

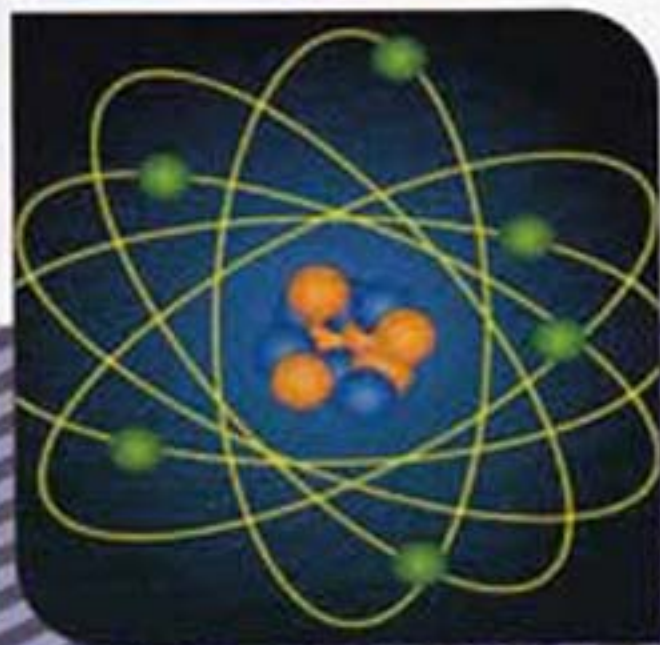
As per **MHT-CET 2018** Syllabus
WEIGHTAGE & PATTERN

PHYSICS

For

MHT-CET

SAROJ KUMAR



 **NIRALI**
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

FOR 2018

**As per MHT-CET 2018
Syllabus weightage
and pattern**

PHYSICS

Section - I & II

MHT-CET

FOR

**ENGINEERING AND TECHNOLOGY (B.E./B.TECH),
PHARMACY AND PHARM. D (B. PHARMACY AND PHARM. D.)**

LEARNING SIMPLIFIED

- **Author of Great Repute**
 - **Explanation of each Point in Brief with Appropriate Examples, Diagrams etc.**
 - **Important Formulae and Theoretical Concepts**
 - **Step-by-Step Approach**
 - **Variety of MCQs with Hints and Solutions**
-

SAROJ KUMAR

Price ₹ 440/-

 **NIRALI**TM
PRAKASHAN
ADVANCEMENT OF KNOWLEDGE

N0001

First Edition : January 2018**© : Author**

The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Author with whom the rights are reserved. Breach of this condition is liable for legal action.

Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the author or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom.

**Published By :
NIRALI PRAKASHAN****(CTP)****Printed By :****SHREE OM PRINTERS PVT. LTD.**

Abhyudaya Pragati, 1312, Shivaji Nagar

Survey No. 28/25, Dhayri Near Pari Company

Off J.M. Road, Pune – 411005

Pune - 411 041

Tel - (020) 25512336/37/39, Fax - (020) 25511379

Tel - (020) 24690371

Email : niralipune@pragationline.com

DISTRIBUTION CENTRES**PUNE****Nirali Prakashan :** 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra

Tel : (020) 2445 2044, 66022708, Fax : (020) 2445 1538

Email : bookorder@pragationline.com, niralilocal@pragationline.com

Nirali Prakashan : S. No. 28/27, Dhayri, Near Pari Company, Pune 411041

Tel : (020) 24690204 Fax : (020) 24690316

Email : dhayri@pragationline.com, bookorder@pragationline.com

MUMBAI**Nirali Prakashan :** 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd.,

Girgaum, Mumbai 400004, Maharashtra

Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976

Email : niralimumbai@pragationline.com

DISTRIBUTION BRANCHES**JALGAON****Nirali Prakashan :** 34, V. V. Golani Market, Navi Peth, Jalgaon 425001,

Maharashtra, Tel : (0257) 222 0395, Mob : 94234 91860

KOLHAPUR**Nirali Prakashan :** New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank

Kolhapur 416 012, Maharashtra. Mob : 9850046155

NAGPUR**Pratibha Book Distributors :** Above Maratha Mandir, Shop No. 3, First Floor,

Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra

Tel : (0712) 254 7129

DELHI**Nirali Prakashan :** 4593/21, Basement, Aggarwal Lane 15, Ansari Road, Daryaganj

Near Times of India Building, New Delhi 110002

Mob : 08505972553

BENGALURU**Pragati Book House :** House No. 1, Sanjeevappa Lane, Avenue Road Cross,

Opp. Rice Church, Bengaluru – 560002.

Tel : (080) 64513344, 64513355, Mob : 9880582331, 9845021552

Email: bharatsavla@yahoo.com

CHENNAI**Pragati Books :** 9/1, Montieth Road, Behind Taas Mahal, Egmore,

Chennai 600008 Tamil Nadu, Tel : (044) 6518 3535,

Mob : 94440 01782 / 98450 21552 / 98805 82331,

Email : bharatsavla@yahoo.com

PREFACE

We feel as great pleasure in presenting this book of **MHT-CET Physics**. It is according to the revised syllabus of **Maharashtra, Health and Technical - Common Entrance Tests** with effect from 2018.

The basic purpose of this book is to present a clear and valid treatment of every aspect of the topics in the prescribed syllabus from the point view of Common Entrance Test. The subject matter has been arranged systematically and methodically. Efforts have been made to make treatment simple, lucid and comprehensive. Simple language and step-by-step solving of questions are given so that the matter in the subject will become easy for the students to understand.

Each chapter in the book is arranged systematically. At the start of each chapter, 'Review of Basic Concepts' is given which will enable students to revise the topic at a glance. A large number of multiple choice questions are given in each chapter. The questions are arranged in hierarchical order so that first students have to solve simple theory based questions and then problems and concept oriented questions. This will help students to achieve conceptual coherent framework knowledge of Physics, which is necessary in entrance tests. At the end of each chapter, hints and explanations are given for difficult questions.

Every attempt has been made to maintain accuracy. In spite of great care, some misprints and omissions might occur. All constructive suggestions by readers for improvement of the books will be gratefully acknowledged.

We are extremely thankful to Shri. Dinesh K. Furia, Jignesh Furia and staff of Publication. Special thanks are due to Mrs. Varsha Bodake and Mr. Ilyas Shaikh, for the pains they have taken to bring out this book.

Errors if any are unintentional and we would be grateful if these are brought to our notice. Suggestions for further improvement of this book will be appreciated and thankfully acknowledged.

We wish you all the best. Do well.

Authors

MHT-CET 2018 SYLLABUS, WEIGHTAGE AND PATTERN

Maharashtra State Board of Secondary and Higher Secondary Education, the syllabus, weightage and pattern for MHT-CET 2018 to be conducted in the month of May, 2018 is being notified as under :

1. The questions will be based on Syllabus of Maharashtra State Board of Secondary and Higher Secondary Education.
2. Approximately 20% weightage will be given to Std. XI curriculum and 80% weightage will be given to Std. XII curriculum while settling the question paper.
3. There will be no Negative Marking, however difficulty level will be as par with the JEE (Main) for Mathematics, Physics, chemistry and difficulty level for Biology will be at par with NEET. The questions will be mainly application based.
4. MHT-CET will consist of 3 question papers of Multiple Choice Questions (MCQ) and each paper will be of 100 marks. Details are as given below :

Paper	Solution	Approximate No. of Multiple Choice Questions (MCQ) based on		Mark(s) per Question	Total Marks	Duration in Minutes
		Std. XI	Std. XII			
Paper I	Mathematics	10	40	2	100	90
Paper II	Physics	10	40	1	100	90
	Chemistry	10	40			
Paper III	Biology (Botany)	10	40	1	100	90
	Biology (Zoology)	10	40			

5. The question will be set on :
 - (a) Whole syllabus of Physics, Chemistry, Biology and Mathematics subjects of Std. XII.
 - (b) Syllabus of Std. XI as mentioned below :

Sr. No.	Subject	Chapter/Units of Std. XI Syllabus
1.	Physics	Measurements, Scalars and Vectors, Force, Friction in Solids and Liquids, Refraction of Light, Ray Optics, Magnetic Effect of Electric Current, Magnetism.
2.	Chemistry	Some Basic Concepts of Chemistry, States of Matter : Gases and Liquids, Redox Reaction, Surface Chemistry, Nature of Chemical Bond, Hydrogen, s-Block Elements (Alkali and Alkaline Earth Metals), Basic Principles and Techniques in Organic chemistry, Alkanes.
3.	Mathematics	Trigonometric Functions, Trigonometric Functions of Compound Angles, Factorisation Formulae, Straight Line, Circle and Conics, Sets, Relations and Functions, Probability, Sequences and Series.
4.	Biology	
	Section I - Botany	Diversity In Organisms, Biochemistry Of Cell, Plant Water Relations and Mineral Nutrition, Plant Growth and Development.
	Section II - Zoology	Organization of Cell, Animal Tissues, Human Nutrition, Human Respiration.

CONTENTS

SECTION - I : STD. XI

1. Measurement	1.1 – 1.20
2. Scalars and Vectors	2.1 – 2.14
3. Force and Friction	3.1 – 3.32
4. Refraction of Light	4.1 – 4.18
5. Ray Optics	5.1 – 5.30
6. Magnetic Effect of Electric Current and Magnetism	6.1 – 6.22

SECTION - II : STD. XII

1. Circular Motion	1.1 – 1.26
2. Gravitation	2.1 – 2.16
3. Rotational Motion	3.1 – 3.20
4. Oscillations	4.1 – 4.18
5. Elasticity	5.1 – 5.20
6. Surface Tension	6.1 – 6.12
7. Wave Motion	7.1 – 7.14
8. Stationary Waves	8.1 – 8.20
9. Kinetic Theory of Gases and Radiation	9.1 – 9.28
10. Wave Theory of Light	10.1 – 10.12
11. Interference and Diffraction	11.1 – 11.18
12. Electrostatics	12.1 – 12.24
13. Current Electricity	13.1 – 13.18
14. Magnetic Effect of Electric Current	14.1 – 14.20
15. Magnetism	15.1 – 15.18
16. Electromagnetic Induction	16.1 – 16.26
17. Electrons and Photons	17.1 – 17.14
18. Atoms, Molecules and Nuclei	18.1 – 18.20
19. Semiconductors	19.1 – 19.20
20. Communication Systems	20.1 – 20.14
• Solved Question Papers - 2015, 2016 & 2017	P.1 – P.12

SECTION - I : STD. XI

Physical Quantity

- The quantity in terms of which the laws of Physics can be expressed is called a physical quantity.
For example : distance, speed, time, force etc.

Units

- To measure a physical quantity, the chosen standard of the same kind taken as a reference is called a unit.

For example : Unit of length is metre, unit of mass is kg. etc.

Therefore,

Physical Quantity (X) = Numerical value (n) × unit (u)

$$\boxed{X = n \cdot u}$$

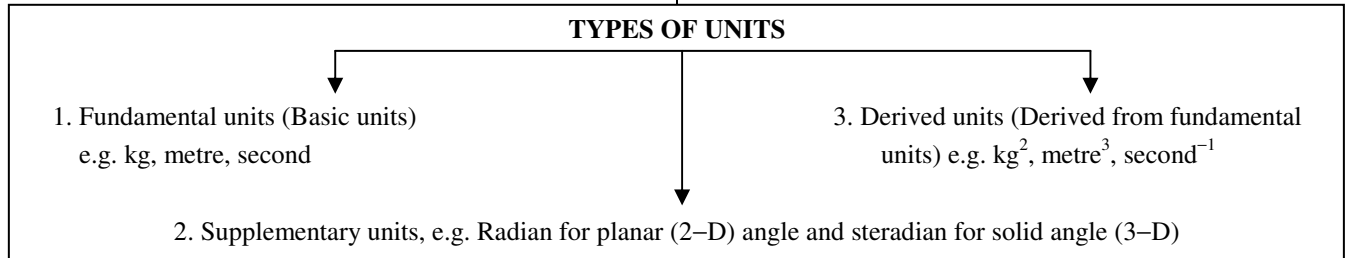


Table 1.1 : Practical Fundamental Units

Sr. No.	Mass	Length	Time
1.	1 Quintal = 100 kg	1 Light year = 9.46×10^{15} m	1 year = 365.25 days
2.	1 Metric ton = 1000 kg	1 Par sec = 3.26 Light Year = 3.08×10^6 m	1 Lunar month = 27.3 solar days
3.	1 Pound = 0.4537 kg	1 A. U. = 1.496×10^{11} m	1 Solar day = 8600 s
4.	1 Slug = 14.56 kg	1 Seamile = 6076 ft.	1 Shake = 10^{-8} s
5.	1 Chandrashekhar limit (C. L.) = 1.4 times of mass of the sun 1C.L. = 2.8×10^{30} kg 1 atomic mass unit (a.m.u) = 1.66×10^{-27} kg	1 Angstrom Å = 10^{-10} m 1 Fermi = 10^{-15} m	

Dimensions and Dimensional Formulae

- The dimensions of a given physical quantity are the powers to which the fundamental units of mass, length and time must be raised in order to obtain its units, i.e., for a given physical quantity [X], the dimensional equation can be expressed as :

$$[X] = [M^a L^b T^c]$$

where a, b and c are the dimensions of mass, length and time respectively.

e. g.

$$\begin{aligned} \text{Force} &= \text{Mass} \times \text{Acceleration} \\ &= \text{Mass} \times \frac{\text{Velocity}}{\text{Time}} \end{aligned}$$

$$= \text{Mass} \times \frac{\text{Distance}}{\text{Time} \times \text{Time}}$$

$$= [M] \times \frac{[L]}{[T] \times [T]}$$

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

$$= [MLT^{-2}]$$

- So dimensions of force are 1 for mass, 1 for length and - 2 for time.

- In the above said equation $[M^a L^b T^c]$, if a = b = c = 0 then the physical quantity will be dimensionless.

E.g. : Angle, solid angle, relative density, specific gravity, Reynolds's number, refractive index, dielectric constant, susceptibility and relative permittivity.

Table 1.2 : Dimensional Formulae with S.I. Units of Physical Quantities

Sr. No.	Physical Quantity	Physical Formula	Dimensional Formula	S. I. Unit
1.	Mass	Mass	$[ML^0T^0] = [ML^0T^0]$	kg
2.	Length/Distance/ Displacement/Height	Length	$[M^0L^1T^0] = [M^0L^1T^0]$	m
3.	Time	Time	$[M^0L^0T^1] = [M^0L^0T^1]$	s
4.	Area	Length \times Breadth	$L \times L = L^2 = [M^0L^2T^0]$	m^2
5.	Volume	Length \times Breadth \times Height	$L \times L \times L = L^3 = [M^0L^3T^0]$	m^3
6.	Density	Mass/Volume	$\frac{M}{L^3} = ML^{-3} = [ML^{-3}T^0]$	$kg \cdot m^{-3}$
7.	Specific Gravity	$\frac{\text{Density of material}}{\text{Density of water at } 4^\circ \text{C}}$	No dimension –	–
8.	Speed/Velocity	$\frac{\text{Distance}}{\text{Time}}$ or $\frac{\text{Displacement}}{\text{Time}}$	$\frac{L}{T} = LT^{-1} = [M^0LT^{-1}]$	ms^{-1}
9.	Linear Acceleration (a) or Acceleration due to gravity (g)	$\frac{\text{Velocity}}{\text{Time}}$	$\frac{LT^{-1}}{T} = LT^{-2} = [M^0LT^{-2}]$	ms^{-2}
10.	Linear momentum (p) or Impulse (I)	Mass \times Velocity Force \times Time	$M \times LT^{-1} = MLT^{-1} = [MLT^{-1}]$ $MLT^{-2} \times T = MLT^{-1} = [MLT^{-1}]$	$kg \ ms^{-1}$ or Ns
11.	Force/Thrust/Tensions (T) Weight	Mass \times Acceleration	$M \times LT^{-2} = MLT^{-2} = [MLT^{-2}]$	Newton (N)
12.	Force constant or Surface Tension	$\frac{\text{Force}}{\text{Change in length}}$	$\frac{MLT^{-2}}{L} = MT^{-2} = [ML^0T^{-2}]$	Nm^{-1}
13.	Pressure (P) or Stress or Coefficient of Elasticity (E)	$\frac{\text{Force}}{\text{Area}}$	$\frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2} = [ML^{-1}T^{-2}]$	Nm^{-2}
14.	Work/Energy/Heat/ Torque (Moment of force)	Force \times Displacement	$MLT^{-2} \times L = ML^2T^{-2} = [ML^2T^{-2}]$	N·m or Joule (J)
15.	Gravitational Constant (G)	$\frac{\text{Force} \times (\text{Distance})^2}{\text{Mass} \times \text{Mass}}$	$\frac{MLT^{-2} \times L^2}{M \times M} = M^{-1}L^3T^{-2} = [M^{-1}L^3T^{-2}]$	$Nm^2 \ kg^{-2}$
16.	Power (P)	$\frac{\text{Work}}{\text{Time}}$	$\frac{ML^2T^{-2}}{T} = ML^2T^{-3} = [ML^2T^{-3}]$	watt (W)

17.	(a) Hubble Constant (H)	$\frac{\text{Velocity of recession}}{\text{Distance}}$	$\frac{LT^{-1}}{L} = T^{-1} = [M^{\circ}L^{\circ}T^{-1}]$	s^{-1}
	(b) Velocity Gradient	$\frac{\text{Velocity}}{\text{Distance}}$	$\frac{LT^{-1}}{L} = T^{-1} = [M^{\circ}L^{\circ}T^{-1}]$	s^{-1}
	(c) Frequency	$\frac{1}{\text{Time period}}$	$\frac{1}{T} = T^{-1} = [M^{\circ}L^{\circ}T^{-1}]$	s^{-1} or Hz (Hertz)
18.	(a) Radius of Gyration	Distance	$L = L = [M^{\circ}L^{\circ}T^{\circ}]$	m
	(b) Wavelength (λ)	Length	$L = L = [M^{\circ}L^{\circ}T^{\circ}]$	m
	(c) Light year	Length	$L = L = [M^{\circ}L^{\circ}T^{\circ}]$	m
19.	Coefficient of viscosity (η)	$\frac{\text{Force}}{\text{Area} \times \text{Velocity gradient}}$	$\frac{MLT^{-2}}{L^2 \times T^{-1}} = ML^{-1}T^{-1} = [ML^{-1}T^{-1}]$	daP (decapoise)
20.	Moment of Inertia (I)	$\text{Mass} \times (\text{Radius})^2$	$M \times L^2 = ML^2 = [ML^2T^{\circ}]$	kgm^2
21.	Planck's Constant (h)	$\frac{\text{Energy}}{\text{Frequency}}$	$\frac{ML^2T^{-2}}{T^{-1}} = ML^2T^{-1} = [ML^2T^{-1}]$	Js
22.	(a) Wave number (γ)	$\frac{1}{\text{Wavelength}}$	$\frac{1}{L} = L^{-1} = [M^{\circ}L^{-1}T^{\circ}]$	m^{-1}
	(b) Rydberg's constant (R)	$\frac{\text{Mass} \times (\text{Charge})^4}{8 \epsilon_0^2 h^3 \times \text{Velocity}}$	$\frac{M \times [AT]^4}{[M^{-1}L^{-3}T^4A^2]^2 \times [ML^2T^{-1}]^{-3} \times [LT^{-1}]}$ $= [M^{\circ}L^{-1}T^{\circ}]$	m^{-1}
23.	Work function (ϕ)	Energy	$ML^2T^{-2} = [ML^2T^{-2}]$	J
24.	Angular Velocity (ω)	Angle/Time	$\frac{1}{[T]} = T^{-1} = [M^{\circ}L^{\circ}T^{-1}]$	$rad s^{-1}$
25.	Angular Acceleration (α)	Angular Velocity /Time	$\frac{T^{-1}}{T} = T^{-2} = [M^{\circ}L^{\circ}T^{-2}]$	$rad s^{-2}$
26.	Angular Momentum	M.I \times Angular Velocity	$ML^2 \times T^{-1} = ML^2T^{-1} = [ML^2T^{-1}]$	$kg m^2 s^{-1}$
27.	Angular Frequency	$2\pi \times$ Frequency	$T^{-1} = T^{-1} = [M^{\circ}L^{\circ}T^{-1}]$	$rad s^{-1}$
28.	Angular Impulse	Torque \times Time	$ML^2T^{-2} \times T = [ML^2T^{-1}]$ $= ML^2T^{-1}$	N–ms
29.	Rotational K.E.	$\frac{1}{2} \times$ M.I. \times (Angular velocity) ²	$ML^2 (T^{-1})^2 = ML^2T^{-2} = [ML^2T^{-2}]$	$kgm^2 s^{-2}$
30.	Electric Current (I)	I	$[M^{\circ}L^{\circ}T^{\circ}A] = [M^{\circ}L^{\circ}T^{\circ}A]$	A (Ampere)
31.	Electric Charge (q)	Current \times Time	$[A \times T] = [M^{\circ}L^{\circ}TA]$	C (Coulomb)
32.	Electric Potential (V) or E.M.F. (E)	Work/Charge	$\frac{ML^2T^{-2}}{[A \times T]} = ML^2T^{-3}A^{-1} = [ML^2T^{-3}A^{-1}]$	V (Volt)
33.	Electrical permittivity of free space (ϵ_0)	$\frac{\text{Charge} \times \text{Charge}}{\text{Force (Distance)}^2}$	$\frac{TA \times TA}{MLT^{-2} \times L^2} = [M^{-1}L^{-3}T^4A^2]$ $= M^{-1}L^{-3}T^4A^2$	C^2Nm^{-2}

34.	Electric Flux (ϕ_E)	Electric field \times Area or $\frac{\text{Force}}{\text{Charge}} \times \text{Area}$	$\frac{MLT^{-2}}{TA} \times L^2 = [ML^3T^{-3}A^{-1}]$ $= ML^3T^{-3}A^{-1}$	Nm^2C^{-1}
35.	Capacitance (C)	Charge/Potential difference	$\frac{TA}{ML^2T^{-3}A^{-1}} = [M^{-1}L^{-2}T^4A^2]$ $= M^{-1}L^{-2}T^4A^2$	CV^{-1} Or F (farad)
36.	Electric Dipole Moment (p)	Charge \times Length	$TA \times L = LTA = [M^0LTA]$	cm
37.	Electric Resistance (R)	$\frac{\text{Potential difference}}{\text{Current}}$	$\frac{ML^2T^{-3}A^{-1}}{A} = [ML^2T^{-3}A^{-2}]$ $= ML^2T^{-3}A^{-2}$	Ω (ohm)
38.	Resistivity or Specific Resistance (ρ)	$\frac{R \times \text{Area}}{\text{Length}}$	$\frac{ML^2T^{-3}A^{-2} \times L^2}{L} = [ML^3T^{-3}A^{-2}]$ $= ML^3T^{-3}A^{-2}$	Ωm
39.	Electric Conductance (G)	$\frac{1}{\text{Resistance}}$	$\frac{1}{ML^2T^{-3}A^{-2}} = [M^{-1}L^{-2}T^3A^2]$	Ω^{-1} or Mho or S(Siemen)
40.	Electric Conductivity (σ)	$\frac{1}{\text{Resistivity}}$	$\frac{1}{ML^3T^{-3}A^{-2}} = [M^{-1}L^{-3}T^3A^2]$	Sm^{-1} or $\Omega^{-1} m^{-1}$
41.	Coefficient of Self Induction or Self Inductance (L) or Mutual Inductance (M)	$\frac{E.M.F \times \text{Time}}{\text{Current}}$	$\frac{ML^2T^{-3}A^{-1} \times T}{A} = [ML^2T^{-2}A^{-2}]$	$VA^{-1}s$ or H (Henry)
42.	Inductive Reactance (X_L)	$\omega \times L$	$T^{-1} \times ML^2T^{-2}A^{-2} = [ML^2T^{-3}A^{-2}]$	Ω
43.	Capacitive Reactance (X_C)	$\frac{1}{\omega \cdot c}$	$\frac{1}{T^{-1} \times M^{-1}L^{-2}T^4A^2} = [ML^2T^{-3}A^{-2}]$	Ω
44.	Permeability for Free Space (μ_0)	$\frac{2\pi \times r \times F}{I^2 \times l}$	$\frac{L \times MLT^{-2}}{A^2 \times L} = [MLT^{-2}A^{-2}]$	NA^{-2} or $WbA^{-1} m^{-1}$
45.	Magnetic Pole Strength (m)	$\frac{\text{Current} \times \text{Area}}{2 \times \text{Length}}$	$\frac{A \times L^2}{L} = AL = [M^0LT^0A]$	Am
46.	Magnetic Dipole (M)	$m \times 2l$	$LA \times L = L^2A = [M^0L^2T^0A]$	Am^2
47.	Magnetic Field Intensity (\vec{B})	$\frac{\mu_0 nI}{2\pi r}$	$\frac{MLT^{-2}A^{-2} \times A}{L} = [ML^0T^{-2}A^{-1}]$	T (Tesla) or $Nm^{-1}A^{-1}$
48.	Magnetic Flux (ϕ_m)	B \times Area	$MT^{-2}A^{-1} \times L^2 = [ML^2T^{-2}A^{-1}]$	Wb (Weber) or NmA^{-1}

Principle of Homogeneity

- According to the Principle of Homogeneity, "the dimensions of L.H.S. dimensional equation should be equal to the dimensions of R.H.S. dimensional equation".

$$\text{i.e. } [M^a L^b T^c]_{\text{L.H.S}} = [M^a L^b T^c]_{\text{R.H.S}}$$

Uses of Dimensions

- To check the correctness of a given formula.
- To establish the relationship between various physical quantities (not more than four physical quantities).
- To convert one system of units into another system of units $[Q = n_1 u_1 = n_2 u_2]$

$$n_2 = n_1 \left[\frac{M_1}{M_2} \right]^a \left[\frac{L_1}{L_2} \right]^b \left[\frac{T_1}{T_2} \right]^c$$

Limitations

- It gives no information about dimensional constants (K).
- We cannot obtain the values of trigonometric functions, logarithmic values as well as exponential functions.

Error in Measurement

- During experiments, we use a number of observations for reducing the errors produced by various factors such as change in temperature, pressure, humidity etc.

Calculations for Error

- True Value Or Mean Value (x_m)

It is the mean value of a number of observations, So,

$$x_m = \frac{x_1 + x_2 + x_3 + \dots + x_n}{n} = \frac{1}{n} \sum_{i=1}^n x_i$$

Absolute Error (Δx)

It is the difference between the mean value and observed value. Then,

$$\left. \begin{array}{l} \Delta x_1 = x_m - x_1 \\ \Delta x_2 = x_m - x_2 \\ \vdots \\ \Delta x_n = x_m - x_n \end{array} \right\} \text{Result may be (+ ve) or (- ve)}$$

- Mean Absolute Error ($\Delta \bar{x}$)**

It is the mean of all values of absolute errors. (All should be taken as + ve values)

$$\Delta \bar{x} = \frac{|\Delta x_1| + |\Delta x_2| + \dots + |\Delta x_n|}{n}$$

- Relative or Functional Error**

It is the ratio of mean absolute error to the true value.

i.e.

$$\text{Relative error} = \pm \left(\frac{\Delta \bar{x}}{x_m} \right)$$

- Percentage Error**

$$\% \text{ Error} = \pm \text{Relative error} \times 100\%$$

$$= \pm \left[\frac{\Delta \bar{x}}{x_m} \right] \times 100\%$$

Example 1.1 : In a physics lab, a student has various observations of the value of g such as, 10.2 ms^{-2} , 9.8 ms^{-2} , 10.4 ms^{-2} , 10.6 ms^{-2} , and 10.8 ms^{-2} . The percentage error will be :

$$(a) 4.6\% \qquad (b) 2.7\%$$

$$(c) 3.7\% \qquad (d) 5.7\%$$

Solution : Mean value or true value

$$x_m = \frac{10.2 + 9.8 + 10.4 + 10.6 + 10.8}{5} = 10.36 \approx 10.4 \text{ ms}^{-2}$$

Absolute error

$$\Delta x_1 = 10.4 - 10.2 = 0.2$$

$$\Delta x_2 = 10.4 - 9.8 = 0.6$$

$$\Delta x_3 = 10.4 - 10.4 = 0.0$$

$$\Delta x_4 = 10.4 - 10.6 = -0.2$$

$$\Delta x_5 = 10.4 - 10.8 = -0.4$$

Mean absolute error

$$\Delta \bar{x} = \frac{0.2 + 0.6 + 0.0 + 0.2 + 0.2}{5}$$

$$\Delta \bar{x} = \frac{1.4}{5} = 0.28 \text{ ms}^{-2}$$

$$\text{Relative error} = \pm \frac{\Delta \bar{x}}{x_m} = \pm \frac{0.28}{10.4} = \pm 0.0269$$

$$\begin{aligned} \text{Percentage error} &= \pm (\text{Relative error}) \times 100\% \\ &= \pm (0.0269) \times 100\% \end{aligned}$$

$$\% \text{ Error} = \pm 2.7\%$$

Combination of Errors

- For Summation**

$$\text{If } z = x + y, \text{ then } \Delta z = \pm (\Delta x + \Delta y)$$

Therefore, the maximum relative or fractional error,

$$\frac{\Delta z}{z} = \frac{\Delta x + \Delta y}{x + y}$$

- For Difference**

If $z = x - y$, then the maximum absolute error will be

$$\Delta z = \pm (\Delta x + \Delta y).$$

Hence the maximum fractional error,

$$\frac{\Delta z}{z} = \frac{\Delta x + \Delta y}{x - y}$$

For Product

If $z = xy$, then the maximum fractional error,

$$= \frac{\Delta z}{z} = \pm \left(\frac{\Delta x}{x} + \frac{\Delta y}{y} \right)$$

For Division

If $z = \frac{x}{y}$, then the maximum fractional error,

$$\frac{\Delta z}{z} = \pm \left(\frac{\Delta x}{x} + \frac{\Delta y}{y} \right)$$

For Power

If $z = x^n$, then $\frac{\Delta z}{z} = n \cdot \frac{\Delta x}{x}$

Similarly if $z = \frac{A^k B^L}{C^M}$

then the maximum fractional error in z is,

$$\frac{\Delta z}{z} = K \frac{\Delta A}{A} + L \cdot \frac{\Delta B}{B} + M \cdot \frac{\Delta C}{C}$$

Example 1.2 : If the percentage errors of measurements in a, b, c and d are 4%, 2%, 3% and 1% respectively, then the percentage error in $z = \frac{a^2 b^3}{cd^{1/2}}$ will be,

Solution : When $z = \frac{a^2 b^3}{c.d^{1/2}}$

Then,

$$\begin{aligned} \% \text{ Error in } z &= (2 \times \% \text{ error in } a) + (3 \times \% \text{ error in } b) \\ &= (1 \times \% \text{ error in } c) + (1/2 \times \% \text{ error in } d) \\ &= (2 \times 4) + (3 \times 2) + (1 \times 3) + (1/2 \times 1) \\ &= 8 + 6 + 3 + \frac{1}{2} \end{aligned}$$

% error in $z = 17.5\%$

Significant Figures

The significant figures express the accuracy of numerical value of a given physical quantity.

Rules for significant figures :

(a) All non-zero digits are significant figures.

e. g.

Number	Significant Figures (S.F.)
8	1
82	2
862	3
8621	4

(b) All zeros occurring between non-zero digits are significant figures.

e. g.

Number	Significant Figures (S.F.)
802	3
108.002	6

(c) All zeros to the right of the last non-zero digit are not significant figures.

e. g.

Number	Significant Figures (S.F.)
60	1
640	2
6480	3

(d) All zeros to the right of a decimal point and to the left of a non zero digit are not significant figures.

e. g.

Number	Significant Figures (S.F.)
0.04	1
0.003	1
0.0123	3
0.132	3

(e) All zeros to the right of a decimal point and to the right of a non-zero digit are significant figures.

e. g.

Number	Significant Figures (S.F.)
0.30	2
0.320	3
0.07800	4

(f) All zeros to the right of a decimal point are significant, if they are not followed by a non-zero digit.

e. g.

Number	Significant Figures (S.F.)
70.00	4
470.00	5

(g) The powers of ten are not counted as significant figures.

e. g. 1.49×10^{-7} has only S.F. = 3

Measuring Instruments

(a) Least count of vernier callipers = $\frac{1 \text{ Main Scale Division (M.S.D.)}}{\text{Vernier Scale Division (V.S.D.)}}$

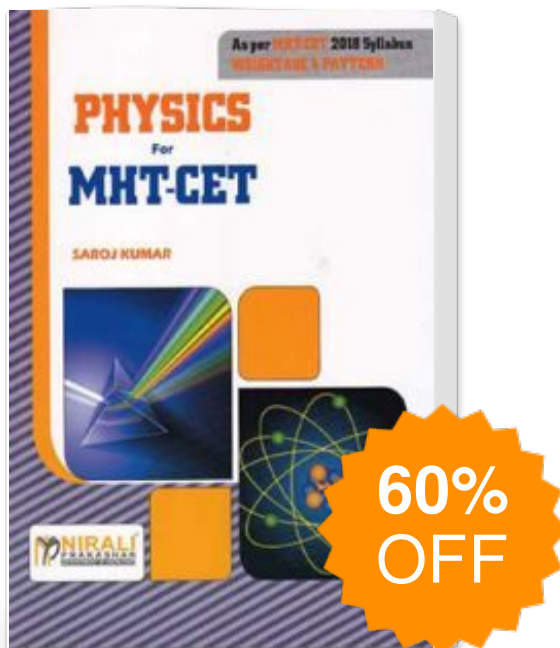
(b) Least count of screw-gauge

$$= \frac{\text{Pitch}}{\text{Total number of C.S. Divisions}}$$

where, Pitch is the distance covered by the main scale in one revolution.

(c) Least Count = $\frac{\text{Value of 1 main scale division}}{\text{Total no. of V.S.D. or C.S.D.}}$

Physics Section - I & II MHT - CET (2018)



Publisher : Nirali Prakashan

ISBN : 9789387397132

Author : Saroj Kumar

Type the URL : <http://www.kopykitab.com/product/21833>



Get this eBook