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CRASH COURSE

FOR

NEET

Class XI

PHYSICS

CONTENTS

CHAPTER

1 Units and Measurements

PHYSICAL QUANTITIES

All quantities that can be measured are called physical quantities. *e.g.* length, mass, force, work done, etc. There are two types of physical quantities

(i) Fundamental quantities

(ii) Derived quantities

Fundamental Quantity: Physical quantities which cannot be expressed in terms of any other physical quantites are called fundamental physical quantities.

E.g. length, mass, time, temperature etc.

Derived Quantity: Physical Quantities which are derived from fundamental quantities are called derived quantities.

E.g. Area, density, force etc.

System of Units

❖ There are four systems of units

F.P.S C.G.S

M.K. SSI

❖ **International system (SI) of units:** This system is modification of 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.

(*a*) 7 fundamental quantities

(*b*) 2 supplementary quantities

(*c*) Derived quantities

SET OF FUNDAMENTAL QUANTITIES

SI base quantities and their units

S. No.	Physical quantity	Unit	Symbol
1.	Length	Metre	m
2.	Mass	Kilogram	kg
3.	Time	Second	s
4.	Temperature	Kelvin	K
5.	Electric current	Ampere	A
6.	Luminous Intensity	Candela	cd
7.	Amount of substance	Mole	mol

Supplementary quantities			
1.	Plane angle	Radian	rad
2.	Solid angle	Steradian	sr

ERROR

Relative Error

❖ The relative error of a measured physical quantity is the ratio of the mean absolute error to the mean value of the quantity measured.

Relative error $= \dfrac{\Delta a_{\text{mean}}}{a_{\text{mean}}}$

It is a pure number having no units.

Percentage Error

$$\delta a = \left[\frac{\Delta a_{\text{mean}}}{a_{\text{mean}}} \times 100\right]\%$$

Combination of Errors

❖ **Error due to addition**

If $Z = A + B$

$\Delta Z = \Delta A + \Delta B$ (Max. Possible error)

❖ **Error due to subtraction**

If $Z = A - B$

$\Delta Z = \Delta A + \Delta B$ (Max. Possible error)

❖ Error due to Multiplication

If $Z = AB$ then $\dfrac{\Delta Z}{Z} = \dfrac{\Delta A}{A} + \dfrac{\Delta B}{B}$

Percentage error $= \dfrac{\Delta Z}{Z} \times 100$

$$= \left(\frac{\Delta A}{A} \times 100\right) + \left(\frac{\Delta B}{B} \times 100\right)$$

❖ Here Percentage error is the sum of individual percentage errors.

❖ **Error due to Division**

$Z = \frac{A}{B}$

Maximum possible relative error

$\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$

Max. Percentage error in division

$\left(\frac{\Delta Z}{Z} \times 100\right) = \left(\frac{\Delta A}{A} \times 100\right) + \left(\frac{\Delta B}{B} \times 100\right)$

❖ **Error due to Power**

If $Z = A^n$

$\frac{\Delta Z}{Z} = n\frac{\Delta A}{A}$

❖ If $Z = \frac{A^p B^q}{C^r}$ then maximum fractional error in Z is

$\frac{\Delta Z}{Z} = p\frac{\Delta A}{A} + q\frac{\Delta B}{B} + r\frac{\Delta C}{C}$

As we check for maximum error, therefore + *ve* sign is to be taken for the term $r\frac{\Delta C}{C}$

Maximum Percentage error in

$Z = \frac{\Delta Z}{Z} \times 100 = p\frac{\Delta A}{A} \times 100 + q\frac{\Delta B}{B} \times 100 + r\frac{\Delta C}{C} \times 100$

SIGNIFICANT FIGURES

Rules for Counting Significant Figures

For a number greater than 1

❖ All non-zero digits are significant.

❖ All zeros between two non-zero digits are significant. Location of decimal does not matter.

❖ If the number is without decimal part, then the terminal or trailing zeros are not significant.

❖ Trailing zeros in the decimal part are significant.

For a Number less than 1

Any zero to the right of a non-zero digit is significant. All zeros between decimal point and first non-zero digit are not significant.

Significant Figures

All accurately known digits in measurement plus the first uncertain digit together form significant figure.

Ex. 0.108 → 3SF, 40.000 → 5SF,

1.23×10^{-19} → 3SF, 0.0018 → 2SF

DIMENSIONAL EQUATION

Whenever the dimension of a physical quantity is equated with its dimensional formula, we get a dimensional equation.

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 $[M^X L^Y T^Z]$.

Principle of Homogeneity

The magnitude of a physical quantity may be added or subtracted from another physical quantity only if they have the same dimensions, also the dimensions on both sides of an equation must be same. This is called as principle of homogeneity.

Physical Quantities Having Same Dimensional Formulas

❖ Angular momentum, Angular impulse, Planck's constant $[ML^2T^{-1}]$

❖ Stress, Pressure, Modulus of Elasticity, Energy density $[ML^{-1}T^{-2}]$

❖ Thermal capacity, Entropy, Boltzmana constant, Molar thermal capacity, $[ML^2T^{-2}K^{-1}]$

❖ Electric potential, potential difference, electromotive force $[ML^2T^{-3}A^{-1}]$

❖ If L, C and R stand for inductance, capacitance and resistance respectively then $\frac{L}{R}, \sqrt{LC}, RC$ and time have same dimentional formula $[M^0L^0T]$

Uses of Dimensional Analysis

(i) To check the dimensional correctness of a given physical relation

It is based on the 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.

❖ Powers raised to any physical quantity are dimensionless

❖ sin θ, e^{θ}, cos θ, log θ are dimensionless.

❖ We can add or subtract quantities having same dimensions.

(ii) 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.

(iii) To convert units of a physical quantity from one system of units to another

LEVEL-1

1. The dimensions of magnetic moment are
   (*a*) L^2A^{-1} (*b*) L^2A^1
   (*c*) LA^2 (*d*) L^2A^{-3}

2. The velocity "v" of a particle is given in terms of time t as $v = \text{at} + \dfrac{b}{t+c}$.
   The dimensions of a, b, c are
   (*a*) L^2 ; M ; LT^{-2} (*b*) LT^2 ; LT ; L
   (*c*) LT^{-2} ; L ; T (*d*) L ; LT ; T^2

3. A new system of units is proposed in which, unit of mass is α kg, unit of length is β *m* and unit of time is γ s. What will be value of 5 J in this new system?
   (*a*) $5\alpha\beta^2\gamma^{-2}$ (*b*) $5\alpha^{-1}\beta^{-2}\gamma^2$
   (*c*) $5\alpha^{-2}\beta^{-1}\gamma^{-2}$ (*d*) $5\alpha^{-1}\beta^2\gamma^2$

4. 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
   (*a*) $[G^{1/2}h^{1/2}c^{-5/2}]$ (*b*) $[G^{-1/2}h^{1/2}c^{-1/2}]$
   (*c*) $[G^{-1/2}h^{1/2}c^{-3/2}]$ (*d*) $[G^{-1/2}h^{1/2}c^{1/2}]$

5. 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 $P = \dfrac{a^3b^2}{cd}$. % error in P is
   (*a*) 4% (*b*) 14%
   (*c*) 10% (*d*) 7%

6. Which of the following sets cannot enter into the list of fundamental quantities in any system of units?
   (*a*) Length, time and velocity
   (*b*) Length, mass and velocity
   (*c*) Mass, time and velocity
   (*d*) Length, time and mass

7. Which one of the following has the dimensions of pressure?
   (*a*) $\dfrac{ML}{T^2}$ (*b*) $\dfrac{M}{L^2T^2}$
   (*c*) $\dfrac{M}{LT^2}$ (*d*) $\dfrac{M}{LT}$

8. The dimensions of physical quantity X in the equation, force $= \dfrac{X}{\sqrt{\text{Density}}}$ is given by
   (*a*) $M^1L^4T^{-2}$ (*b*) $M^2L^{-2}T^{-1}$
   (*c*) $M^{3/2}L^{-1/2}T^{-2}$ (*d*) $M^1L^{-2}T^{-1}$

9. The dimensions of "K" in equation $W = \dfrac{1}{2}Kx^2$ is
   (*a*) $[M^1\ L^0\ T^{-2}]$ (*b*) $[M^0\ L^1\ T^{-1}]$
   (*c*) $[M^1\ L^1\ T^{-2}]$ (*d*) $[M^1\ L^0\ T^{-1}]$

10. The velocity of a particle (v) at a instant (t) is given by $v = at + bt^2$ the dimension of b is
    (*a*) L (*b*) LT^{-1}
    (*c*) LT^{-2} (*d*) LT^{-3}

11. If units of length, mass and force are chosen as fundamental units, the dimensions of time would be
    (*a*) $M^{1/2}\ L^{-1/2}\ F^{1/2}$ (*b*) $M^{1/2}\ L^{1/2}\ F^{1/2}$
    (*c*) $M^{1/2}\ L^{1/2}\ F^{-1/2}$ (*d*) $M^1\ L^{-1/2}\ F^{-1/2}$

12. If speed of light (c), acceleration due to gravity (g) and pressure (P) are taken as fundamental units, the dimensions of gravitational constant (G) are
    (*a*) $c^0\ g\ P^{-3}$ (*b*) $c^2\ g^3\ P^{-2}$
    (*c*) $c^0\ g^2\ P^{-1}$ (*d*) $c^2\ g^2\ P^{-2}$

13. A physical quantity of the dimensions of length that can be formed out of c, G and $\dfrac{e^2}{4\pi\varepsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and e is charge]
    (*a*) $c^2\left[G\dfrac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$ (*b*) $\dfrac{1}{c^2}\left[\dfrac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$
    (*c*) $\dfrac{1}{c^2}G\dfrac{e^2}{4\pi\varepsilon_0}$ (*d*) $\dfrac{1}{c^2}\left[G\dfrac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

14. 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
    (*a*) 1.6048 g cm^{-3} (*b*) 1.69 g cm^{-3}
    (*c*) 1.7 g cm^{-3} (*d*) 1.695 g cm^{-3}

15. The numbers 2.745 and 2.735 on rounding off to 3 significant figures will give
    (*a*) 2.75 and 2.74 (*b*) 2.74 and 2.73
    (*c*) 2.75 and 2.73 (*d*) 2.74 and 2.74

16. The relative density of a metal may be found by hanging a block of the metal from a spring balance and nothing that in air, the balance reads (5.00 ± 0.05)N while in water, it reads (4.00 ± 0.05)N. The relative density would be quoted as
    (*a*) 5.00 ± 0.05 (*b*) 5.00 ± 11%
    (*c*) 5.00 ± 0.10 (*d*) 5.00 ± 6%

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

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

18. The respective number of significant figure for the number 23.023, 0.0003 and 2.1×10^{-3} are

(*a*) 5, 1, 2 (*b*) 5, 1, 5
(*c*) 5, 5, 2 (*d*) 4, 4, 2

19. The absolute error in density of a sphere of radius 10.01 m and mass 4.692 kg is

(*a*) 3.59 kg m^{-3} (*b*) 4.692 kg m^{-3}
(*c*) 0 (*d*) 1.12 kg m^{-3}

20. In a vernier callipers, 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 callipers is

(*a*) $\left(\frac{n-1}{n}\right)x$ (*b*) $\left(\frac{nx}{n-1}\right)$
(*c*) $\frac{x}{n}$ (*d*) $\left(\frac{x}{n-1}\right)$

21. If $x = a^n$, then fractional error $\frac{\Delta x}{x}$ is equal to

(*a*) $\pm\left(\frac{\Delta a}{a}\right)^n$ (*b*) $\pm n\left(\frac{\Delta a}{a}\right)$
(*c*) $\pm n \log e \frac{\Delta a}{a}$ (*d*) $\pm n \log \frac{\Delta a}{a}$

22. 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

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

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

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

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

23. Which of the following is not a unit of time?

(*a*) Second (*b*) Decade
(*c*) Year (*d*) Light year

24. The dimensions of impulse are equal to that of

(*a*) Pressure
(*b*) Linear momentum
(*c*) Force
(*d*) Angular momentum

25. Which of the following dimensions will be the same as that of time?

(*a*) $\frac{L}{R}$ (*b*) $\frac{C}{L}$
(*c*) LC (*d*) $\frac{R}{L}$

26. What are dimensions of E/B?

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

27. Surface tension has the same dimensions as that of

(*a*) Coefficient of viscosity
(*b*) Impulse
(*c*) Momentum
(*d*) Spring constant

28. Dimensional formula of self inductance is

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

29. Photon is quantum of radiation with energy $E = h\nu$, where ν is frequency and h is Planck's constant. The dimensions of h are the same as that of

(*a*) Linear impulse (*b*) Angular impulse
(*c*) Linear momentum (*d*) Angular velocity

30. If C and R denote capacitance and resistance, the dimensional formula of CR is

(*a*) $[M^0L^0T^1]$
(*b*) $[M^0L^0T^0]$
(*c*) $[M^0L^0T^{-1}]$
(*d*) Not expressible in terms of MLT

31. $ML^3T^{-1}Q^{-2}$ is dimensions of

(*a*) Resistivity (*b*) Conductivity
(*c*) Resistance (*d*) None of these

32. If n is number and u is the unit of a physical quantity then which of the following is correct for the measurement of "n"?

(*a*) $n \propto$ size of u (*b*) $n \propto u^2$
(*c*) $n \propto \sqrt{u}$ (*d*) $n \propto \frac{1}{u}$

33. In C.G.S. system the magnitude of the force is 100 dynes. In another system where the fundamental physical quantities are kilogram, meter and minute, the magnitude of the force is

(*a*) 0.036 (*b*) 0.36
(*c*) 3.6 (*d*) 36

34. Pick out the right choice $s^2 = at^4$. Here s is measured in meters, t in second. Then the unit of 'a' is

(*a*) ms^{-2} (*b*) ms^2
(*c*) m^2s^4 (*d*) m^2s^{-4}

35. If the units M and L are increased three times, then the units of energy will be increased by

(*a*) 3 times (*b*) 6 times

(*c*) 27 times (*d*) 81 times

36. The ratio of S.I. to C.G.S units for Stefan's constant is

(*a*) $\frac{1}{100}$ (*b*) $\frac{1}{1000}$

(*c*) 100 (*d*) 1000

37. Out of the following which pair of quantities do not have same dimensions?

(*a*) Planck's constant and angular momentum

(*b*) Work and torque

(*c*) Impulse and momentum

(*d*) Torque and moment of inertia

38. The dimensions of light year is

(*a*) T (*b*) L

(*c*) LT (*d*) T^{-1}

39. Which of the following is dimensional constant?

(*a*) Refractive index (*b*) Poisson's ratio

(*c*) Relative density (*d*) Gravitational constant

40. For $10^{(at+3)}$, the dimension of a is

(*a*) $M^0L^0T^0$ (*b*) $M^0L^0T^1$

(*c*) $M^0L^0T^{-1}$ (*d*) None of these

41. A book with many printing errors contains four different formulae for the displacement y of a particle undergoing a certain periodic motion.

I. $y = a\sin\frac{2\pi t}{T}$

II. $y = a \sin vt$

III. $y = \left(\frac{a}{T}\right)\sin(t/a)$

IV. $y = \left(\frac{a}{\sqrt{2}}\right)\left(\sin\frac{2\pi t}{T} + \cos\frac{2\pi t}{T}\right)$

(Where, a = maximum displacement of the particle, v = speed of the particle, T = time period of motion). Which is the wrong formulae on dimensional grounds?

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

(*c*) I and IV (*d*) II and I

42. If voltage V = (100 ± 5)V and current I = (10 ± 0.2)A, the percentage error in resistance R is

(*a*) 5.2% (*b*) 25%

(*c*) 7% (*d*) 10%

43. The dimensions of the coefficient of viscosity are

(*a*) $ML^{-1}T^{-1}$ (*b*) MLT

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

44. The unit of $\frac{1}{\ell}\sqrt{\frac{T}{m}}$ is the same as that of (where T is tension and m is mass/length)

(*a*) Frequency (*b*) Time period

(*c*) Wave-length (*d*) Wave number

45. Which of the following is not dimensionally correct (T = tension, m = mass/length, s = distance, a is acceleration v is velocity h = height)

(*a*) $s = \frac{1}{2}at^2$ (*b*) $v = \sqrt{T/m}$

(*c*) $t = \frac{2h}{g}$ (*d*) $a = \frac{v^2}{r}$

46. In a given relation $F = at^1 + bt^2$, F and t denote the force and the time respectively, then dimensions of a and b are respectively as

(*a*) $M°L°T^1$, $M°L°T^{-2}$ (*b*) $M°L^1T^{-2}$, $M°L^2T^{-2}$

(*c*) $M^1L^1T^{-3}$, $M^1L^1T^{-4}$ (*d*) $M^1L^1T^{-1}$, $M^1L^1T^{-2}$

47. Dimensional formula for volume elasticity is

(*a*) $M^2L^{-2}T^{-2}$ (*b*) $M^1L^{-3}T^{-2}$

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

48. With usual notation, amongst the following, the one which does not represent the dimensions of time is

(*a*) $\left[\frac{L}{R}\right]$ (*b*) $[RC]$

(*c*) $\left[\sqrt{LC}\right]$ (*d*) $\left[\frac{1}{\sqrt{LC}}\right]$

49. The dimension of Planck's constant equals to that of

(*a*) Energy (*b*) Momentum

(*c*) Angular momentum (*d*) Power

LEVEL-2

Statement Based MCQs

Directions: These questions consist of two statements each, printed as Statement-I and Statement-II. While answering these questions, you are required to choose any one of the following four responses.

(*a*) Both Statement-I and Statement-II are correct.

(*b*) Both Statement-I and Statement-II are incorrect.

(*c*) Statement-I is correct and Statement-II is incorrect.

(*d*) Statement-I is incorrect and Statement-II is correct.

1. **Statement-I:** The units of some physical quantities can be expressed as combination of the base units.
   Statement-II: We need only a limited number of units for expressing the derived physical quantities.
2. **Statement-I:** The number 1.202 has four significant figures and the number 0.0024 has two significant figures.
   Statement-II: All the non zero digits are significant.
3. **Statement-I:** All physical quantities can be added or subtracted.
   Statement-II: The physical quantities should not have same dimensions for additions and subtraction.
4. **Statement-I:** Let us consider an equation $1/2\ mv^2 = mgh$ where, m is the mass of the body, v is velocity, g is the acceleration due to gravity and h is the height. This equation is dimensionally correct.
   Statement-II: All dimensionally correct equations are correct.
5. **Statement-I:** The given equation $x = x_0 + u_0 t + \frac{1}{2}at^2$ 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.
   Statement-II: Dimensional analysis can be used for checking the dimensional consistency or homogeneity of the equation.

Assertion & Reason MCQs

Directions: These questions consist of two statements each, printed as Assertion and Reason. While answering these questions, you are required to choose any one of the following four responses.

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

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

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

(*d*) Assertion is False but Reason is True.

6. **Assertion:** Light year is the distance that light travels with velocity of 3×10^8 m s^{-1} in one year.
   Reason: Light year is the unit for measuring time.
7. **Assertion:** Dimensions of Planck's constant is equal to the dimensions of angular momentum.
   Reason: Dimensions of work is ML^2T^{-2}.
8. **Assertion:** A dimensionally wrong or inconsistent equation must be wrong.
   Reason: A dimensionally consistent equation is an exact or a correct equation.
9. **Assertion:** When the units of measurement of a quantity changed, its numerical value changes.
   Reason: Smaller the unit of measurement, smaller is its numerical value.

Rank Booster MCQs

10. The SI unit of length is the meter. Suppose we adopt a new unit of length which equals to x meters. The area $1m^2$ expressed in terms of the new unit has a magnitude
    (*a*) x (*b*) x^2
    (*c*) $\frac{1}{x}$ (*d*) $\frac{1}{x^2}$
11. If the units of M and L are doubled then the unit of kinetic energy will become
    (*a*) 8 times
    (*b*) 16 times
    (*c*) 4 times
    (*d*) 2 times
12. A and B are two physical quantities having different dimensions. Then which of the following operation is dimensionally correct?
    (*a*) $A + B$ (*b*) $\log \frac{A}{B}$
    (*c*) $\frac{A}{B}$ (*d*) $e^{A/B}$
13. If velocity (V), time (T) and force (F) were chosen as fundamental quantities, the dimensions of mass will be
    (*a*) FTV (*b*) $F^{-1}TV$
    (*c*) FTV^{-1} (*d*) $FT^{-1}V$
14. A uniform wire of length L and mass M is stretched between two fixed points, keeping a tension F. A sound of frequency μ is impressed on it. Then the maximum vibrational energy is existing in the wire when μ =
    (*a*) $\frac{1}{2}\sqrt{\frac{ML}{F}}$ (*b*) $\sqrt{\frac{FL}{M}}$
    (*c*) $2\times\sqrt{\frac{FM}{L}}$ (*d*) $\frac{1}{2}\sqrt{\frac{F}{ML}}$

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

(*a*) A (*b*) B

(*c*) C (*d*) D

16. A particle of mass m is suspended by a spring of spring constant k if frequency of its oscillation is $n = cm^xk^y$ here c is a constant then the value 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*) $x=\frac{1}{2}, y=-\frac{1}{2}$

17. In the formula $V = E^bd^a$, if V, E and d are the velocity of longitudinal waves, bulk modulus of elasticity and density of the gaseous medium respectively, then the values of a and b are respectively

(*a*) $-\frac{1}{2}$ and $\frac{1}{2}$ (*b*) $\frac{1}{2}$ and $-\frac{1}{2}$

(*c*) $-\frac{1}{\sqrt{2}}$ and $\frac{1}{\sqrt{2}}$ (*d*) $-\frac{1}{\sqrt{2}}$ and $-\frac{1}{\sqrt{2}}$

18. If force (F), area (A) and density (D) are taken as the fundamental units, the dimensional representation of Youngs modulus will be

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

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

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

(*a*) EV^2 (*b*) EV^{-2}

(*c*) FV^{-1} (*d*) FV^{-2}

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

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

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

21. The velocity of ripples on water surface depends upon the wavelength λ, density of water d and acceleration due to gravity g. Which of the following relations is correct among these quantities?

(*a*) $V^2 \propto g\lambda$ (*b*) $V^2 \propto \frac{1}{g\lambda}$

(*c*) $V^2 \propto \frac{1}{gd}$ (*d*) $V^2\ \lambda\ g\ \lambda d$

22. If E, m, l and G denote energy, mass, angular momentum and gravitational constant respectively, the quantity $\left(\frac{El^2}{m^5G^2}\right)$ has the dimensions of

(*a*) Mass (*b*) Length

(*c*) Time (*d*) Angle

23. The dimension of a/b in the equation $P=\frac{a-t^2}{bx}$ where P is pressure, x is distance and t is time, are

(*a*) $[M^2LT^{-3}]$ (*b*) $[MT^{-2}]$

(*c*) $[LT^{-3}]$ (*d*) $[ML^3T^{-1}]$

24. Given: $\text{Force}=\frac{\alpha}{\text{density}+\beta^3}$. What are the dimensions of α, β?

(*a*) $ML^{-2}T^{-2}$, $ML^{-1/3}$

(*b*) $M^2L^4T^{-2}$, $M^{-1/3}L^{-1}$

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

(*d*) $M^2L^{-2}T^{-2}$, ML^{-3}

25. Given that $\int\frac{dx}{\sqrt{2ax-x^2}}=a^n\sin^{-1}\left(\frac{x-a}{a}\right)$ where a = constant, using dimensional analysis, the value of n is

(*a*) 1 (*b*) –1

(*c*) 0 (*d*) None of the above

26. Frequency is the function of density (ρ), length (a) and surface tension (T). Frequency is equal to

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

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

27. The relation $p=\frac{\alpha}{\beta}e^{\frac{-\alpha Z}{k\theta}}$ where p is pressure, Z is distance, k is Boltzmann constant and θ is temperature. The dimensional formula of β will be

(*a*) $[M^0L^2T^0]$ (*b*) $[ML^2T]$

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

28. A uniform wire of length L, diameter D and density ρ is stretched under a tension T. The correct relation between its fundamental frequency f, the length L and the diameter D is

(*a*) $f\propto\frac{1}{LD}$ (*b*) $f\propto\frac{1}{L\sqrt{D}}$

(*c*) $f\propto\frac{1}{D^2}$ (*d*) $f\propto\frac{1}{LD^2}$

29. A gas bubble formed from an explosion under water oscillates with a period T proportional to pa db Ec, where p is pressure, d is the density of water and E is the total energy of explosion. The values of a, b and c are

(*a*) a = 1, b = 1, c = 2 (*b*) a = 1, b = 2, c = 1

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

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

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

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

Past 5 Years Questions

1. Consider the diameter of a spherical object being measured with the help of a Vernier callipers. Suppose its 10 Vernier Scale Divisions (V.S.D.) are equal to its 9 Main Scale Divisions (M.S.D.). The least division in the M.S. is 0.1 cm and the zero of V.S. is at $x = 0.1$ cm when the jaws of Vernier callipers are closed.

If the main scale reading for the diameter is M = 5 cm and the number of coinciding vernier division is 8, the measured diameter after zero error correction, is: **(2025)**

(*a*) 5.18 cm (*b*) 5.08 cm

(*c*) 4.98 cm (*d*) 5.00 cm

2. The quantities which have the same dimensions as those of solid angle are: **(2024)**

(*a*) strain and arc (*b*) angular speed and stress

(*c*) strain and angle (*d*) stress and angle

3. A force defined by $F = \alpha t^2 + \beta t$ acts on a particle at given time t. The factor which is dimensionless, if α and β are constants, is: **(2024)**

(*a*) $\alpha\beta t$ (*b*) $\alpha\beta/t$

(*c*) $\beta t/\alpha$ (*d*) $\alpha t/\beta$

4. The pitch of an error free screw gauge is 1 mm and there are 100 divisions on the circular scale. While measuring the diameter of a thick wire, the pitch scale reads 1 mm and 63rd division on the circular scale coincides with the reference line. The diameter of the wire is: **(2024 Re)**

(*a*) 1.63 cm (*b*) 0.163 cm

(*c*) 0.163 m (*d*) 1.63 m

5. In a vernier calipers, $(N + 1)$ 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)**

(*a*) 100 N (*b*) $10(N + 1)$

(*c*) $\frac{1}{10N}$ (*d*) $\frac{1}{100(N+1)}$

6. The errors in the measurement which arise due to unpredictable fluctuations in temperature and voltage supply are: **(2023)**

(*a*) Random errors (*b*) Instrumental errors

(*c*) Personal errors (*d*) Least count errors

7. 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)**

(*a*) 1.4% (*b*) 1.2%

(*c*) 1.3% (*d*) 1.6%

8. Plane angle and solid angle have: **(2022)**

(*a*) Both units and dimension

(*b*) Units but no dimensions

(*c*) Dimensions but no units

(*d*) No units and no dimensions

9. The dimension $[MLT^{-2}A^{-2}]$ belong to the : **(2022)**

(*a*) Electric permittivity (*b*) Magnetic flux

(*c*) Self inductance (*d*) Magnetic permeability

10. 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)**

(*a*) 14×10^2 (*b*) 138×10^1

(*c*) 1382 (*d*) 1382.5

11. If E and G respectively denote energy and gravitational constant, then E/G has the dimensions of: **(2021)**

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

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

12. 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:

(*a*) 0.026 cm (*b*) 0.26 cm

(*c*) 0.052 cm (*d*) 0.52 cm

13. If force [F], acceleration [A] and time [T] are chosen as the fundamental physical quantities. Find the dimensions of energy. **(2021)**

(*a*) $[F]\,[A]\,[T^2]$ (*b*) $[F]\,[A]\,[T^{-1}]$

(*c*) $[F]\,[A^{-1}]\,[T]$ (*d*) $[F]\,[A]\,[T]$

Answer Key

Level–1

1. (*b*)	**2.** (*c*)	**3.** (*b*)	**4.** (*a*)	**5.** (*b*)	**6.** (*a*)	**7.** (*c*)	**8.** (*c*)	**9.** (*a*)	**10.** (*d*)
11. (*c*)	**12.** (*c*)	**13.** (*d*)	**14.** (*c*)	**15.** (*d*)	**16.** (*b*)	**17.** (*c*)	**18.** (*a*)	**19.** (*a*)	**20.** (*c*)
21. (*b*)	**22.** (*b*)	**23.** (*d*)	**24.** (*b*)	**25.** (*a*)	**26.** (*a*)	**27.** (*d*)	**28.** (*c*)	**29.** (*b*)	**30.** (*a*)
31. (*a*)	**32.** (*d*)	**33.** (*c*)	**34.** (*d*)	**35.** (*c*)	**36.** (*d*)	**37.** (*d*)	**38.** (*b*)	**39.** (*d*)	**40.** (*c*)
41. (*b*)	**42.** (*c*)	**43.** (*a*)	**44.** (*a*)	**45.** (*c*)	**46.** (*c*)	**47.** (*d*)	**48.** (*d*)	**49.** (*c*)	

Level–2

1. (*a*)	**2.** (*a*)	**3.** (*b*)	**4.** (*c*)	**5.** (*a*)	**6.** (*c*)	**7.** (*b*)	**8.** (*c*)	**9.** (*c*)	**10.** (*d*)
11. (*a*)	**12.** (*c*)	**13.** (*c*)	**14.** (*d*)	**15.** (*c*)	**16.** (*c*)	**17.** (*a*)	**18.** (*c*)	**19.** (*b*)	**20.** (*c*)
21. (*a*)	**22.** (*d*)	**23.** (*b*)	**24.** (*c*)	**25.** (*c*)	**26.** (*d*)	**27.** (*a*)	**28.** (*a*)	**29.** (*d*)	**30.** (*b*)

Past 5 Years Questions

1. (*c*)	**2.** (*c*)	**3.** (*d*)	**4.** (*b*)	**5.** (*d*)	**6.** (*a*)	**7.** (*d*)	**8.** (*b*)	**9.** (*d*)	**10.** (*a*)
11. (*d*)	**12.** (*c*)	**13.** (*a*)							

Explanation

Level–1

1. (*b*) Magnetic moment = Current × Area

2. (*c*) As c is added to t, therefore, c has the dimensions of T.

As $\frac{b}{t} = v$,

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

From v = at, $a = \frac{v}{t} = \frac{LT^{-1}}{T} = \left[LT^{-2}\right]$

3. (*b*) Joule is a unit of energy.

$n_1 = 5$	$n_2 = ?$
$M_1 = 1$ kg	$M_2 = \alpha$ kg
$L_1 = 1$ m	$L_2 = \beta$ m
$T_1 = 1$ s	$T_2 = \gamma$ s

Dimensional formula of energy is $[ML^2T^{-2}]$. Comparing with $[M^aL^bT^c]$, we get

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

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

$$= 5\left(\frac{1\,\text{kg}}{\alpha\,\text{kg}}\right)^1\left(\frac{1\,\text{m}}{\beta\,\text{m}}\right)^2\left(\frac{1\,\text{s}}{\gamma\,\text{s}}\right)^{-2} = \frac{5\gamma^2}{\alpha\beta^2} = 5\alpha^{-1}\beta^{-2}\gamma^2$$

4. (*a*) $c = [M^0 L^1 T^{-1}]$, $G = [M^{-1} L^3 T^{-2}]$, $h = [M^1 L^2 T^{-1}]$

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

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

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

a + 3b + 2c = 0, a + 2b + c = –1

Solving the three equations

a = –5/2, b = ½, c = 1/2

$T = [c^{-5/2} G^{1/2} h^{1/2}]$

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

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

6. (*a*) Mass is a fundamental quantity in any system of units which is not present in option (*a*).

7. (*c*) $P = \frac{F}{A} = \frac{MLT^{-2}}{L^2} = \left[ML^{-1}T^{-2}\right] = \frac{M}{LT^2}$

8. (*c*) $[X] = [F]\times[\rho]^{1/2}$

$= [MLT^{-2}]\times\left[\frac{M}{L^3}\right]^{1/2}$

$= \left[M^{3/2}L^{-1/2}T^{-2}\right]$

9. (*a*) $W = \frac{1}{2}Kx^2 \Rightarrow [K] = \frac{[W]}{[x^2]} = \frac{[ML^2T^{-2}]}{[L^2]} = [MT^{-2}]$

10. (*d*) $v = at + bt^2$

$[v] = [bt^2]$

$LT^{-1} = bT^2 \Rightarrow [b] = [LT^{-3}]$

11. (c) $F = M^1 L^1 T^{-2}$

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

$T = M^{1/2} L^{1/2} F^{-1/2}$

12. (*c*) Let $G = c^x g^y P^z$

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

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

Equating the powers from both sides

$z = -1,\ x + y - z = 3$

$-x - 2y - 2z = -2$

On solving, we get,

$y = 2 , x = 0$

$\therefore G = c^0 g^2 P^{-1}$

13. (*d*) $L = [c]^a [G]^b \left[\frac{e^2}{4\pi\varepsilon_0}\right]^c$

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

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

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

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

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

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

14. (*c*) Density $\rho = \frac{\text{mass}}{\text{volume}}$

$= \frac{4.237\ g}{2.5\ cm^3}$

$= 1.6948\ g/cm^3$

$= 1.7\ g/cm^3$

rounded off to two significance

15. (*d*) Rounding off 2.745 to 3 significant figures it would be 2.74. Rounding off 2.735 to 3 significant figures it would be 2.74.

16. (*b*) Relative density $= \frac{\text{Weight in air}}{\text{Loss of weight in water}}$

$\rho = \frac{5.00}{1.00} = 5.00$

$\frac{d\rho}{\rho} = \frac{0.05}{5.00} + \frac{0.1}{1.00} = 0.11 = 11\%$

$P = 5.00 \pm 11\%$

17. (*c*) Volume of sphere $= \frac{4}{3}\pi r^3$

$\Delta r = 2\% \Rightarrow \frac{\Delta V}{V} = \frac{3\Delta r}{r}$

$\Rightarrow \frac{\Delta V}{V} = 3 \times 2 = 6\%$

Error in determination of volume of sphere is equal to 6%.

18. (*a*) $23.023 \to 5,\ 0.0003 = 1,\ 2.1 \times 10^{-3} = 2$

19. (*a*) $\rho = \frac{m}{\frac{4}{3}\pi r^3} = \frac{4.692 \times 3}{4 \times 3.14 \times (10.01)^3 \times 10^{-6}}$

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

abs. errors:

$\Delta m = 1gm = 0.001\ kg$

$\Delta r = 0.01\ m$

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

$\Delta\rho = \left(\frac{0.001}{4.692} + \frac{3 \times 0.01}{10.01}\right) \times 1.12 \times 10^3$

$= 3.59\ kg/m^3$

20. (*c*) One main scale division, 1 M.S.D = x cm

One vernier scale division, 1 V.S.D = $\frac{(n-1)x}{n}$

Least count = 1 M.S.D – 1 V.S.D

$= \frac{nx - nx + x}{n} = \frac{x}{n}\ cm$

21. (*b*) If, $x = a^n$

then; $\frac{\Delta x}{x} = \pm n\left(\frac{\Delta a}{a}\right)$

22. (*b*) Here, maximum fractional error is:

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

$\therefore$ Absolute error in Q, i.e.,

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

23. (*b*) 1 Light year = 9.4607×10^{12} km and km is a unit of distance.

24. (*b*) Impulse = Force × Time

Therefore dimensional formula of impulse = dimensional formula of force × dimensional formula of time = $[MLT^{-2}]\ [T] \Rightarrow [MLT^{-1}]$ and dimensional formula of linear momentum $[p] = MLT^{-1}$.

25. (*a*) L/R is known as the time constant of the series LR circuit, as its dimension is [T]

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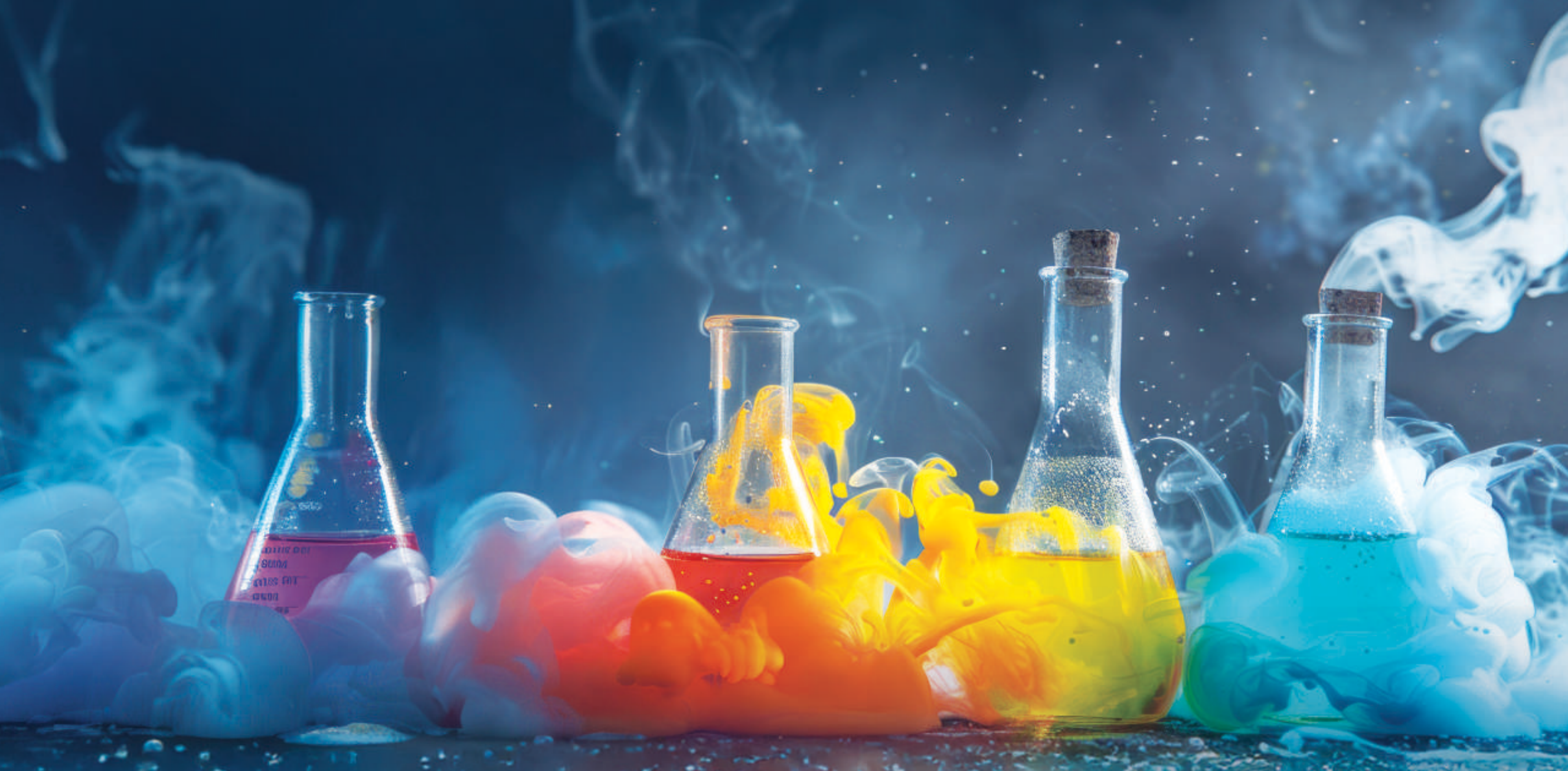

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