NEET-UG & JEE (Main)

PHYSICS Vol - I

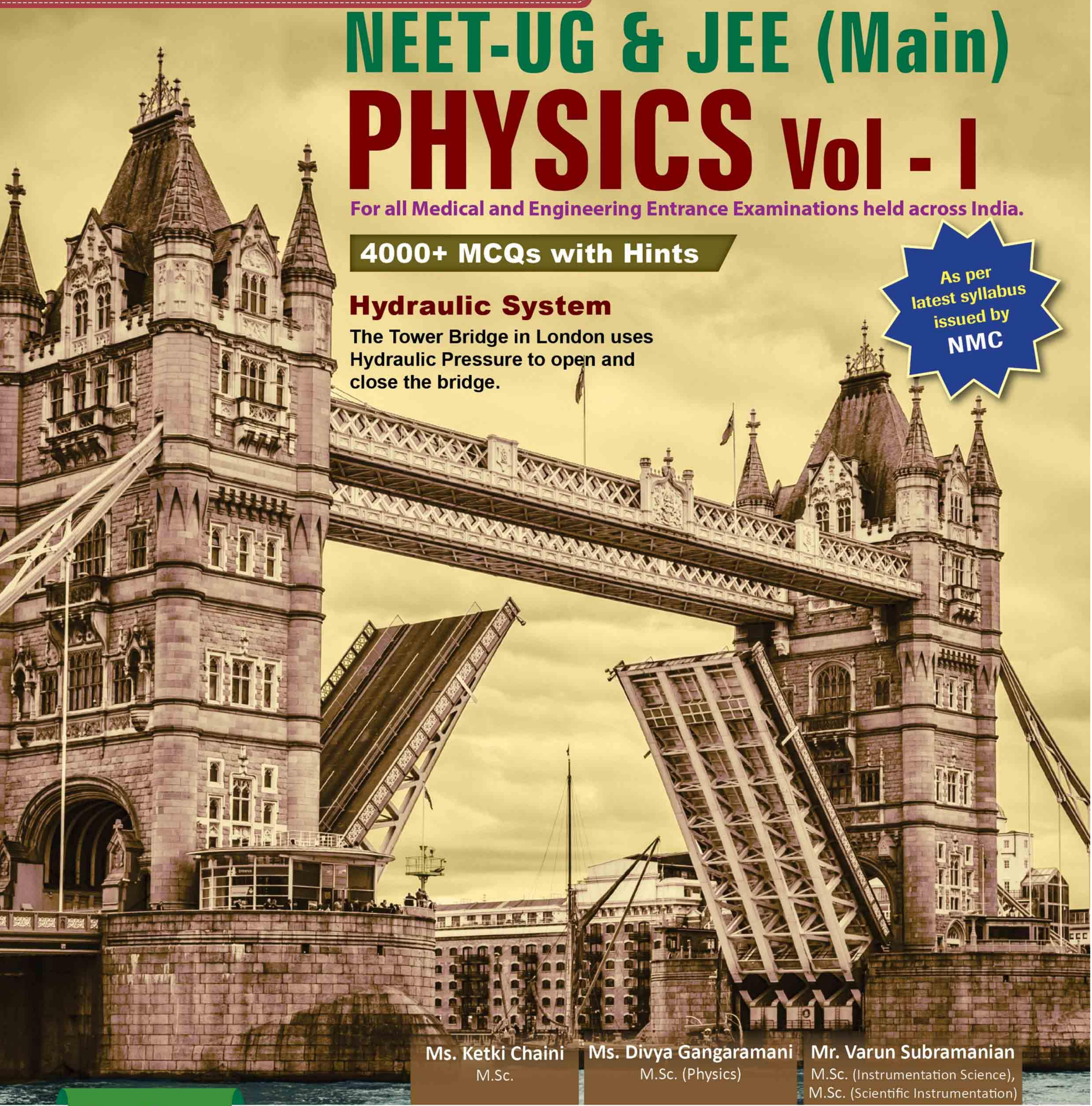
For all Medical and Engineering Entrance Examinations held across India.

4000+ MCQs with Hints

As per latest syllabus issued by NMC

Hydraulic System

The Tower Bridge in London uses Hydraulic Pressure to open and close the bridge.



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For all Medical and Engineering Entrance Examinations held across India.

Absolute
NEET (UG) & JEE (Main)
Physics Vol. I

Now with more study techniques

Updated as per latest syllabus for:
NEET (UG) 2024 issued by **NMC on 6th October, 2023**
JEE (Main) 2024 issued by **NTA on 1st November, 2023**

Salient Features

- Comprehensive theory for every topic
- Subtopic-wise segregation of MCQs for efficient practice
- Exhaustive coverage of questions including questions from previous years' NEET (UG), JEE (Main) and other competitive examinations **till year 2023:**
  - **3994** MCQs
  - **90** Numerical Value Type (NVT) questions
  - Solutions to the questions are provided for better understanding
- Includes **Smart Keys:** Multiple study techniques to enhance understanding and problem solving:
  - ***Time Saver***
  - ***Smart tip***
  - ***Caution***
  - ***Learning Pointers***
  - ***Think out of the box***
- Includes relevant Solved Questions from:
  - NEET (UG) 2023
  - JEE (Main) 2023 24th Jan (Shift - II)
  - NEET (UG) Manipur 2023
- Includes Question Paper and Answer Keys (Solutions through Q.R. code) of:
  - JEE (Main) 2024 31st January (Shift - I)
- Topic Test provided in each chapter for self-assessment
- Q.R. codes provide:
  - Video links for boosting conceptual retention
  - Answers & Solutions to Topic Tests

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PREFACE

'Absolute Physics Vol - I' is a complete guidebook, extremely handy for preparation of various competitive exams like NEET (UG), JEE (Main). This edition provides an unmatched comprehensive amalgamation of theory with MCQs. The chapters are aligned with the latest syllabus for **NEET (UG) and JEE (Main) 2024** examinations. Although the alignment runs parallel to NCERT curriculum, the structure of the chapters prioritizes knowledge building of the students. The book provides the students with scientifically accurate context, several study techniques and skills required to excel in these examinations.

All the questions included in a chapter have been specially created and compiled to enable students solve complex problems which require strenuous effort with promptness.

These MCQs are framed considering the importance given to every topic as per the NEET (UG) and JEE (Main) exam to form a strong foundation. They are a healthy mix of theoretical, numerical and graphical based questions.

The level of difficulty of these questions is at par with that of various competitive examinations held across India. Questions from various examinations such as NEET (UG), JEE (Main), MHT CET, K CET, WB JEE, AP EAMCET, AP EAPCET, TS EAMCET (Med. and Engg.), GUJ CET are exclusively covered.

Features in each chapter:

- Coverage of **'Theoretical Concepts'** that form a vital part of any competitive examination.
- **'Multiple Choice Questions'** are segregated topic-wise to enable easy assimilation of questions based on the specific concept.
- **'Formulae'** covers all the key formulae in the chapter, making it useful for students to glance at while solving problems and revising at the last minute.
- **'Topic Test'** has been provided at the end of each chapter to assess the level of preparation of the student on a competitive level.

All the features of this book pave the path of a student to excel in examination. The features are designed keeping the following elements in mind: Time management, easy memorization or revision and non-conventional yet simple methods for MCQ solving.

We hope the book benefits the learner as we have envisioned.

A book affects eternity; one can never tell where its influence stops.

Publisher

Edition: Eighth

The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.

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KEY FEATURES

Formulae

'**Formulae**' cover all of the key formulae in the chapter which is useful for students while solving problems and revising at last minute at a glance.

Examples

'**Examples**' are provided to elucidate a concept using theory or MCQ or numerical question and help students hone their problem-solving skills.

Smart Keys

'**Smart Keys**' comprise a set of remarkable study techniques contrived to benefit students.

Time Saver

'**Time Saver**' illustrates quick method over lengthy conventional method of solving numerical.

Smart Tips

'**Smart Tips**' comprise important theoretical or formula based short tricks considering their usage in solving MCQ.

Caution

'**Caution**' apprises students about mistakes which are made while solving an MCQs.

Learning Pointers

'**Learning Pointers**' provide compilation of additional notes which involve fusion of two concepts from different chapters or come as indirect extensions of subtopics.

Think out of the box

'**Think out of the box**' reveals quick witted approach to crack the specific question.

To be continued...

KEY FEATURES

For your knowledge

'**For your knowledge**' includes additional information relevant to concept.

Connection

'**Connection**' enables students to interlink concepts covered in different chapters.

Gyan Guru

'**Gyan Guru**' illustrates real life applications or examples related to the concept discussed.

Clock symbol

'**Clock Symbol**' instructs students that given MCQ can be solved apace by applying either smart tips, Time saver, Learning Pointers or Think out of the box.

QR Code

'**QR code**' provides:

i. Access to a video/PDF in order to boost understanding of a concept or activity.
ii. Answers & Solutions to Topic Test of each chapter.
iii. Solutions to JEE (Main) 2024 31st January (Shift - 1) question paper.

Frequently Asked Questions

- **Why Absolute Series?**

  Gradually, every year the nature of competitive entrance exams is inching towards conceptual understanding of topics. Moreover, it is time to bid adieu to the stereotypical approach of solving a problem using a single conventional method.

  To be able to successfully crack the NEET(UG) /JEE (Main) examinations, it is imperative to develop skills such as data interpretation, appropriate time management, knowing various methods to solve a problem, etc. With Absolute Series, we are sure, you'd develop all the aforementioned skills and take a more holistic approach towards problem solving. The way you'd tackle advanced level MCQs with the help of Hints, Examples, Smart tips, Time Saver and Think out of the box would give you the necessary practice that would be a game changer in your preparation for the competitive entrance examinations.

- **What is the intention behind the launch of Absolute Series?**

  The sole objective behind the introduction of Absolute Series is to cater to needs of students across a varied background and effectively assist them to successfully crack the NEET(UG) /JEE (Main) examinations. With a healthy mix of MCQs, we intend to develop a student's MCQ solving skills within a stipulated time period.

- **What do I gain out of Absolute Series?**

  After using Absolute Series, students would be able to:

  a. assimilate the given data and apply relevant concepts with utmost ease.

  b. tackle MCQs of different pattern such as match the columns, diagram based questions, multiple concepts and assertion-reason efficiently.

  c. garner the much needed confidence to appear for competitive exams.

  d. easy and time saving methods to tackle tricky questions will help ensure that time consuming questions do not occupy more time than you can allot per question.

- **How to derive the best advantage of the book?**

  To get the maximum benefit of the book, we recommend :

  a. Go through the detailed theory and Examples solved alongwith at the beginning of a chapter for concept clarity. Commit Smart Tips and Time saver into memory and pay attention to Caution.

  b. Read through the Learning pointers section minutely.

  c. Know all the Formulae compiled at the end of theory by-heart.

  d. Using subtopic wise segregation as a leverage, complete MCQs in each subtopic at your own pace. Questions from exams such as JEE (Main), NEET(UG) are tagged and placed along the flow of subtopic. Mark these questions specially to gauge the trends of questions in various exams.

  e. Be extra receptive to Think out of the box, Alternate Method and application of Smart Tips and Time saver. Assimilate them into your thinking.

Best of luck to all the aspirants!

CONTENTS

Page no. **1** to **10** are purposely left blank.

To see complete chapter buy **Target Notes** or **Target E-Notes**

1 Units and Measurement

- Unit of measurement and system of units
- Fundamental and derived units
- Least count of measuring instruments
- Errors in measurement
- Significant figures
- Dimensions of physical quantities
- Dimensional analysis and its applications

Connections
The chapter being a building block of Physics links to every other chapter discussed in the book. Hence, it is inconvenient to offer connection at every place and is avoided. Formulae and relations used in this chapter will be discussed through the course of the book.

Unit of measurement and system of units

➢ **Unit of measurement:**

i. A physical quantity is represented completely by its magnitude and unit. For example, 10 metre means a length which is ten times the unit of length i.e., 1 metre. Here 10 represents the numerical value of the given quantity and metre represents the unit of quantity under consideration.

ii. In expressing a physical quantity, we first choose a unit and then find how many times that unit is contained in the given physical quantity.

Physical quantity(Q) = Magnitude × Unit

$= n \times u$

where, n represents the numerical value and u represents the unit.

iii. While expressing definite amount of physical quantity, as the unit (u) changes, the magnitude (n) will also change but product 'nu' will remain the same.

n u = constant,

$\therefore \quad n \propto \frac{1}{u}$ or $n_1u_1 = n_2u_2$

where,

n_1 = numerical value of a physical quantity in unit u_1 and

n_2 = numerical value of a physical quantity in unit u_2.

iv. Thus, magnitude of a physical quantity and units are inversely proportional to each other. Larger the unit, smaller will be the magnitude.

➢ **System of units:**

i. A complete set of units, both fundamental and derived for all kinds of physical quantities is called system of units.

ii. The common systems of units are given below:

a. **CGS system:** This system is also called Gaussian system of units. In this system, length, mass and time are chosen as the fundamental quantities and corresponding fundamental units are centimetre (cm), gram (g) and second (s) respectively.

b. **MKS system:** This system is also called Giorgi system. In this system, length, mass and time are taken as fundamental quantities. Their corresponding fundamental units are metre (m), kilogram (kg) and second (s).

c. **FPS system:** In this system, foot, pound and second are used respectively for measurements of length, mass and time. This is British engineering system of unit.

d. **S.I. system:** It is known as International system of units and is extended system of units applied to whole Physics.

There are seven fundamental quantities in this system.

➢ **SI Unit:**

i. Internationally accepted units are called SI units.

ii. It corresponds to M.K.S system of unit.

iii. SI units of various fundamental quantities are given below.

Sr. No.	Quantity	Unit	Symbol
1.	Length	metre	m
2.	Mass	kilogram	kg
3.	Time	second	s
4.	Electric Current	ampere	A
5.	Temperature	kelvin	K
6.	Amount of substance	mole	mol
7.	Luminous Intensity	candela	cd

iv. Besides the above seven fundamental units, two supplementary units are also defined.
Radian (*rad*) for plane angle and Steradian (*sr*) for solid angle.

CAUTION

Degree though widely used is not SI unit.

FUNDAMENTAL AND DERIVED UNITS

➢ **Fundamental units:**

i. *Units which can neither be derived nor be resolved into other units are called fundamental units. All fundamental units are different from one another.*

ii. In mechanics, unit of mass in (kg), unit of length in (m) and unit of time in (s) are fundamental units.

➢ **Definitions of some fundamental units in SI system:**

i. **Metre:** *One metre is defined as the distance travelled by light in vacuum during a time interval of* $\frac{1}{299792458}$ *seconds.*

ii. **Kilogram:** *One kilogram is defined as the mass of a cylinder made of platinum-iridium placed at the International Bureau of Weights and Measures in Sevres (France).*

For your knowledge

Till May 20, 2019 the *kilogram* did not have a definition; it was mass of the prototype cylinder kept under controlled conditions of temperature and pressure at the SI museum at Paris. A rigorous and meticulous experimentation has shown that the mass of the *standard* prototype for the *kilogram* has changed in the course of time. This shows the acute necessity for standardization of units. The new definitions aim to improve the SI without changing the size of any units, thus ensuring continuity with existing measurements.

As per new SI units, each of the seven fundamental units (metre, kilogram, etc.) uses ***one*** of the following 7 constants which are proposed to be having ***exact values*** as given below:

The Planck constant (h),
The elementary charge (e),
The Boltzmann constant (k_B),
The Avogadro constant (number) (N_A),
The speed of light in vacuum (c),
The ground state hyperfine structure transition frequency of Caesium-133 atom ($\Delta\nu_{Cs}$).
The luminous efficacy of monochromatic radiation of frequency 540×10^{12} Hz (K_{Cd})
Unit kilogram is now defined using Planck constant, the metre and the second.

Students can scan the adjacent QR code in *Quill - The Padhai App* to get information about **Redefining SI unit of mass; kilogram** with the aid of a linked video.

iii. **Second:** *One second is defined as the time required for 9,192,631,770 periods of the light wave emitted by caesium –133 atoms making a particular atomic transition.*

iv. **Ampere:** *One ampere is that constant current, if maintained in two straight parallel conductors of infinite length of negligible circular cross-section and placed 1 metre apart in vacuum, produce between these conductors, a force equal to* 2×10^{-7} *newton per metre of length.*

v. **Kelvin:** *One kelvin is the fraction* $\frac{1}{273.16}$ *of the thermodynamic temperature of triple point of water.*

vi. **Mole:** *One mole is the amount of substance of a system, which contains as many elementary entities as there are atoms in 0.012 kilogram of carbon-12.*

vii. **Candela:** *One candela is the unit of luminous intensity in a given direction of a source that emits monochromatic radiation of frequency* 540×10^{12} *hertz and has a radiant intensity of* $\frac{1}{683}$ *watt per steradian in that direction.*

viii. **Radian (rad):** *1 radian is an angle that subtends an arc equal to length of radius of circle, at the centre of the circle.*

ix. **Steradian (sr):** *One steradian is the solid angle subtended at the centre of a sphere by an area equal to square of radius of the sphere.*

➢ **Derived units:**

i. *Unit which is obtained by combining two or more fundamental units is called derived unit.*

EXAMPLE - 1.1

Find the unit of force.

Solution:

Step 1: Write the formula of the derived quantity.
F = ma

Step 2: Convert the formula into fundamental physical quantities.
$$F = m\frac{\Delta v}{\Delta t} = \frac{m}{\Delta t}\frac{\Delta s}{\Delta t}$$

Step 3: Write the corresponding units in proper system.
$$F = \frac{\text{kilogram} \times \text{metre}}{\text{second} \times \text{second}}$$

Step 4: Make proper algebraic combination to get the result.
The unit of force = kg-m/s^2

Time saver - 3

Dimensionless quantities i.e., trigonometric functions, exponential functions, logarithms, angles, pure numbers can be eliminated to simplify the equation to approach the correct answer.

Example:

Force is given by the expression F = A cos(Bx) + C cos(Dt) where x is displacement and t is time. The dimension of $\left[\frac{D}{B}\right]$ is same as that of [TS EAMCET (Engg.) 2016]

(A) velocity.
(B) velocity gradient.
(C) angular velocity.
(D) angular momentum.

Conventional Method:

F = A cos(Bx) + C cos(Dt)

But,

$F = A\cos\left(\frac{2\pi x}{\lambda}\right) + C\cos\left(\frac{2\pi t}{T}\right)$

on comparing we get,

$B = \frac{2\pi}{\lambda}$ = metre^{-1}

and, $D = \frac{2\pi}{T}$ = second^{-1}

i.e., $\frac{D}{B} = \frac{\text{second}^{-1}}{\text{metre}^{-1}} = \frac{\text{metre}}{\text{second}}$

$\therefore \left[\frac{D}{B}\right]$ = [velocity]

Ans: (A)

Quick method:

Trigonometric functions being dimensionless, argument of cos is dimensionless.

$\Rightarrow [B] = \frac{1}{[x]}$ and $[D] = \frac{1}{[t]}$

$\therefore \left[\frac{D}{B}\right] = \left[\frac{x}{t}\right] = \left[\frac{L}{T}\right]$ = [velocity]

Ans: (A)

➢ **Dimensions, units, formulae of some quantities:**

Quantity	Formula	Unit	Dimension
Speed	$\frac{\text{Distance}}{\text{Time}}$	ms^{-1}	$[M^0L^1T^{-1}]$
Acceleration	$\frac{\text{Change in velocity}}{\text{Time}}$	ms^{-2}	$[M^0L^1T^{-2}]$
Force	Mass × Acceleration	N (newton)	$[M^1L^1T^{-2}]$
Pressure	$\frac{\text{Force}}{\text{Area}}$	Nm^{-2}	$[M^1L^{-1}T^{-2}]$
Density	$\frac{\text{Mass}}{\text{Volume}}$	kg m^{-3}	$[M^1L^{-3}T^0]$
Work	Force × distance	joule	$[M^1L^1T^{-2}]$ $[L^1]$= $[M^1L^2T^{-2}]$
Energy	Force × distance	joule	$[M^1L^1T^{-2}]$ $[L^1]$= $[M^1L^2T^{-2}]$
Power	$\frac{\text{Work}}{\text{Time}}$	watt	$[M^1L^2T^{-3}]$
Momentum	Mass × Velocity	kg ms^{-1}	$[M^1L^1T^{-1}]$
Impulse	Force × Time	Ns	$[M^1L^1T^{-1}]$
Torque	$\vec{\tau} = \vec{r} \times \vec{F}$	N-m	$[M^1L^1T^{-2}]$ [L] = $[M^1L^2T^{-2}]$
Temperature (T)	--	kelvin	$[M^0L^0T^0K^1]$
Heat (Q)	Energy	joule	$[M^1L^2T^{-2}]$
Specific heat (c)	$\frac{Q}{m\theta}$	joule/kg-K	$[M^0L^2T^{-2}K^{-1}]$

Thermal capacity	--	joule/K	$[M^1L^2T^{-2}K^{-1}]$
Latent heat (L)	$\frac{\text{heat}(Q)}{\text{mass}(m)}$	joule/kg	$[M^0L^2T^{-2}]$
Gas constant (R)	$\frac{PV}{T}$	joule/mol-K	$[M^1L^2T^{-2}K^{-1}]$
Boltzmann constant (k)	$\frac{R}{N}$, N = Avogadro number	joule/K	$[M^1L^2T^{-2}K^{-1}]$
Coefficient of viscosity (η)	$\eta = \frac{F}{A}.\frac{1}{\left(\frac{dv}{dx}\right)}$	$\frac{\text{newton}-\text{second}}{m^2}$	$[M^1L^{-1}T^{-1}]$
Coefficient of thermal conductivity (K)	$K = \frac{\Delta Q}{\Delta t}\left(\frac{\Delta x}{\Delta T}\right)\times\frac{1}{A}$	joule/m-s-K	$[M^1L^1T^{-3}K^{-1}]$
Stefan's constant (σ)	$\sigma = \frac{E}{T^4}$	watt/m^2-K^4	$[M^1L^0T^{-3}K^{-4}]$
Wien's constant (b)	$b = \lambda_m \times T$	metre-K	$[M^0L^1T^0K^1]$
Planck's constant (h)	$\frac{\text{Energy}(E)}{\text{Frequency}(F)}$	joule-s	$[M^1L^2T^{-1}]$
Coefficient of linear Expansion (α)	--	kelvin^{-1}	$[M^0L^0T^0K^{-1}]$
Mechanical equivalent of Heat(J)	--	joule/calorie	$[M^0L^0T^0]$
Electricity			
Electric charge (q)	Current × Time	coulomb	$[M^0L^0T^1A^1]$
Electric current (I)	--	ampere	$[M^0L^0T^0A^1]$
Capacitance (C)	$\frac{\text{Charge}}{\text{P.D.}}$	coulomb/ volt or farad	$[M^{-1}L^{-2}T^4A^2]$
Electric potential (V)	$\frac{\text{Work}}{\text{Charge}}$	joule/ coulomb	$[M^1L^2T^{-3}A^{-1}]$
Permittivity of free space (ε_0)	$\varepsilon_0 = \frac{q_1 q_2}{4\pi Fr^2}$	$\frac{\text{coulomb}^2}{\text{newton}-\text{metre}^2}$	$[M^{-1}L^{-3}T^4A^2]$
Dielectric constant (K)	$\varepsilon_r = \frac{\varepsilon}{\varepsilon_0}$	Unitless	$[M^0L^0T^0]$
Resistance (R)	$\frac{\text{P.D.}}{\text{Current}}$	volt/ampere or ohm	$[M^1L^2T^{-3}A^{-2}]$
Resistivity or Specific resistance (ρ)	$\frac{Ra}{l}$	ohm-metre	$[M^1L^3T^{-3}A^{-2}]$
Coefficient of Self-induction (L)	$L = \frac{(W/q)dt}{dI}$	$\frac{\text{volt}-\text{second}}{\text{ampere}}$ or henry or ohm-second	$[M^1L^2T^{-2}A^{-2}]$
Coefficient of mutual inductance (M)	$\frac{edt}{dI}$	henry	$[M^1L^2T^{-2}A^{-2}]$
Magnetic flux (ϕ)	$d\phi = \frac{Wdt}{q}$	volt-second or weber	$[M^1L^2T^{-2}A^{-1}]$
Magnetic induction (B)	$B = \frac{F}{qv}$	$\frac{\text{newton}}{\text{ampere}-\text{metre}}$ or $\frac{\text{joule}}{\text{ampere}-\text{metre}^2}$ or $\frac{\text{volt}-\text{second}}{\text{metre}^2}$ or tesla	$[M^1L^0T^{-2}A^{-1}]$
Magnetic intensity (H)	$H = \frac{Idl}{r^2}$	ampere/ metre	$[M^0L^{-1}T^0A^1]$

Magnetic dipole moment (M)	M = IA	ampere-metre^2	$[M^0L^2T^0A^1]$
Permeability of free space (μ_0)	$\mu_0 = \frac{4\pi(dB)r^2}{I(dl)\sin\theta}$	$\frac{\text{newton}}{\text{ampere}^2}$ or $\frac{\text{joule}}{\text{ampere}^2 - \text{metre}}$ or $\frac{\text{volt} - \text{second}}{\text{ampere} - \text{metre}}$ or $\frac{\text{ohm} - \text{second}}{\text{metre}}$ or $\frac{\text{henry}}{\text{metre}}$	$[M^1L^1T^{-2}A^{-2}]$
Surface charge density(σ)	$\sigma = \frac{\text{charge}}{\text{area}}$	coulomb metre^{-2}	$[M^0L^{-2}T^1A^1]$
Electric dipole moment (p)	q(2a)	coulomb – metre	$[M^0L^1T^1A^1]$
Conductance	$\frac{1}{R}$	ohm^{-1}	$[M^{-1}L^{-2}T^3A^2]$
Conductivity (σ)	$\frac{1}{\rho}$	ohm^{-1}metre^{-1}	$[M^{-1}L^{-3}T^3A^2]$
Current density (J)	Current per unit area	ampere/m^2	$[M^0L^{-2}T^0A^1]$
Intensity of electric field (E)	$\frac{\text{Force}}{\text{Charge}}$	volt/metre, newton/coulomb	$[M^1L^1T^{-3}A^{-1}]$
Rydberg constant (R)	$\frac{2\pi^2mk^2e^4}{ch^3}$; $k = \frac{1}{4\pi\varepsilon_0}$	m^{-1}	$[M^0L^{-1}T^0]$

Smart tip - 2

➢ **Quantities having same dimensions:**

M	L	T	θ	Quantity / Formulae
0	0	–1	-	Frequency, Angular frequency, Velocity gradient, Angular velocity, Decay constant
0	0	0	-	Strain, refractive index, relative density, angle, solid angle, distance gradient, relative permittivity (dielectric constant), relative permeability, specific gravity, Poisson's ratio, Reynold's number, all the trigonometric ratios, magnetic susceptibility etc.
0	0	1	-	$\sqrt{l/g}$, $\sqrt{m/k}$, $\sqrt{R/g}$, where l = length, g = acceleration due to gravity, m = mass, k = spring constant, R = Radius of earth L/R, $\sqrt{LC}$, RC where L = inductance, R = resistance, C = capacitance
0	1	–2	-	Acceleration due to gravity, gravitational field intensity
0	2	–2	-	Latent heat and gravitational potential
1	–1	–2	-	Modulus of rigidity, Young's modulus, Stress, Pressure, Energy density, Bulk modulus
1	0	–2	-	Surface tension, surface energy (energy per unit area), spring constant
1	1	–2	-	Thrust, force, weight, energy gradient
1	1	–1	-	Momentum, impulse
1	2	–2	-	Moment of force, Work, Internal energy, Torque, Potential energy, Kinetic energy I^2Rt, $\frac{V^2}{R}t$, VIt, qV, LI^2, $\frac{q^2}{C}$, CV^2 where I = current, t = time, q = charge, L = inductance, C = capacitance, R = resistance
1	2	–2	–1	Thermal capacity, Boltzmann constant and entropy
1	2	–1	-	Angular momentum and Planck's constant

Formulae

1. **Measure of physical quantity:** M = nu
2. **Relation between numerical value and size of unit:** $n_1u_1 = n_2u_2$
3. **Average value or mean value:**
$$\bar{a}_m = \frac{a_1 + a_2 + a_3 + .. + a_n}{n} = \frac{1}{n}\sum_{i=1}^{n} a_i$$
4. **Absolute error:**
$|\Delta a| = |\text{Average value} - \text{Measured value}|$
$= |a_m - a_n|$
5. **Mean absolute error:**
$$\overline{\Delta a} = \frac{|\Delta a_1| + |\Delta a_2| + ... + |\Delta a_n|}{n} = \frac{1}{n}\sum_{i=1}^{n}\Delta a_i$$
6. **Relative (fractional) error** $= \frac{|\overline{\Delta a}|}{a_m}$
7. **Percentage error** $= \frac{|\overline{\Delta a}|}{a_m} \times 100\%$
8. **Combination of percentage errors:**
   i. If x = a ± b then, the percentage error in x is,
   $$\frac{\Delta x}{x}\times 100 = \left(\frac{\Delta a + \Delta b}{a \pm b}\right)\times 100\%$$
   ii. If x = a × b or x = $\frac{a}{b}$ then, the percentage error in x is, $\frac{\Delta x}{x}\times 100 = \left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right)\times 100\%$
   iii. If x = a^n then, the percentage error in x is,
   $$\frac{\Delta x}{x}\times 100 = n\left(\frac{\Delta a}{a}\right)\times 100\%$$

➢ **To express large or small magnitudes following prefixes are used:**

Power of 10	Prefix	Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecta	h
10	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

➢ **A few quick conversions:**

i. Pressure:
$1 \text{ N/m}^2 = 10 \text{ dyne/ cm}^2$ or
$1 \text{ dyne/cm}^2 = 0.1 \text{ N/m}^2$.

ii. Density:
$1 \text{ kg/m}^3 = 10^{-3} \text{ g/cm}^3$ or
$1 \text{ g/cm}^3 = 10^3 \text{ kg/m}^3$.

iii. Coefficient of viscosity:
SI unit is decapoise (Ns/m^2) and CGS unit is poise.
1 poise = 10^{-1} decapoise or
1 decapoise = 10 poise.

iv. Magnetic induction:
SI unit is tesla (Wb/m^2) and CGS unit is gauss.
1 gauss = 10^{-4} tesla or
1 tesla = 10^4 gauss.

v. Magnetic flux:
SI unit is weber and CGS unit is maxwell.
1 Wb = 10^8 maxwell or
1 maxwell = 10^{-8} Wb.

Learning Pointers

1. A dimensionless quantity has the same numeric value in all the system of units.
2. If units or dimensions of two physical quantities are same, these need not represent the same physical characteristics. For example, torque and work have the same units and dimensions but their physical characteristics are different.

Multiple Choice Questions

Unit of Measurement and System of Units

1. A physical quantity is represented completely by
   (A) its magnitude only.
   (B) its unit only.
   (C) its magnitude as well as unit.
   (D) neither magnitude nor unit but its direction.

2. The reference standard used for the measurement of a physical quantity is called
   (A) standard quantity
   (B) dimension
   (C) constant
   (D) unit

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61. The frequency (ν) 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: $\nu = r^a \rho^b s^c$. The values of a, b and c respectively are

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

Numerical Value Type Questions

1. If error in the determination of radius of a sphere is 3%, then the error in volume determination of the sphere will be _______%.

2. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction, respectively. The dimensions of Y in MKS system will have power of Q as n. The value of n is _______.

3. A length-scale (l) depends on the permittivity (ε) of a dielectric material, Boltzmann's constant (k_B), the absolute temperature (T), the number per unit volume (n) of certain charged particles. If q is the charge carried by each of the particles then, for relation $l = q^{-x}\sqrt{\frac{\varepsilon k_B T}{n}}$ to hold true, value of x should be _______.

4. Displacement of an oscillating particle is given by y = A sin (Bx + Ct + D). The dimensional formula for [ABCD] is $[M^n L^n T^{n-1}]$. Value of n is _______.

Topic Test

1. Crane is British unit of volume. (One crane = 170.474 litre). Convert crane into SI unit.
(A) 0.170474 m^3
(B) 17.0474 m^3
(C) 0.0017474 m^3
(D) 1704.74 m^3

2. A resistor of 2 kΩ with tolerance 10% is connected in parallel with a resistor of 4 kΩ with tolerance 10%. The tolerance of the parallel combination is approximately
(A) 10% (B) 20%
(C) 30% (D) 40%

3. 20.27 N of force is required to produce a displacement of 1.51 m. The work done upto approximate significant figures is
(A) 30.608 J (B) 30.61 J
(C) 30.6077 J (D) 30.6 J

4. Which among the following is the unit for mass in metric or M.K.S system?
(A) gram (B) kilogram
(C) pound (D) milligram

5. Which of the following is NOT a fundamental quantity?
(A) temperature (B) electric charge
(C) mass (D) electric current

6. A spherometer has 100 equal divisions marked along the periphery of its disc and one full rotation of the disc advances on the main scale by 0.01 cm. The least count of the system is
(A) 10^{-4} cm (B) 10^{-2} cm
(C) 10^{-3} cm (D) 10^{2} cm

7. If the pointer of the voltmeter is not exactly at the zero of the scale, the error is called
(A) instrumental error
(B) systematic error
(C) personal error
(D) random error

8. The length, breadth and height of a rectangular block of wood were measured to be
$l = 13.12 \pm 0.02$ cm, $b = 7.18 \pm 0.01$ cm,
$h = 4.16 \pm 0.02$ cm respectively
The percentage error in the volume of the block will be
(A) 7 % (B) 0.77 %
(C) 0.72 % (D) 0.27 %

9. If the digit to be dropped is 5 or 5 followed by zeroes, then the preceding digit is
(A) raised by one if it is odd.
(B) raised by one if it is even.
(C) lowered by one if it is even.
(D) unchanged if it is odd.

10. The number of significant figures in 0.0009 is
(A) 4 (B) 3
(C) 2 (D) 1

11. Latent heat has the same dimensions as that of
(A) Velocity gradient
(B) Potential gradient
(C) Energy gradient
(D) Gravitational potential

12. Dimensions of 'ohm' are same as that of
(A) $\frac{h}{e}$ (B) $\frac{h^2}{e}$
(C) $\frac{h}{e^2}$ (D) $\frac{h^2}{e^2}$

13. Taking frequency f, velocity v and density ρ to be the fundamental quantities, the dimensional formula for momentum will be
(A) $\rho v^4 f^{-3}$ (B) $\rho v^3 f^{-1}$
(C) $\rho v f^2$ (D) $\rho^2 v^2 f^2$

14. One pico farad is equal to
(A) 10^{-24} F (B) 10^{-18} F
(C) 10^{-12} F (D) 10^{-6} F

15. A set of fundamental and derived units is known as
(A) supplementary units
(B) system of units
(C) complementary units
(D) metric units

16. A physical quantity x depends on quantities y and z by the relation x = Ay + B tan Cz, where A, B and C are constants. Which of the following do not have the same dimensions?
(A) x and B (B) C and z^{-1}
(C) y and B/A (D) x and A

17. If $Z = \frac{at}{c}e^{-\frac{ax}{c}}$ where, 'a' is force, 'x' is distance, 't' is time then, Z has dimensions of
(A) Reciprocal of velocity
(B) Torque
(C) Impulse
(D) Velocity

18. What are the units of magnetic permeability?
(A) Wb A^{-1} m^{-1} (B) Wb^{-1} Am
(C) Wb A m^{-1} (D) Wb A^{-1} m

19. μ_0 and ε_0 denote the permeability and permittivity of free space, the dimensions of $\mu_0\varepsilon_0$ are
(A) $[LT^{-1}]$ (B) $[L^{-2}T^2]$
(C) $[M^{-1}L^{-3} Q^2T^2]$ (D) $[M^{-1}L^{-3}I^2T^2]$

20. If velocity v, acceleration a and force F are chosen as fundamental quantities, then the dimensional formula of angular momentum in terms of v, a and F would be
(A) $[Fa^{-1}v]$ (B) $[Fv^3a^{-2}]$
(C) $[Fv^2a^{-1}]$ (D) $[F^2v^2a^{-1}]$

Scan the adjacent Q.R. Code in *Quill - The Padhai App* to access Answers & Solutions to Topic Test.

1. Units and Measurement

Smart Keys

Smart tip

1. i. An exact number has infinite number of significant figures. For example, 6 can be written as 6.0 or 6.00 or 6.000 and so on.
ii. Significant figures do not change if we measure a physical quantity in different units.

➢ **Quantities having same dimensions:**

M	L	T	θ	Quantity / Formulae
0	0	–1	-	Frequency, Angular frequency, Velocity gradient, Angular velocity, Decay constant
0	0	0	-	Strain, refractive index, relative density, angle, solid angle, distance gradient, relative permittivity (dielectric constant), relative permeability, specific gravity, Poisson's ratio, Reynold's number, all the trigonometric ratios, magnetic susceptibility etc.
0	0	1	-	$\sqrt{l/g}$, $\sqrt{m/k}$, $\sqrt{R/g}$, where l = length, g = acceleration due to gravity, m = mass, k = spring constant, R = Radius of earth L/R, $\sqrt{LC}$, RC where L = inductance, R = resistance, C = capacitance
0	1	–2	-	Acceleration due to gravity, gravitational field intensity
0	2	–2	-	Latent heat and gravitational potential
1	–1	–2	-	Modulus of rigidity, Young's modulus, Stress, Pressure, Energy density, Bulk modulus
1	0	–2	-	Surface tension, surface energy (energy per unit area), spring constant
1	1	–2	-	Thrust, force, weight, energy gradient
1	1	–1	-	Momentum, impulse
1	2	–2	-	Moment of force, Work, Internal energy, Torque, Potential energy, Kinetic energy I^2Rt, $\frac{V^2}{R}t$, VIt, qV, LI^2, $\frac{q^2}{C}$, CV^2 where I = current, t = time, q = charge, L = inductance, C = capacitance, R = resistance
1	2	–2	–1	Thermal capacity, Boltzmann constant and entropy
1	2	–1	-	Angular momentum and Planck's constant

Time saver

1. Observe if given equation can be obtained in different form keeping objective of question in mind. Reduce equation to simplified form and then perform dimensional analysis.

2. Instead of doing dimensional analysis of given quantities in a straight forward manner, study if quantities can be clubbed suitably to form a physical quantity of same dimensions.

3. Dimensionless quantities i.e., trigonometric functions, exponential functions, logarithms, angles, pure numbers can be eliminated to simplify the equation to approach the correct answer.

Learning Pointers

1. A dimensionless quantity has the same numeric value in all the system of units.

2. If units or dimensions of two physical quantities are same, these need not represent the same physical characteristics. For example, torque and work have the same units and dimensions but their physical characteristics are different.

Answers and Solutions

Unit of measurement and system of units

1. **(C)** 2. **(D)** 3. **(A)**
4. **(B)** 5. **(D)** 6. **(C)**
7. **(D)** 8. **(D)**

Fundamental and derived units

1. **(A)**
In S.I. system, there are seven fundamental quantities.

2. **(A)** 3. **(B)**

4. **(C)**
$$\text{Angular acceleration} = \frac{\text{Angular velocity}}{\text{Time}} = \frac{\text{rad}}{\text{s}^2}$$

5. **(A)** 6. **(D)**

7. **(D)**
Because temperature is a fundamental quantity.

8. **(D)**
$$F = \frac{1}{4\pi\varepsilon_0}\frac{Q_1Q_2}{r^2}$$
$$\therefore \quad \varepsilon_0 \propto \frac{Q^2}{F\times r^2}$$
So ε_0 has units of coulomb^2/(newton m^2)

9. **(D)**

10. **(D)**
$$E = -\frac{dV}{dx}$$

11. **(D)** 12. **(A)**

13. **(B)**
$$L = \frac{\phi}{I} = \frac{Wb}{A} = \text{henry.}$$

14. **(A)**
$\frac{L}{R}$ is a time constant of L-R circuit. Hence, henry/ohm can be expressed as second.

15. **(B)**
$$\frac{\text{watt}}{\text{ampere}} = \frac{\text{volt ampere}}{\text{ampere}} = \text{volt}$$

16. **(B)** 17. **(C)**

18. **(C)**
Energy = force × distance, so if both are increased by 4 times, then energy will increase by 16 times.

19. **(C)**

20. **(D)**
$[x] = [bt^2]$
$$\text{unit of b} = \frac{x}{t^2} = \frac{\text{metre}}{(\text{hour})^2} = \frac{m}{hr^2}$$

21. **(A)** 22. **(C)** 23. **(A)**

24. **(C)**

25. **(D)**
Poisson's ratio is a unitless quantity.

26. **(A)**
1 Faraday = 96500 coulomb

27. **(C)**
PV = nRT
$$\therefore \quad R = \frac{PV}{nT} = \frac{\text{joule}}{\text{mole}\times\text{kelvin}} = JK^{-1}mol^{-1}$$

28. **(D)**
joule-second is the unit of angular momentum whereas others are units of energy.

29. **(B)**

30. **(D)**
$$\frac{\text{mass}\times\text{force}\times\text{volume}}{\text{area}\times\text{mass}} = \text{force} \times \text{length} = \text{work}$$

31. **(A)** 32. **(C)** 33. **(D)**
34. **(C)** 35. **(A)** 36. **(C)**

37. **(A)**
$$\text{Resistance} = \frac{V}{I} = \frac{W}{qI} = \frac{kgm/s^2\times m}{As\times A}$$
$$\therefore \quad \text{The unit of resistance} = \frac{kgm^2}{s^2\times As\times A}$$
$$= kg\ m^2A^{-2}s^{-3}$$

38. **(B)**
Impulse = force × time
= mass × acceleration × time
= mass × change in velocity
= change in momentum.

39. **(D)**
Radian is the unit of angle.

40. **(C)**

41. **(D)**
watt = joule/second = ampere × volt
= ampere^2 × ohm

42. **(C)**
Unit of energy is kg m^2/s^2

43. **(C)**
watt = joule/s.

44. **(C)**
$$F = \frac{Gm_1m_2}{d^2};$$
$$\therefore \quad G = \frac{Fd^2}{m_1m_2} = Nm^2/kg^2$$

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To see complete chapter buy **Target Notes** or **Target E-Notes**

$\therefore$ $\sigma = \frac{P}{AT^4} = \frac{[M^1L^2T^{-3}]}{[L^2][K^4]} = [M^1L^0T^{-3}K^{-4}]$

The wavelength of maximum intensity of emission of black body is given by,

$\lambda = b\frac{1}{T}$ ….(where, b = Wien's constant)

$\therefore$ $b = \lambda T = [L^1][K^1] = [M^0L^1K^1]$

$\therefore$ The dimensions of σb^4 are,

$\sigma b^4 = [M^1L^0T^{-3}K^{-4}][M^0L^4K^4] = [M^1L^4T^{-3}]$

48. (A)

Let the physical quantity formed of the dimensions of length be given as,

$[L] = [c]^x [G]^y \left[\frac{e^2}{4\pi\varepsilon_0}\right]^z$ ….(i)

Now,

Dimensions of velocity of light $[c]^x = [LT^{-1}]^x$

Dimensions of universal gravitational constant $[G]^y = [M^{-1}L^3T^{-2}]^y$

Dimensions of $\left[\frac{e^2}{4\pi\varepsilon_0}\right]^z = [ML^3T^{-2}]^z$

Substituting these in equation (i)

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

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

Solving for x, y, z

$x + 3y + 3z = 1$

$-y + z = 0$

$x + 2y + 2z = 0$

Solving the above equations,

$x = -2, y = \frac{1}{2}, z = \frac{1}{2}$

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

49. (C)

From principle of homogeneity, 'b' will have the dimensions of x^2

$\therefore$ $[b] = [L^2]$

Also,

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

$[t] = [T^1]$

$\therefore$ $[a] = \frac{[b]}{[P][t]} = \frac{[L^2]}{[M^1L^2T^{-3}][T^1]}$

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

$\therefore$ $\frac{[b]}{[a]} = \frac{[L^2]}{[M^{-1}T^2]} = [M^1L^2T^{-2}]$ ….(i)

Torsional constant $K = \frac{\tau}{\theta}$

$\therefore$ $[K] = [\tau]$

$[K] = [M^1L^2T^{-2}]$ ….(ii)

From (i) and (ii) we have,

$\frac{[b]}{[a]} = [K]$

50. (B)

51. (D)

$X = \varepsilon_0 L \times \frac{\Delta V}{\Delta t}$

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

$= [M^0L^0T^0A^1]$

52. (D)

Think out of the box - Q. 52

Instead of performing dimensional analysis, formulae relations can be used.

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

Hence, option (C) represents dimensions of frequency.

Also, $f = \frac{\text{Inductive reactance}}{2\pi L}$

As [Inductive reactance] = [R]

$\therefore$ $[f] = \left[\frac{R}{L}\right]$

Hence, option (B) represents dimensions of frequency.

Similarly,

$f = \frac{1}{2\pi \times \text{capacitive reactance} \times C}$

As [Capacitive reactance] = [R]

$\therefore$ $[f] = \left[\frac{1}{RC}\right]$

Hence, option (A) represents dimensions of frequency.

53. (B)

Let $[G] \propto c^x g^y P^z$

By substituting the following dimensions we get,

$[G] = [M^{-1}L^3T^{-2}]$, $[c] = [LT^{-1}]$, $[g] = [LT^{-2}]$

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

and by comparing the powers of M, L, T on both sides

we get x = 0, y = 2, z = –1

$\therefore$ $[G] \propto c^0g^2P^{-1}$

54. (B)

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

$[c] = [M^0L^1T^{-1}]$

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

$\therefore \quad \dfrac{[A]}{[D]} = \dfrac{[M^1L^1T^{-2}]}{[L^{-1}]} = [M^1L^2T^{-2}] \quad \ldots.(i)$

and $\dfrac{[B]}{[C]} = \dfrac{[M^1L^1T^{-2}]}{[T^{-1}]} = [M^1L^1T^{-1}] \quad \ldots.(ii)$

Equation (i) represents dimensions of energy and equation (ii) represents dimensions of impulse.

59. **(C)**

Dimension of L.H.S is,

$$\int \frac{[dx]}{4[a]^2 - [x]^2} = \frac{[L]}{\sqrt{[L^2]}} = [L^0] \quad \ldots.(i)$$

Refer ***Time Saver – 3,***

Since, the trigonometric functions are dimensionless and 'a' represents length, the dimension of RHS are

$$a^n \sin^{-1}\left(\frac{x}{2a}\right) = [L]^n = [L^n] \quad \ldots.(ii)$$

Equating (i) and (ii) we get,

$L^0 = L^n$

$\Rightarrow n = 0$

60. **(C)**

Given: $W = \alpha\beta^2 e^{-\frac{x^2}{\alpha kT}}$

Refer ***Time Saver – 3,***

Here, $\dfrac{x^2}{\alpha kT}$ is dimensionless

$\therefore \quad \alpha = \dfrac{x^2}{kT} = \dfrac{x^2}{E}$

$\therefore \quad$ Dimension of $\alpha = \dfrac{[M^0L^2T^0]}{[M^1L^2T^{-2}]} = [M^{-1}L^0T^2]$

$\therefore \quad \beta^2 = \dfrac{W}{\alpha}$

$\therefore \quad [\beta^2] = \dfrac{[M^1L^2T^{-2}]}{[M^{-1}L^0T^2]} = [M^2L^2T^{-4}]$

$\therefore \quad [\beta] = [M^1L^1T^{-2}]$

61. **(D)**

Given $\nu = r^a\rho^b s^c$

Applying the principle of homogeneity,

we get,

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

equating the powers on both sides, we get,

T	M	L
$-2c = -1$	$0 = b + c$	$0 = a - 3b$
$c = \dfrac{1}{2}$	$0 = b + \dfrac{1}{2}$	$a = 3b$
	$b = \dfrac{-1}{2}$	$a = 3 \times \dfrac{-1}{2}$
		$a = \dfrac{-3}{2}$

$\therefore \quad a = \dfrac{-3}{2},\ b = \dfrac{-1}{2},\ c = \dfrac{1}{2}$

Numerical Value Type Questions

1. **(9)**

Volume of sphere (V) $= \dfrac{4}{3}\pi R^3 \quad \ldots.(i)$

Given: error in radius determination $\left(\dfrac{dR}{R}\right) = 3\%$

Differentiating equation (i),

$\dfrac{dV}{V} = \dfrac{3dR}{R}$

$\therefore \quad$ Error in volume determination $\left(\dfrac{dV}{V}\right) = 3 \times 3\%$

$= 9\%$

2. **(4)**

$[X] = [C] = [M^{-1}\,L^{-2}\,T^2\,Q^2]$

$[Z] = [B] = [M\,T^{-1}\,Q^{-1}]$

$\therefore \quad [Y] = \dfrac{[M^{-1}L^{-2}T^2Q^2]}{[MT^{-1}Q^{-1}]^2} = [M^{-3}\,L^{-2}\,T^4\,Q^4]$

$\Rightarrow n = 4$

3. **(1)**

$l = q^{-x}\sqrt{\dfrac{\varepsilon k_B T}{n}}$

$\therefore \quad$ L.H.S. = [L] and

R.H.S.

$$= [AT]^{-x}\frac{[M^{-1}L^{-3}T^4A^2]^{1/2}[M^1L^2T^{-2}K^{-1}]^{1/2}[K^1]^{1/2}}{[L^{-3}]^{1/2}}$$

Equating power of A,

$-x + 1 = 0 \Rightarrow x = 1$

4. **(0)**

Applying dimensional analysis,

$[A] = [y] = [L],\ [B] = \left[\dfrac{1}{x}\right] = [L^{-1}],$

$C = \left[\dfrac{1}{t}\right] = [T^{-1}]$ and $[D] = [M^0L^0T^0]$

$\therefore \quad [ABCD] = [M^0L^0T^{-1}] \Rightarrow n = 0$

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To see complete chapter buy **Target Notes** or **Target E-Notes**

JEE (Main) - 2024 QUESTION PAPER
31st January (SHIFT – I)

[Note: The following questions belong to chapters of Absolute Physics Volume - I]

Multiple Choice Questions

Units and Measurements

1. If the percentage errors in measuring the length and the diameter of a wire are 0.1% each. The percentage error in measuring its resistance will be:
(A) 0.2% (B) 0.144%
(C) 0.3% (D) 0.1%

2. A force is represented by $F = ax^2 + bt^{\frac{1}{2}}$ where x = distance and t = time. The dimensions of b^2/a are:
(A) $[ML^2T^{-3}]$ (B) $[ML^3T^{-3}]$
(C) $[ML^{-1}T^{-1}]$ (D) $[MLT^{-2}]$

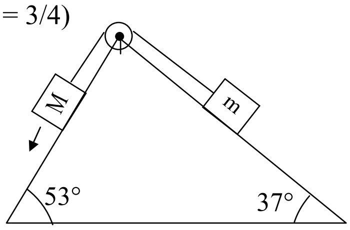
Motion in a Straight Line

3. The relation between time 't' and distance 'x' is $t = \alpha x^2 + \beta x$, where α and β are constants. The relation between acceleration (a) and velocity (v) is:
(A) $a = -2\alpha v^3$ (B) $a = -4\alpha v^4$
(C) $a = -3\alpha v^2$ (D) $a = -5\alpha v^5$

Laws of Motion

4. A coin is placed on a disc. The coefficient of friction between the coin and the disc is μ. If the distance of the coin from the centre of the disc is r, the maximum angular velocity which can be given to the disc, so that the coin does not slip away
(A) $\frac{\mu}{\sqrt{rg}}$ (B) $\sqrt{\frac{\mu g}{r}}$ (C) $\frac{\mu g}{r}$ (D) $\sqrt{\frac{r}{\mu g}}$

5. In the given arrangement of a doubly inclined plane two blocks of masses M and m are placed. The blocks are connected by a light string passing over an ideal pulley as shown. The coefficient of friction between the surface of the plane and the blocks is 0.25. The value of m, for which M = 10 kg will move down with an acceleration of 2 m/s^2, is: (take g = 10 m/s^2 and tan 37° = 3/4)



(A) 6.5 kg (B) 4.5 kg
(C) 2.25 kg (D) 9 kg

Work, Energy and Power

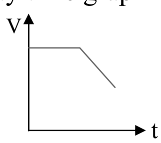
6. An artillery piece of mass M_1 fires a shell of mass M_2 horizontally. Instantaneously after the firing, the ratio of kinetic energy of the artillery and that of the shell is:
(A) $M_1/(M_1 + M_2)$ (B) $M_2/(M_1 + M_2)$
(C) $\frac{M_1}{M_2}$ (D) $\frac{M_2}{M_1}$

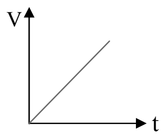
Gravitation

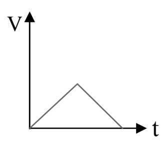
7. Four identical particles of mass m are kept at the four corners of a square. If the gravitational force exerted on one of the masses by the other masses is $\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$, the length of the sides of the square is
(A) 2L (B) 4L
(C) 3L (D) $\frac{L}{2}$

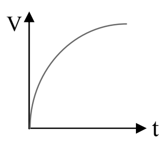
Mechanical Properties of Fluids: Viscosity

8. A small steel ball is dropped into a long cylinder containing glycerine. Which one of the following is the correct representation of the velocity time graph for the transit of the ball?

(A)


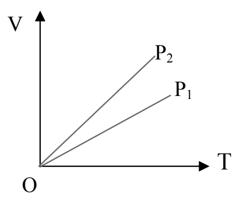
(B)


(C)


(D)


Thermodynamics

9. The given figure represents two isobaric processes for the same mass of an ideal gas, then



(A) $P_1 > P_2$ (B) $P_2 > P_1$
(C) $P_1 = P_2$ (D) $P_2 \geq P_1$

Kinetic Theory

10. The parameter that remains the same for molecules of all gases at a given temperature is:
(A) kinetic energy (B) mass
(C) speed (D) momentum

Waves

11. The fundamental frequency of a closed organ pipe is equal to the first overtone frequency of an open organ pipe. If length of the open pipe is 60 cm, the length of the closed pipe will be:
(A) 30 cm (B) 45 cm
(C) 60 cm (D) 15 cm

Numerical Value Type Questions

Motion in a Plane

1. A body starts falling freely from height H hits an inclined plane in its path at height h. As a result of this perfectly elastic impact, the direction of the velocity of the body becomes horizontal. The value of $\frac{H}{h}$ for which the body will take the maximum time to reach the ground is_______. **[Ans: 2]**

System of Particles and Rotational Motion

2. A solid circular disc of mass 50 kg rolls along a horizontal floor so that its centre of mass has a speed of 0.4 m/s. The absolute value of work done on the disc to stop it is_______J. **[Ans: 6]**

Mechanical Properties of Solids

3. The depth below the surface of sea to which a rubber ball be taken so as to decrease its volume by 0.02% is _______m.
(Take density of sea water = 10^3 kgm^{-3}, Bulk modulus of rubber = 9×10^8 Nm^{-2}, and g = 10 ms^{-2}) **[Ans: 18]**

Oscillations

4. A particle performs simple harmonic motion with amplitude A. Its speed is increased to three times at an instant when its displacement is $\frac{2A}{3}$. The new amplitude of motion is $\frac{nA}{3}$. The value of n is_______. **[Ans: 7]**

Answer Key

1.	(C)	2.	(B)	3.	(A)	4.	(B)
5.	(B)	6.	(D)	7.	(B)	8.	(D)
9.	(A)	10.	(A)	11.	(D)		