3) $[ML^2T^{-3}A^{-2}]$

(4) $[ML^2T^{-3}A^{-1}]$

Sol. $\because V = RI$ or $R = \frac{V}{I}$

Dimensions of $V = \frac{W}{q} = \frac{\left[ML^2T^{-2}\right]}{[AT]}$

$\therefore [R] = \frac{\left[ML^2T^{-2}/AT\right]}{[A]} = \left[ML^2T^{-3}A^{-2}\right]$

Therefore, option (3) is the correct answer.

6. The speed of light c, gravitational constant G and Planck's constant h are taken as fundamental units in a system. The dimensions of time in this new system should be:

(1) $[G^{1/2}h^{1/2}c^{-5/2}]$ (2) $[G^{-1/2}h^{1/2}c^{-1/2}]$

(3) $[G^{-1/2}\,h^{1/2}c^{-3/2}]$ (4) $[G^{-1/2}\,h^{1/2}c^{1/2}]$

Sol. $c = [\,M^0\,L^1\,T^{-1}]$, $G = [\,M^{-1}\,L^3\,T^{-2}]$, $h = [\,M^1\,L^2\,T^{-1}]$

$T = c^a\,G^b\,h^c$

14. In an experiment four quantities a, b, c and d are measured with percentage error 1%, 2%, 3% and 4% respectively. Quantity P is calculated as follows: $P = \frac{a^3b^2}{cd}$. The percentage error in P is:

(1) 4 %
(2) 14 %
(3) 10 %
(4) 7 %

Sol. $P = \frac{a^3b^2}{cd} \Rightarrow \frac{\Delta P}{P} = \pm\left(3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{\Delta c}{c} + \frac{\Delta d}{d}\right)$

$= \pm(3\times1 + 2\times2 + 3 + 4) = \pm14\%$

Therefore, option (2) is the correct answer.

15. A physical quantity is given by $X = [M^aL^bT^c]$. The percentage error in measurements of M, L and T are α, β, γ. Then, the maximum % error in the quantity X is:

(1) $a\alpha + b\beta + c\gamma$
(2) $a\alpha + b\beta - c\gamma$
(3) $\frac{a}{\alpha} + \frac{b}{\beta} + \frac{c}{\gamma}$
(4) $a\alpha - b\beta - c\gamma$

Sol. $X = M^aL^bT^c$

$\frac{dX}{X} = a\frac{dM}{M} + b\frac{dL}{L} + c\frac{dT}{T}$

$\frac{dX}{X} = a\alpha + b\beta + c\gamma$

Therefore, option (1) is the correct answer.

16. The absolute error in density of a sphere of radius 10.01 cm and mass 4.692 kg is:

(1) 3.59 kg m^{-3}
(2) 4.692 kg m^{-3}
(3) 0
(4) 1.12 kg m^{-3}

Sol. $\rho = \frac{m}{\frac{4}{3}\pi r^3} = \frac{4.692\times3}{4\times3.14\times(10.01)^3\times10^{-6}}$

$\rho = 1.12 \times 10^3$ kg /m^3

abs. errors:

Δm = 1gm = 0.001 kg

Δr = 0.01 m

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

$\Delta\rho = \left(\frac{0.001}{4.692} + \frac{3\times0.01}{10.01}\right)\times1.12\times10^3$

= 3.59 kg/m^3

Therefore, option (1) is the correct answer.

17. If A = (1.0 ± 0.2) m and B = (2.0 ± 0.2) m , then $\sqrt{AB}$ is:

(1) 1.4 m ± 0.4 m
(2) 1.41 m ± 0.15 m
(3) 1.4 m ± 0.3 m
(4) 1.4 m ± 0.2 m

Sol. $x = \sqrt{AB} = \sqrt{1.0\times2.0} = 1.414$ m

Rounding off x = 1.4 m

$\frac{\Delta x}{x} = \frac{1}{2}\left(\frac{\Delta A}{A} + \frac{\Delta B}{B}\right) = \frac{1}{2}\left(\frac{0.2}{1.0} + \frac{0.2}{2.0}\right)$m (in rounded figure)

$\Delta x = x\left(\frac{1}{2}\right)(0.3)$

$\Delta x = \frac{1.4\times0.3}{2} = 21$

$\therefore \sqrt{AB} = (1.4\pm0.2)$ m Δx = 0.2 (after one decimal)

Therefore, option (4) is the correct answer.

Prarambh Exercise-1 (Topicwise)

DIMENSIONS & DIMENSIONAL FORMULA

1. Select the pair whose dimensions are same.
(1) Pressure and stress (2) Momentum and impulse
(3) Torque and energy (4) All of these

2. The velocity "v" of a particle is given in terms of time t as $v = at + \frac{b}{t+c}$.
The dimensions of a, b, c are:
(1) L^2 ; ML ; T^{-2} (2) LT^2 ; LT ; L
(3) LT^{-2} ; L ; T (4) L ; LT ; T^2

3. Which of the following pairs of physical quantities does not have same dimensional formula?
(1) Work and torque
(2) Angular momentum and Planck's constant
(3) Tension and surface tension
(4) Impulse and linear momentum

4. The equation of a wave is given by:
$y = A\sin\omega\left(\frac{x}{v} - k\right)$
where ω is the angular velocity and v is the linear velocity. The dimension of k is:
(1) LT (2) T
(3) T^{-1} (4) T^2

5. A unitless quantity:
(1) May have a non-zero dimension
(2) Always has a non-zero dimension
(3) Never has a non-zero dimension
(4) Does not exist

6. The Young's modulus of steel is 1.9×10^{11} N/m^2. When expressed in CGS units of dyne/cm^2, it will be equal to (1 N = 10^5 dyne, 1 m^2 = 10^4 cm^2)
(1) 1.9×10^{10} (2) 1.9×10^{11}
(3) 1.9×10^{12} (4) 1.9×10^{13}

7. The position x of a particle at time "t" is given by-
$$x = \frac{v_0}{a}\left(1 - e^{-at}\right)$$
Where v_0 is a constant and a > 0.
The dimensions of v_0 and a are:
(1) $M^0 L T^{-1}$ and T^{-1} (2) $M^0 L T^0$ and T^{-1}
(3) $M^0 L T^{-1}$ and LT^{-2} (4) $M^0 L T^{-1}$ and T

8. The dimensions of intensity are:
(1) $M^1 L^0 T^{-3}$ (2) $M^2 L^1 T^{-2}$
(3) $M^1 L^2 T^{-2}$ (4) $M^2 L^0 T^{-3}$

9. Surface tension has the same dimensions as that of:
(1) Coefficient of viscosity
(2) Impulse
(3) Momentum
(4) Spring constant

10. The dimensional formula of angular velocity is:
(1) $[M^0L^0T^{-1}]$ (2) $[MLT^{-1}]$
(3) $[M^0L^0T^1]$ (4) $[ML^0T^{-2}]$

11. The dimensions of planck's constant and angular momentum are respectively:
(1) $M^1L^2T^{-1}$ and M^1LT^{-1} (2) $M^1L^2T^{-1}$ and $M^1L^2T^{-2}$
(3) M^1LT^{-1} and $M^1L^2T^{-1}$ (4) $M^1L^2T^{-1}$ and $M^1L^2T^{-1}$

12. The pair having the same dimensions are:
(1) Angular momentum, work
(2) Work, torque
(3) Potential energy, linear momentum
(4) Kinetic energy, velocity

13. Dimensional formula of ΔQ, heat supplied to the system is given by:
(1) $M^1L^2T^{-2}$ (2) $M^1L^1T^{-2}$
(3) $M^1L^2T^{-1}$ (4) ML^1T^{-1}

14. $[ML^2T^{-3}]$ is the dimension of:
(1) Work (2) Power
(3) Force (4) Momentum

15. Which of the following ratios express pressure?
(1) Force/Length (2) Energy/Volume
(3) Energy/Area (4) Force/Volume

16. The dimensions of force constant of spring are:
(1) MT^{-2} (2) MLT^{-1}
(3) MLT^{-2} (4) $ML^{-1}T^{-1}$

17. The dimensions of physical quantity X in the equation force = $\frac{X}{\sqrt{\text{Density}}}$ is given by:
(1) $M^1L^4T^{-2}$ (2) $M^2L^{-2}T^{-1}$
(3) $M^{3/2}L^{-1/2}T^{-2}$ (4) $M^1L^{-2}T^{-1}$

18. Given that V is speed, r is the radius and g is the acceleration due to gravity. Which of the following is dimensionless?
(1) V^2/rg (2) V^2r/g
(3) V^2g/r (4) V^2rg

54. In a vernier calipers, one main scale division is x cm and n division of the vernier scale coincide with (n-1) divisions of the main scale. The least count (in cm) of the calipers is:

(1) $\left(\frac{n-1}{n}\right)x$ (2) $\left(\frac{nx}{n-1}\right)$

(3) $\frac{x}{n}$ (4) $\left(\frac{x}{n-1}\right)$

55. A student measure the diameter of a thick wire using a screw gauge of least count 0.001 cm. The main scale reading is 2 mm and zero of circular scale division coincides with 50 division above the reference level. If the screw gauge has a zero error of 0.002 cm, the correct diameter of the thick wire in cm is:

(1) 0.248 (2) 0.428 (3) 0.521 (4) 0.224

56. In a vernier caliper, 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:

(1) 0.5 mm (2) 0.1 mm

(3) 0.05 mm (4) 0.005 mm

57. A vernier caliper 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–

(1) 0.5 mm (2) 1 mm

(3) 2 mm (4) 1/4 mm

58. A vernier caliper 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

(1) n = 10, m = 0.5 cm (2) n = 9, m = 0.4 cm

(3) n = 10, m = 0.8 cm (4) n = 10, m = 0.2 cm

59. The dimensions of a rectangular block measured with a vernier caliper 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

(1) 5 % (2) 10 % (3) 15 % (4) 20 %

60. The smallest division on the main scale of a vernier caliper 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

(1) 2.05 cm (2) 3.05 cm

(3) 2.50 cm (4) 3.50 cm

Prabal Exercise-2 (Learning Plus)

1. The time dependence of a physical quantity P is given by $P = P_0 \exp(-\alpha t^2)$, where α is a constant and t is time. The constant α is:

(1) Dimensionless (2) Dimensions T^{-2}

(3) Dimension of P (4) Dimensions T^2

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

(1) Length, time and velocity

(2) Length, mass and velocity

(3) Mass, time and velocity

(4) Length, time and mass

3. The velocity of a particle (v) at a instant (t) is given by $v = at + bt^2$ the dimension of b is:

(1) L (2) LT^{-1} (3) LT^{-2} (4) LT^{-3}

4. If force (F), length (L), Current (I) and time (T) are taken as bases then the dimensions of ε_0 are:

(1) $[FL^2 I^2 T^{-2}]$ (2) $[F^{-1} L^2 I^2 T^2]$

(3) $[F^{-1}L^{-2}T^2I^2]$ (4) $[F^2L^2T^2I^2]$

5. The SI unit of energy is $J = kg\ m^2\ s^{-2}$, that of speed v is ms^{-1} and of acceleration a is ms^{-2}. Which of the formula for kinetic energy (K) given below can you rule out on the basis of dimensional arguments (m stands for the mass of the body).

I. $K = m^2v^2$ II. $K = (1/2)\, mv^2$

III. $K = ma$ IV. $K = (3/16)\, mv^2$

V. $K = \left(\frac{1}{2}\right)mv^2 + ma$

(1) I and II (2) Only II

(3) II and IV (4) I, III and V

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

(1) A (2) B (3) C (4) D

7. 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:

(1) (3.45 ± 0.2)m/s (2) (3.45 ± 0.3)m/s

(3) (3.45 ± 0.4)m/s (4) (3.45 ± 0.5)m/s

8. If $Q = \frac{X^n}{Y^m}$ and Δx is absolute error in the measurement of X, Δy is absolute error in the measurement of Y, then absolute error ΔQ in Q is:

(1) $\Delta Q = \pm\left(m\frac{\Delta x}{x} + n\frac{\Delta y}{y}\right)Q$

(2) $\Delta Q = \pm\left(n\frac{\Delta x}{x} + m\frac{\Delta y}{y}\right)Q$

(3) $\Delta Q = \pm\left(n\frac{\Delta x}{x} - m\frac{\Delta y}{y}\right)Q$

(4) $\Delta Q = \pm\left(\frac{m\Delta x}{x} - \frac{n\Delta y}{y}\right)Q$

9. The length of a rod is (11.05 ± 0.05)cm. What is the length of two rods?

(1) (22.1 ± 0.05) cm (2) (22.1 ± 0.2) cm

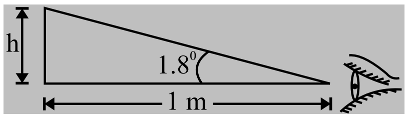
(3) (22.10 ± 0.05) cm (4) (22.10 ± 0.10) cm

10. If E = energy, G = gravitational constant, I = Impulse and M = mass, then dimensions of $\frac{GIM^2}{E^2}$ are same as that of

(1) Time (2) Mass

(3) Length (4) Force

11. A normal human eye can see an object making an angle of 1.8° at the eye. What is the approximate height of object which can be seen by an eye placed at a distance of 1 m from the object?



(1) π cm (2) 2π cm

(3) 4π cm (4) 3π cm

12. In the relation $P = \frac{\alpha}{\beta} e^{\frac{-\alpha z}{K\theta}}$ P is pressure, z is the distance, K is Boltzmann's constant and θ is the temperature. The dimensional formula of α will be:

(1) $[M^1L^1T^{-2}]$ (2) $[M^1L^2T^1]$

(3) $[M^1L^0T^{-1}]$ (4) $[M^0L^2T^{-1}]$

13. If P, Q, R are physical quantities, having different dimensions, which of the following combinations can never be a meaningful quantity?

(1) $\frac{(P - Q)}{R}$ (2) $PQ - R$

(3) $\frac{PQ}{R}$ (4) $\frac{(PR - Q^2)}{R}$

14. Given that the displacement of an oscillating particle is given by y = A sin(Bx + Ct + D). The dimensional formula for (ABCD) is:

(1) $[M^0L^{-1}T^0]$ (2) $[M^0L^0T^{-1}]$

(3) $[M^0L^{-1}T^{-1}]$ (4) $[M^0L^0T^0]$

15. Force F and density d are related as $F = \frac{\alpha}{\beta + \sqrt{d}}$ then find the dimensions of α:

(1) $[M^{1/2}L^{-1/2}T^{-2}]$ (2) $[M^{3/2}L^{1/2}T^2]$

(3) $[M^{3/2}L^{-1/2}T^{-2}]$ (4) $[M^2L^{-1/2}T^2]$

16. Frequency is the function of density (ρ), length (a) and surface tension (T). The value is:

(1) $\frac{k\rho^{1/2}a^{3/2}}{\sqrt{T}}$ (2) $\frac{k\rho^{3/2}a^{3/2}}{\sqrt{T}}$

(3) $\frac{k\rho^{1/2}a^{3/2}}{T^{3/4}}$ (4) $\frac{k\sqrt{T}}{\rho^{1/2}a^{3/2}}$

17. The mass and volume of a body are 4.237 g and 2.5 cm^3, respectively. The density of the material of the body in correct significant figures is:

(1) 1.6048 g cm^{-3} (2) 1.69 g cm^{-3}

(3) 1.7 g cm^{-3} (4) 1.695 g cm^{-3}

18. The length and breadth of a rectangular sheet are 16.2 cm and 10.1 cm, respectively. The area of the sheet in appropriate significant figures and error is:

(1) (164 ± 3) cm^2 (2) (163.62 ± 2.6) cm^2

(3) (163.6 ± 2.6) cm^2 (4) (163.62 ± 3) cm^2

19. You measure two quantities as A = (1.0 ± 0.2 m), B = (2 .0 m ± 0.2 m). We should report correct value for $\sqrt{AB}$ as:

(1) 1.4 m ± 0.4 m (2) 1.41 m ± 0.15 m

(3) 1.4 m ± 0.3 m (4) 1.4 m ± 0.2 m

20. On the basis of dimensions, decide which of the following relations for the displacement of a particle undergoing simple harmonic motion is not correct?

(1) $y = a \sin 2\pi t/T$ (2) $y = a\sin\frac{vt}{\lambda}$

(3) $y = \frac{a}{t}\sin\left(\frac{t}{a}\right)$ (4) $y = a\sqrt{2}\left(\sin\frac{2\pi t}{T} - \cos\frac{2\pi t}{T}\right)$

Parikshit Exercise-3 (Multiconcept)

MATCH THE COLUMN MCQs

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

	Column-I		Column-II
A.	s = 1 mm, n = 10	P.	0.05 mm
B.	s = 0.5 mm, n = 10	Q.	0.01 mm
C.	s = 0.5 mm, n = 20	R.	0.1 mm
D.	s = 1 mm, n = 100	S.	0.025 mm

(1) A-(Q); B-(R); C-(P); D-(S)
(2) A-(R); B-(P); C-(S); D-(Q)
(3) A-(P); B-(Q); C-(R); D-(S)
(4) A-(S); B-(P); C-(R); D-(Q)

2. Match the columns.

	Column-I		Column-II
A.	Backlash error	P.	Always subtracted
B.	Zero error	Q.	Least count = 1 MSD – 1 VSD
C.	Vernier callipers	R.	Always measure zero
D.	Error in screw gauge	S.	Due to loose fittings

(1) A-(S); B-(P); C-(Q); D-(S)
(2) A-(P); B-(Q); C-(R); D-(S)
(3) A-(S); B-(P); C-(R); D-(S)
(4) A-(Q); B-(S); C-(P); D-(R)

3. Using significant figures, match the following.

	Column-I		Column-II
A.	0.12345	P.	5
B.	0.12100 cm	Q.	4
C.	47.23 ÷ 2.3	R.	1
D.	3×10^8	S.	2

(1) A-(P); B-(P); C-(S); D-(R)
(2) A-(P); B-(Q); C-(R); D-(S)
(3) A-(R); B-(P); C-(Q); D-(S)
(4) A-(Q); B-(S); C-(P); D-(R)

STATEMENT BASED MCQs

(1) Both **Statement-I** and **Statement-II** are correct.
(2) Both **Statement-I** and **Statement-II** are incorrect.
(3) **Statement-I** is correct & **Statement-II** is incorrect.
(4) **Statement-I** is incorrect & **Statement-II** is correct.

4. **Statement-I:** When percentage errors in the measurement of mass and velocity are 1% and 2% respectively, the percentage error in KE is 5%.

Statement-II: KE or $E = \frac{1}{2}mv^2$, $\frac{\Delta E}{E} = \frac{\Delta m}{m} + \frac{2\Delta v}{v}$.

5. **Statement-I:** A screw gauge having a smaller value of pitch has greater accuracy.

Statement-II: The least count of screw gauge is directly proportional to the number of divisions on circular scale.

6. **Statement-I:** Unit chosen for measuring physical quantities should not be accessible.

Statement-II: Unit should change with the changing physical conditions like temperature, pressure, etc.

7. **Statement-I:** Specific gravity of a fluid is a dimensionless quantity.

Statement-II: It is the ratio of density of fluid to the density of water.

8. **Statement-I:** Absolute error is unitless and dimensionless.

Statement-II: All types of errors are unitless and dimensionless.

9. **Statement-I:** Two physical quantities having same dimensions, may have different units.

Statement-II: Shake and light year, both measure time.

ASSERTION & REASON MCQs

(1) **Assertion (A)** is true, **Reason (R)** is true; **Reason (R)** is a correct explanation for **Assertion (A).**
(2) **Assertion (A)** is true, **Reason (R)** is true; **Reason (R)** is not a correct explanation for **Assertion (A).**
(3) **Assertion (A)** is true, **Reason (R)** is false.
(4) **Assertion (A)** is false, **Reason (R)** is true.

10. **Assertion (A):** Mass, volume and time may be taken as fundamental quantities in a system of units.

Reason (R): Mass, volume and time are independent of one another.

11. **Assertion (A):** Out of three measurements l = 0.7 m; l = 0.70 m and l = 0.700 m, the last one is most accurate.

Reason (R): In every measurement, only the last significant digit is not accurately known.

12. **Assertion (A):** If x and y are the distance along x and y axes respectively then the dimensions of $\frac{d^3y}{dx^3}$ is $M^0L^{-2}T^0$.

Reason (R): Dimensions of $\int_a^b ydx$ is $M^0L^2T^0$.

13. **Assertion (A):** When we change the unit of measurement of a quantity, its numerical value changes.

Reason (R): Smaller the unit of measurement smaller is its numerical value.

14. **Assertion (A):** Random errors are irregular and thus are random in nature with respect to sign and size.

Reason (R): Random errors arise due to random and unpredictable fluctuations in experimental conditions.

15. **Assertion (A):** Special functions such as trigonometric, logarithmic and exponential functions are not dimensionless.

Reason (R): A pure number, ratio of similar physical quantities, such as angle and refractive index, has no dimensions.

PYQ's Exercise-4 (Important NEET PYQ's)

1. The quantities which have the same dimensions as those of solid angle are: **(2024)**
(1) strain and angle (2) stress and angle
(3) strain and arc (4) angular speed and stress

2. In a vernier callipers, $(N + 1)$ divisions of vernier scale coincide with N divisions of main scale. If 1 MSD represents 0.1 mm, the vernier constant (in cm) is: **(2024)**
(1) $\frac{1}{10N}$ (2) $\frac{1}{100(N+1)}$
(3) $100\,N$ (4) $10\,(N+1)$

3. The errors in the measurement which arise due to unpredictable fluctuations in temperature and voltage supply are: **(2023)**
(1) Personal errors (2) Least count errors
(3) Random errors (4) Instrumental errors

4. A metal wire has mass (0.4 ± 0.002)g, radius (0.3 ± 0.001) mm and length (5 ± 0.02) cm. The maximum possible percentage error in the measurement of density will nearly be: **(2023)**
(1) 1.3% (2) 1.6% (3) 1.4% (4) 1.2%

5. Plane angle and solid angle have: **(2022)**
(1) Both units and dimension
(2) Units but no dimensions
(3) Dimensions but no units
(4) No units and no dimensions

6. The area of a rectangular field (in m^2) of length 55.3 m and breadth 25 m after rounding off the value for correct significant digits is: **(2022)**
(1) 14×10^2 (2) 138×10^1
(3) 1382 (4) 1382.5

7. If E and G respectively denote energy and gravitational constant, then E/G has the dimensions of: **(2021)**
(1) $[M][L^{-1}][T^{-1}]$ (2) $[M][L^0][T^0]$
(3) $[M^2][L^{-2}][T^{-1}]$ (4) $[M^2][L^{-1}][T^0]$

8. A screw gauge gives the following readings when used to measure the diameter of a wire **(2021)**
Main scale reading : 0 mm
Circular scale reading : 52 divisions
Given that 1 mm on main scale corresponds to 100 divisions on the circular scale. The diameter of the wire from the above data is:
(1) 0.026 cm (2) 0.26 cm
(3) 0.052 cm (4) 0.52 cm

9. If force [F], acceleration [A] and time [T] are chosen as the fundamental physical quantities. Find the dimensions of energy. **(2021)**
(1) $[F]\,[A]\,[T^2]$
(2) $[F]\,[A]\,[T^{-1}]$
(3) $[F]\,[A^{-1}]\,[T]$
(4) $[F]\,[A]\,[T]$

10. A screw gauge has least count of 0.01 mm and there are 50 divisions in its circular scale.
The pitch of the screw gauge is: **(2020)**
(1) 0.25 mm (2) 0.5 mm
(3) 1.0 mm (4) 0.01 mm

11. Taking into account of the significant figures, what is the value of 9.99 m – 0.0099 m? **(2020)**
(1) 9.98 m (2) 9.980 m
(3) 9.9 m (4) 9.9801 m

12. Dimensions of stress are: **(2020)**
(1) $[ML^2T^{-2}]$ (2) $[ML^0T^{-2}]$
(3) $[ML^{-1}T^{-2}]$ (4) $[MLT^{-2}]$

13. The intervals measured by a clock given the following readings:
1.25 s, 1.24 s, 1.27 s, 1.21 s and 1.28 s. What is the percentage relative error is the observations? **(2020 Covid)**
(1) 4% (2) 16%
(3) 1.6% (4) 2%

14. The angle of 1′ (minute of arc) in radian is nearly equal to **(2020 Covid Re)**
(1) 4.85×10^{-4} rad
(2) 4.80×10^{-6} rad
(3) 1.75×10^{-2} rad
(4) 2.91×10^{-4} rad

ANSWER KEY

CONCEPT APPLICATION

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

PRARAMBH EXERCISE-1 (TOPICWISE)

1. (4)	**2.** (3)	**3.** (3)	**4.** (2)	**5.** (3)	**6.** (3)	**7.** (1)	**8.** (1)	**9.** (4)	**10.** (1)
11. (4)	**12.** (2)	**13.** (1)	**14.** (2)	**15.** (2)	**16.** (1)	**17.** (3)	**18.** (1)	**19.** (4)	**20.** (3)
21. (1)	**22.** (1)	**23.** (2)	**24.** (2)	**25.** (3)	**26.** (4)	**27.** (3)	**28.** (4)	**29.** (1)	**30.** (4)
31. (1)	**32.** (4)	**33.** (3)	**34.** (3)	**35.** (2)	**36.** (1)	**37.** (4)	**38.** (2)	**39.** (3)	**40.** (3)
41. (4)	**42.** (4)	**43.** (2)	**44.** (1)	**45.** (4)	**46.** (4)	**47.** (1)	**48.** (2)	**49.** (3)	**50.** (1)
51. (3)	**52.** (3)	**53.** (2)	**54.** (3)	**55.** (1)	**56.** (3)	**57.** (3)	**58.** (3)	**59.** (1)	**60.** (1)

PRABAL EXERCISE-2 (LEARNING PLUS)

1. (2)	**2.** (1)	**3.** (4)	**4.** (3)	**5.** (4)	**6.** (3)	**7.** (2)	**8.** (2)	**9.** (4)	**10.** (1)
11. (1)	**12.** (1)	**13.** (1)	**14.** (2)	**15.** (3)	**16.** (4)	**17.** (3)	**18.** (1)	**19.** (4)	**20.** (3)

PARIKSHIT EXERCISE-3 (MULTICONCEPT)

1. (2)	**2.** (1)	**3.** (1)	**4.** (1)	**5.** (3)	**6.** (2)	**7.** (1)	**8.** (2)	**9.** (3)	**10.** (1)
11. (2)	**12.** (2)	**13.** (3)	**14.** (1)	**15.** (4)					

PYQ's EXERCISE-4 (IMPORTANT NEET PYQ's)

1. (1)	**2.** (2)	**3.** (3)	**4.** (2)	**5.** (2)	**6.** (1)	**7.** (4)	**8.** (3)	**9.** (1)	**10.** (2)
11. (1)	**12.** (3)	**13.** (3)	**14.** (4)	**15.** (2)	**16.** (4)	**17.** (3)	**18.** (3)	**19.** (2)	**20.** (2)

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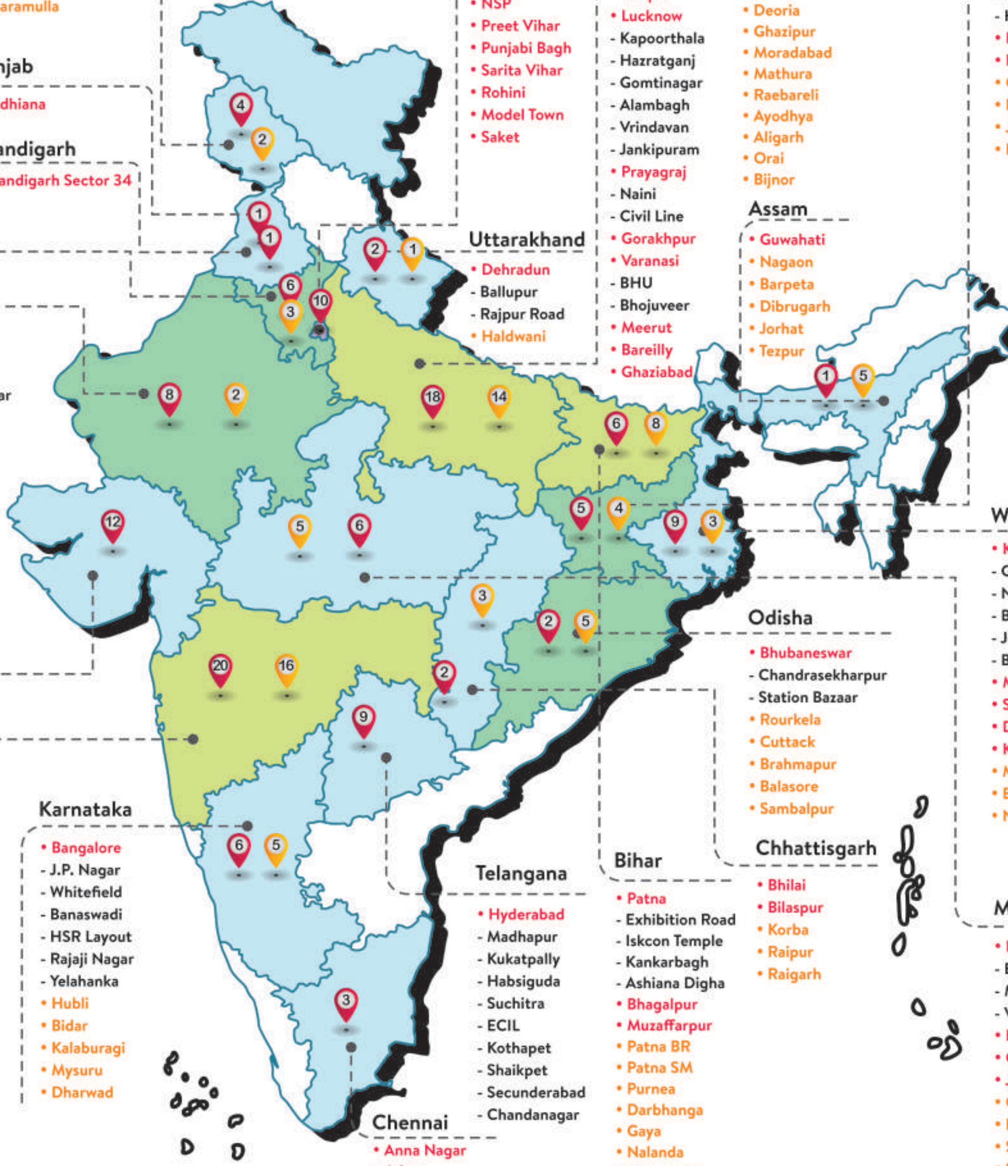

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