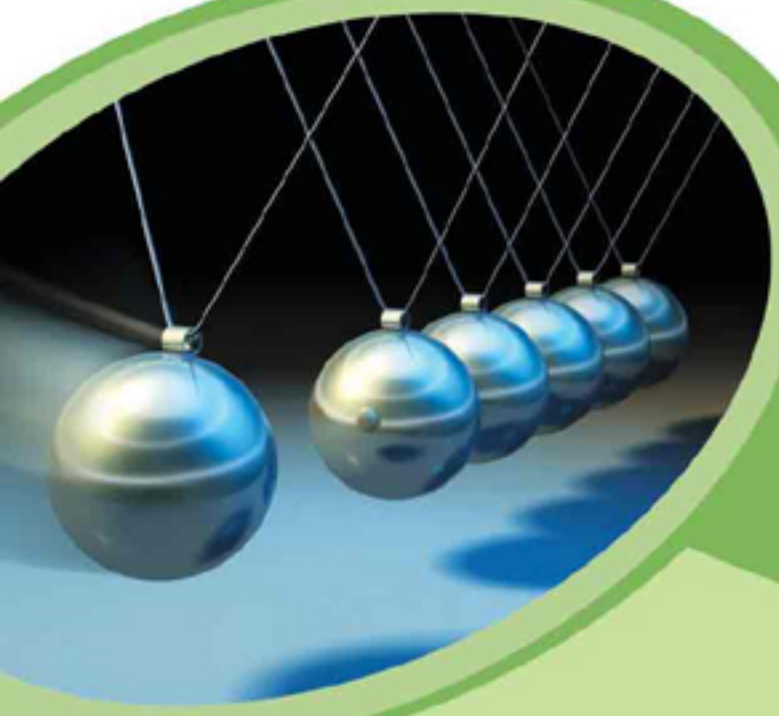
MODERN'S abc OF

Objective PHYSICS

For CET/COMED-K (Karnataka)



R.P. Arora
O.P. Kakkar
Deepak Chopra
Sameer Arora

SPECIAL FEATURES

- Comprehensive, precise and exclusively written for Karnataka
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OBJECTIVE PHYSICS

All Questions of CET/ COMED-K, 2015 Included

MODERN'S abc OF

OBJECTIVE PHYSICS

For

CET/COMED–K

Karnataka Common Entrance Test

Consortium of Medical, Engineering and Dental Colleges of Karnataka

By

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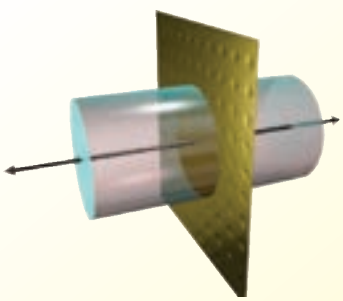

NEW EDITION –2016

Reviewed by

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We are committed to serve students with best of our knowledge and resources. We have taken utmost care and attention while editing and printing this book but we would beg to state that Authors and Publishers should not be held responsible for unintentional mistakes that might have crept in. However, errors brought to our notice, shall be gratefully acknowledged and attended to.

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Preface

We feel pleasure in presenting the book 'Modern's abc of Objective Physics' for students appearing in Karnataka-CET and COMED-K examinations and other board examinations for entrance to different engineering and other professional colleges of the state. The book has been prepared in accordance with the changing trends of different examinations and suggestions of worthy teachers and all my dear students.

REVISION NOTES

This provides thorough discussion on the chapter emphasising all the important formulae, facts and terms. This can serve as quick revision of the chapter before the examination. This part has been revised and enriched with new materials, Key points, Learning Plus, Facts to Memorise, In Focus, etc.

QUESTIONS

These include a variety of questions in the form of multiple choice questions. This part has also been completely revised and restructured. These questions are graded according to degree of difficulty. These are: Level I (Basic Conceptual Questions), Level II (Comprehensive Questions) Recent examination questions from 2009 to 2015 are given separately at the end of each chapter.

ANSWERS

The book provides answers to all relevant questions. This is an important feature of this revised edition. Some of the difficult questions have been solved where as hints to many other questions are given.

REVISION TESTS, SELF-EVALUATION TESTS AND MODEL PAPERS

This is yet another new feature of this revised edition. Revision tests are given at the end of each chapter. These will help students to check their performance after they have gone through the chapters. Eight unit evaluation tests are given at the end of each unit. Five mock test papers covering the complete syllabus are also given at the end of the book. All these will provide sufficient materials to students for practice during their preparation.

APPENDICES AND QUESTION BANK

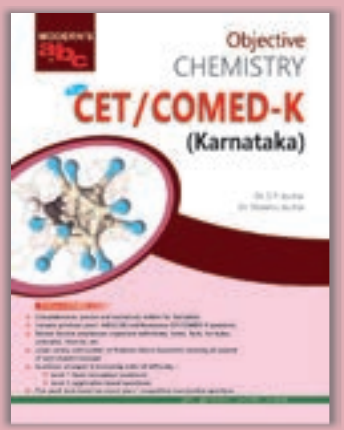
Except for the revision-test, complete solutions to ALL other questions have been given in the part 'HINTS AND SOLUTIONS' appended to each chapter.To aquaint the readers with style and type of questions asked, RECENTLY set competitive questions (RCQ) with complete solutions have been added at the end of each chapter. They will further make the students familiar with the standard and style of the test in details

In fact no pains have been left to render the book flawless, errorless and authentic. Inspite of the best care and effort, if any error, omission or misprint comes to the notice of the reader, it may kindly be brought to the notice of the authors or publisher. It will be thankfully acknowledged and ammended in the subsequent edition. Any useful suggestion from the learned colleagues or student readers which may be relevent to the enhancement of utility and improvement of the contents of the book shall be acknowledged and incorporated in the subsequent editions.

In the presence of ONE SINGLE TEST for the eligibility and admission to MANY of the colleges situated in the Karnataka, our book which is selective and contains VERY IMPORTANT and TYPICAL questions in the form of EXCELLENT, SUPERIOR, USEFUL and carefully SELECTIVE material becomes UNIQUE and a "self teacher"
in itself and we hope it will cater to the need of ONE and ALL aspirants appearing for the test and would form a popular choice with each one of the readers. The price of book has been kept comparatively LOW to suit all stratas of students inspite of the fact that it has colourful, artistic presentation in shape and form.

The authors take this opportunity to thank **Shri Balwant Sharma** and his entire team of Modern Publishers, in general and **Mr. Ravinder Pathania** in particular, for rendering all type of cooperation and guidance during the preparation and printing of the book in its present form within a shortest possible time.

—Authors



MODERN'S abc OF

OBJECTIVE CHEMISTRY

For CET/COMED–K

KARNATAKA COMMON ENTRANCE TEST

ABOUT THE BOOK

We feel pleasure in presenting the book **'Modern's abc of Objective Chemistry'** for students appearing in Karnataka **CET/COMED–K** examinations and other board examinations for entrance to different engineering and other professional colleges. The book has been thoroughly revised in accordance with the changing trends of different examinations and suggestions of worthy teachers and all my dear students.

SPECIAL FEATURES

- Comprehensive, precise and exclusively written for Karnataka
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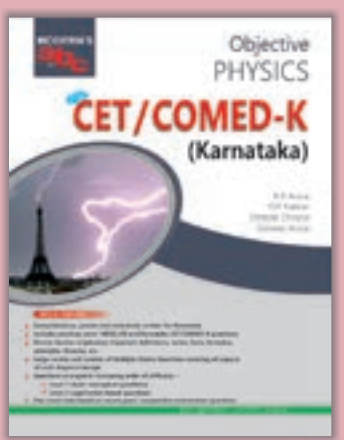

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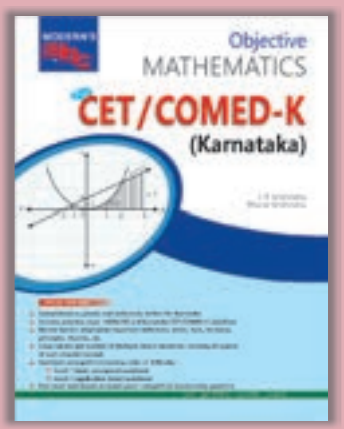

MODERN'S abc OF

OBJECTIVE MATHEMATICS

For CET/COMED–K

KARNATAKA COMMON ENTRANCE TEST

ABOUT THE BOOK

I feel pleasure in presenting the thoroughly revised and updated edition of the book **"Modern's abc of Objective Mathematics"** for the students aspiring to compete for Karnataka **CET/COMED–K**. The book is strictly in accordance with the changing trends of different examinations.

The salient features of the revised book are :

SPECIAL FEATURES

- Comprehensive, precise and exclusively written for Karnataka
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MODERN'S abc OF

OBJECTIVE BIOLOGY

For CET/COMED–K

KARNATAKA COMMON ENTRANCE TEST

ABOUT THE BOOK

The presentation in your hands of **"Modern's abc of Objective Biology"** provides a complete review of the material covered in two year course in Biology at +2 stage.

This book has been prepared strictly in accordance with syllabus and guidelines for Karnataka **CET/COMED–K**. It fulfils the needs of the students aspiring for selection in competitive examinations.

SPECIAL FEATURES

- Comprehensive, precise and exclusively written for Karnataka
- Includes previous years' AIPMT and Karnataka CET/COMED-K questions
- Review Section emphasizes important definitions, terms, facts, formulae, principles, theories, etc.
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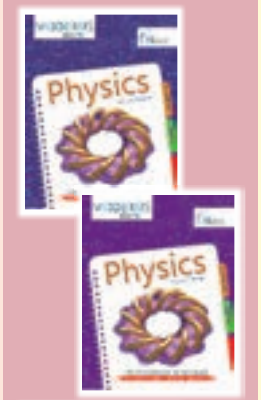

MODERN'S abc+ of PHYSICS

About the Book

The present book is being brought out to present the subject matter and depth of content of Physics in full conformity with the latest syllabi prescribed by the NCERT/CBSE, New Delhi and other State Education Boards. In order to keep pace with the recent trends in education at the national level, the whole textual material has been arranged and presented in a sequential manner, following the NCERT pattern. Special emphasis has been laid on skill development in the problem solving approach for providing better basic conceptual understanding and deep insight of the subject matter in numerical problem solving as well.

A unique feature-**Illustrative Investigation** has been introduced in the book, as a part of much-needed experimentation cum technology-based aspect, to-seek for practical applications of the concepts in day-to-day life of the learners. This aspect is expected to enhance their motivational level in the form of thought process for better and correct learning of Physics, with a view to eradicate misconceptions in Physics.

The textual material of the book has been presented in a systematic and sequential manner, easily comprehensible by the learners to make it learner-friendly. In addition to full coverage of the content, each chapter of the book includes **Illustrative Investigation, Summary** (content revision at a glance), Solved **NCERT Textbook Exercises, Examples** and **Additional Exercises** (to cover HOTS), Solved **NCERT Exemplar Problems,** specially designed **Practice Exercises** (with Hints and Solutions) and **Additional Practice Exercises** (with answers for self-practice), covering most of the previous years' questions from various State Education Boards and Competitive Examinations. Conceptual numerical problems and Short Answer Type, Multiple Choice Type Questions, Assertion and Reason Type Questions, set in different competitive Examinations (CBSE, AIEEE, IIT, CPMT, MNR, AFMC, AIIMS, etc) have been covered thoroughly in the present book.

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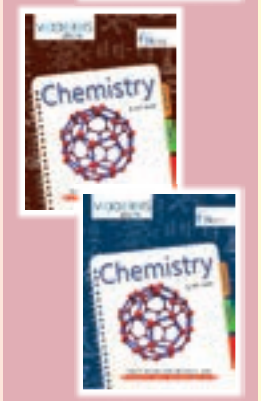

MODERN'S abc+ of CHEMISTRY

KEY FEATURES OF THE BOOK ARE

- Simple language and easily reproducible diagrams.
- Large variety of SOLVED NUMERICAL PROBLEMS.
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- REVISION EXERCISES in the form of 'Very Short Answer Type', 'Short Answer Type' and 'Long Answer Type Questions' with HINTS and SOLUTIONS to some questions is also included.
- CONCEPTUAL QUESTIONS are solved at the end of each chapter.
- Additional information is given under 'Learning Plus','Key Note' and 'Watch Out'.
- For Quick Revision of the chapter objective type questions in the form of 'True or False', 'Complete the Missing Links' and 'Choose the Correct Alternative', under the heading Memory Test along with their answers, are given at the end of each unit.
- COMPETITION FILE which includes 'Additional Information', 'Higher Order Thinking Skills' (HOTS), 'Brain-Twisting Questions' (with answers) and 'Multiple Choice Questions', is also given. This will prepare students for various competitive entrance examinations for entry to Medical, IIT and other Engineering colleges.
- COMPLETE coverage of previous years' questions from all the board examinations and competitive examinations such as AIPMT, JEE(Main), JEE (Advance) and other State Boards.

In a NUTSHELL the book provides Excellent Guidance to students for Boards' examinations as well as for competitive examinations for entrance to professional colleges.

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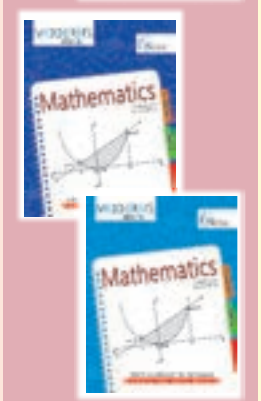

MODERN'S abc+ of MATHEMATICS

About the Book

Modern's abc+of Mathematics for Class-XII – has been especially designed to inculcate in students the basic concepts, methods and logic of Mathematics easily. For better practice and keeping in line with the recent modifications, this edition has been revised, updated and graded with the latest syllabus, curriculum and guidelines laid down by different boards in India.

The wide coverage makes this book essential for aspirants of IIT and other premier engineering colleges of our country.

KEY FEATURES OF THE BOOK ARE

- Solved examples and unsolved problems have been selected very carefully and graded properly.
- Keeping in view with the latest trends, the exercises have been divided into four categories viz., 'Fast Track Answer Type Questions', 'Very Short Answer Type Questions', 'Short Answer Type Questions' and 'Long Answer Type Questions'.
- Value Based Questions **(VBQ)** to enthuse ethical skills have also been added in the text.
- **HOTS** (Higher Order Thinking Skills) questions based on analytical skills have also been included.
- Questions from different boards of the country have also been incorporated.

MODERN'S abc+ of BIOLOGY

About the Book

Modern's abc + of Biology for class XII, written by very well-known authors of the subject, is a comprehensive book written in simple language with lucid presentation of subject matter. It meets the requirements of senior secondary/pre-degree students appearing for their Board examination and also fulfils the requirement of students preparing for different competitive examinations.

In this book, all possible efforts have been made to overcome the practical difficulties which students generally face during the preparation.

Keeping in view the importance of diagrams in Biology all the chapters have been profusely illustrated with eye-catching diagrams which make the subject matter easily comprehensible for the students. The book has also been written keeping the latest trends in mind.

An important feature of this book is the inclusion of some interesting facts for competitive examinations, new terms, objective type questions, very short answer, short answer and long answer questions.

With all these exclusive features, the book is bound to be a 'Bible' for the students, all over India, appearing for Board Examinations and various competitive examinations.

The present book is supported with the first Augmented Reality app, as a novel feature with interactive **Nytra-Watch books come alive.**

CONTENTS

1 UNITS, MEASUREMENTS, DIMENSIONS, ERRORS OF MEASUREMENTS

Revision Notes

Important Formulae, Facts and Terms

UNITS AND MEASUREMENTS

1. What is Physics ? The word physics is based upon a Greek world 'fusis' which means 'nature'. *Thus Physics is a natural science which deals with the study of basic laws of nature and exploration of the natural phenomena. It deals with the physical quantities which can be measured and expressed in numbers such as mass, length, time, speed, velocity, force, work, energy, momentum and moment etc. Physics deals with measurements as small as 10^{-15} m, 10^{-30} kg and 10^{-22} s. It also deals with large measurements of the order of 10^{26} m, 10^{55} kg and 10^{18}s. It helps us to study and understand systematically the various natural phenomena by way of observations and experiments.* It is impossible to develop anything new in science and technology without the help of **Physics.**

2. Need for Measurements. The measurement helps us in analysing the quantitative aspects of the phenomena occuring in the physical world. **The physics is an exact science because it is based on measurements.**

3. Fundamental Physical Quantities. Those physical quantities which do not depend upon any other quantity are called fundamental quantities *e.g.,* mass, length and time etc.

4. Derived Physical Quantities. The physical quantities which can be derived from fundamental quantities and depend on them are called **Derived physical quantities** *e.g.,* velocity, acceleration, force etc.

5. Unit. *The internationally accepted* (*standard*) *amount in terms of which we measure a quantity is called* **unit.** For example, metre as the unit of length.

It is either defined coventionally or on the basis of a mathematical relation.

(*i*) The unit of a physical quantity is that *fixed* and *definite* quantity which is taken to be our *reference standard* to measure it.

(*ii*) The magnitude of a physical quantity is given by the product of unit (u) selected to measure it and the number (n) of times, that unit is contained in the given quantity *i.e.,* $n \times u \approx$ constant = Q.

or $n \propto \frac{1}{u}$ or $u \propto \frac{1}{n}$ *i.e., bigger the unit smaller is its numerical value.*

6. Classification of Units. The units of a physical quantity can be classified as follows :

(*i*) **Fundamental units.** The units of *length*, *mass* and *time* were the first conventionally chosen units and were named as **fundamental units.** In fact, earlier, the length, mass and time were thought to be the fundamental physical quantities in terms of which the units of all other physical quantities could be expressed.

(*ii*) **Basic units.** It was found that the units of some more physical quantities need to be included in the list of fundamental units. At present, in addition to the length, mass and time, we take *electric current, temperature, luminous intensity* and *amount of substance* as the fundamental units. To differentiate them from the earlier nomenclature, they are often called as the basic (instead of fundamental) quantities and their units are called **basic units.**

Key Point

(*i*) 'n' is also called the **numerical value** of the quantity Q.

(*ii*) The numerical value is always a **REAL POSITIVE NUMBER**.

(*iii*) The numerical value is inversely proportional to the unit selected to express the quantity.

(*iv*) The product of numerical value and the unit is called the **MAGNITUDE** of quantity.

(*v*) The magnitude of the quantity is always **POSITIVE.**

(*vi*) For quantity which has no units such as strain, relative density etc., the magnitude consists of numerical value only.

(*vii*) Bigger the unit smaller is the numerical value and vice versa.

(*iii*) **Supplementary units. Two** more conventionally chosen units are required to express the units of some physical quantities in terms of the basic units. They are the units of **plane angle** and that of the **solid angle.** They are called supplementary units.

(*iv*) **Derived units.** The units of physical quantities other than the basic units are called derived units. They are obtained from the mathematical relationship between the given derived physical quantity and the units of above mentioned seven **basic quantities.**

e.g., $\text{Speed} = \frac{\text{Length}}{\text{Time}} = \text{Length} \times (\text{Time})^{-1}$

$\text{Acceleration} = \frac{\text{Length}}{(\text{Time})^2} = \text{Length} \times (\text{Time})^{-2}$

Certain **derived** units are named in honour of great scientist *e.g.*, unit of work is joule ; unit of force is named as newton, unit of capacitance as farad and so on.

7. System of Units. *The set of basic, supplementary and derived units of various physical quantities is called system of units.* The most widely used system of units is known as the *International System of Units*. It is based on seven basic units (metre, kilogram, second, ampere, kelvin, candela and mole) and two supplementary units : radian and steradian. It is abbreviated as S.I. The fundamental units on this system are chosen according to the following characteristics :

(*i*) They are well defined (*ii*) They have suitable size (*iii*) They are easily reproducible (*iv*) They do not vary with time, temperature, place and pressure, etc. (*v*) They are easily accessible (*vi*) They are indestructible. (*vii*) They should be easily convertible.

8. S.I. Units (System International Units).

S.I. (international system of units) is universalization of M.K.S. system of units. It has seven **basic** and two **supplementary** units as detailed below :

S.No.	Physical quantity	Unit	Sym.	Sym. of unit
1.	Mass	Kilogram	M	kg
2.	Length or Displacement	Metre	L	m
3.	Time	Second	T	s
4.	Electric current	Ampere	A	A
5.	Luminous intensity	Candela	I	Cd
6.	Thermodynamic temperature	Kelvin	K	K
7.	Amount of substance	Mole	mol	mol, mole
8.	Plane angle	Radian	θ	rad.
9.	Solid angle	Steradian	ω	Sr.

The above system is coherent and rational system. It is meteric system and its multiples and submultiple can be expressed as power of 10.

9. Prefixes or Multiples and submultiples

Factor	Name of prefix	Symbol	Factor	Prefix	Symbol
10^{1}	*deca*	da	10^{-1}	deci	d
10^{2}	*hecto*	h	10^{-2}	centi	c
10^{3}	*kilo*	k	10^{-3}	milli	m
10^{6}	*mega*	M	10^{-6}	micro	μ
10^{9}	*giga*	G	10^{-9}	nano	n
10^{12}	*tera*	T	10^{-12}	pico	p
10^{15}	*peta*	P	10^{-15}	femto	f
10^{18}	*exa*	E	10^{-18}	atto	a
10^{21}	*zetta*	Z	10^{-21}	zepto	z
10^{24}	*yotta*	Y	10^{-24}	yocto	y

Key Point

Angle is a physical quantity which has units but no dimensions.

Key Point

Do not use plural form for units *e.g. centimetres.*

Key Point

No full stop is used after the symbol.

Key Point

(*i*) It should be noted that correct abbreviation for 'gram' is 'g' and not 'gm'. and that for kilogram is 'kg' not kgm. Also second is abbreviated as 's' and not 'sec' and hour as 'h' and not as 'hr'.

(*ii*) No 's' is added to indicate the plural symbol of unit *e.g.*, centimetre and centimetres both are written as 'cm' and not cm. and 'cms'. *In fact the abbreviation for both singular and plural* is the same.

Key Point

(*i*) Prefix for multiples and submultiples are used either with basic units or with units having names such as newton, joule, farad etc. Only for mass they are used with *gram* to avoid double prefix which is *never* used.

(*ii*) Prefix and symbol forms COMPOSITE unit *i.e.* km^3 and not k $(m)^3$.

9. Some Important Derived Units with their names.

S. No.	Physical qunatity	Name of the unit	Symbol	Relation with the basic units
1.	Force	newton ; dyne	N ; dyn	$N = kg\ ms^{-2}$, $dyn = g\ cm\ s^{-2}$
2.	All forms of energy, work	joule erg	J erg	$J = kg\ m^2\ s^{-2}$ $erg. = g\ cm^2\ s^{-2}$
3.	Power	watt	W	$W = kg\ m^2\ s^{-3}$
4.	Pressure	pascal	Pa	$Pa = N\ m^{-2} = kg\ m^{-1}\ s^{-2}$
5.	Electric charge	coulomb	C	$C = A\ s$
6.	Electric potential	volt	V	$V = kg\ m^2\ s^{-3}\ A^{-1}$
7.	Electric Resistance	ohm	Ω	$\Omega = kg\ m^2\ s^{-3}\ A^{-2}$
8.	Conductance	siemens	S	$S = kg^{-1}\ m^{-2}\ s^3\ A^2$
9.	Capacitance	farad	F	$F = kg^{-1}\ m^{-2}\ s^4\ A^4$
10.	Inductance	henry	H	$H = kg\ m^2\ s^{-2}\ A^{-2}$
11.	Magnetic flux	weber	Wb	$Wb = kg\ m^2\ s^{-2}\ A^{-1}$
12.	Magnetic flux density	tesla	T	$T = kg\ s^{-2}\ A^{-1}$
13.	Frequency	hertz	Hz	$Hz = s^{-1}$
14.	Wavelength	angstrom	Å	$Å = 10^{-10} m$
15.	Modulli of elasticity	pascal	pa	$pa = kg\ m^{-1}\ s^{-2}$ or Nm^{-2}
16.	Coefficient of viscosity	poise poiseuille	p pl	$p = g\ cm^{-1}\ s^{-1}$ $pl = kg\ m^{-1}\ s^{-1}$
17.	Temperature	kelvin celsius fahrenheit reaumur	K °C °F °R	$1°C = 1\ K$ $1°F = \frac{5}{9}\ K$ $1°R = \frac{5}{4}\ K$
18.	Loudness	bell decibell	B *d*B	$1\ dB = \frac{1}{10}\ B$
19.	Electric Current	ampere	A	one of basic units
20.	Reactance and Impedence	ohm	Ω	$\Omega = kg\ m^2\ s^{-3}\ A^{-2}$
21.	Susceptance and admittance	siemens	S	$S = kg^{-1}\ m^{-2}\ s^3\ A^2$
22.	Radioactivity	curie rutherford becquerrel	Ci Rd Bq	$1Ci = 3{\cdot}7 \times 10^{10}$ dis./s $1Rd = 10^6$ dis./s 1Bq = 1 dis./s
23.	Radioactive radiation exposure	roentgen	R	–
24.	Mass (of stars)	Chandershekher limit	CSL	–
25.	E.M.F.	gilbert	Gb	–

10. Other Systems of Units. Following are the commonly used other system of units :

(*i*) **C.G.S. System of Units.** This system of units was set up in France. In this system centimeter, gram and second are choosen as basic units of length, mass and time respectively.

(*ii*) **F.P.S. System.** It is also known as British system of units. In this system foot, pound and second are choosen as basic units of length, mass and time respectively.

(*iii*) **M.K.S. System.** In this system metre, kilogram and second are choosen as basic units of length, mass and time respectively.

Key Point

(*a*) Symbols of units after scientists name have initial capital letter *e.g.* N for the newton.
(*b*) Units after scientists name are not written with capital initial letter *e.g.* newton NOT Newton.
(*c*) The abbreviation of the units named after the name of scientist is written with capital initial letter *e.g.* newton is abbreviated as N.

11. Definitions Of S.I. or Basic Units.

(I) Units of Length. SI unit of length is metre (m). One metre is equal to 1650763·73 wavelengths in vacuum of a radiation emitted due to transition between the levels of $2p_{10}$ and $5d_5$ isotope of krypton which has mass number 86. The light emitted by Kr-86 for this transition has wavelength 6507·8021 Å. The number of these wavelengths in 1 m can be counted by using an optical interferometer.

Some of smaller units are :

(*i*) 1 fermi or femto metre = 10^{-15} m

(*ii*) 1 Angstrom (Å) = 10^{-10} m

(*iii*) 1 micron or 1 micro metre (μm) = 10^{-6} m

(*iv*) 1 millimetre (1 mm) = 10^{-3} m

(*v*) 1 centimetre (1 cm) = 10^{-2} m

(*vi*) 1 decimetre (1 dm) = 10^{-1} m

Some of bigger units are :

(*i*) 1 astromomical unit = 1AU (average distance of the sun form the earth) = 1.496×10^{11} m

(*ii*) 1 light year = 1 ly = 9.46×10^{15} m (distance that light travel with velocity of 3×10^8 ms^{-1}in 1 year)

(*iii*) 1 parsec = 3.08×10^{16} m (parsec is the distance at which average radius of earth's orbit subtends an angle of 1 arc second).

(*iv*) **"**Cubit" was taken as the units of length of the arm from elbow to the tip of the middle finger of a normal man and was taken to be about 10^{-1} *m*.

(II) Units of Mass. Mass of a body is defined as the quantity of matter that body contains. Mass of a body does not change with pressure, temperature or location of the body in space. SI units of mass are kilogram (kg). The kilogram is defined as the mass of cylinder having height 3·7 cm and diameter 3·7 cm and made up of Platinum-Iridium alloy kept at international Bureau of weights and measures at Sevres.

Smaller units of measurement of mass are :	**Some other units of mass are :**
(*i*) 1 gram = 10^{-3} kg	(*i*) 1 kg = 10^3 g = 0.0685 slug
(*ii*) 1 centigram = 10^{-5} kg or 10^{-2} g	(*ii*) 1 g = 6.85×10^{-5} slug
(*iii*) 1 milligram = 10^{-6} kg or 10^{-3} g	(*iii*) 1 slug = 14.59 kg
(*iv*) 1 microgram = 10^{-9} kg or 10^{-6} g	(*iv*) 1 u = 1.661×10^{-27} kg
	(*v*) 1 quintal = 10^2 kg
	(*vi*) 1 metric ton = 10^3 kg

(III) Units of Time. It is the duration of 9,192,631,770 periods of duration corresponding to the transitions between two hyperfine levels of Cs-133 atom in ground state.

A solar day is defined as time that elapses between two moons of two consecutive days and the average solar day is the mean of the solar days in a complete one year and the second is $\frac{1}{86400}$ th part of a average solar day.

(IV) Kelvin (K). It is defined as the $\frac{1}{273 \cdot 16}$ of the thermodynamic temperature of triple point of water.

(V) Ampere (A). It is defined as the constant current that when flows between two parallel infinite straight conductors of negligible area of cross-section held one metre apart in vacuum, produces a force of 2×10^{-7} N per metre of their length.

(VI) Luminous Intensity or Candela (Cd) : One candela is the luminous intensity, in a given direction, of a source that emits monocromatic radiation of frequency 540×10^{12} hertz and has radiant intensity in that direction of 1/683 watt per steradian.

(VII) Mole. It is defined as the amount of substance containing the same number of atoms, molecules or ions etc. as there are atoms in 0·012 kg of C-12 isotope.

(VIIII) Supplementary units and their definitions : In addition to the above mentioned seven basic units, two supplimentary units are also used in SI. They are as follows :

(*a*) The unit of plane angle called the **'radian'**. *It is the plane angle between the two radii of a circle which cut off on the circumference, an arc equal to the length of the radius.*

Key Point

Metre is also defined as the length of the path travelled by light in vacuum in a time interval of $\frac{1}{299792456}$th of a second of time.

Key Point

Index of notation should be used for expressing derived units in terms of basic units $e.g.m.s^{-1}$ instead of *m/s* as the units of speed.

Key Point

Light year is unit of length or distance and not of time.

Key Point

Do not use A.U for **angstrom unit.**

$$\text{Plane angle in radian} = \frac{\text{Length of arc}}{\text{radius}}$$

(*b*) **The unit** of **solid angle** is called the **'steradian'.** *It is the solid angle with its apex at the centre of a sphere that cuts out an area on the surface of the sphere equal to the area of the square whose sides are equal to the radius of the sphere.*

$$\textit{Solid angle in steradian} = \frac{\textit{area cut out on the surface of sphere}}{(\textit{radius})^2}$$

Key Point

1 parsec > 1 Light year > 1 A.U

12. Some Special Types of Units.

1. 1 X-Unit (X.U) = 10^{-11} cm = 10^{-13} m.
2. 1 nanometre (nm) = 10^{-7} cm = 10^{-9} m
3. 1 light year = Distance travelled by light in vacuum in one year = 9.46×10^{15} m ≈ 10^{16}m.
4. 1 parsec (Parallactic second) ≈ 3.08×10^{16} m = 3.26 light year
5. 1 astronomical unit (A.U.) = 1.5×10^{11} m.
6. 1 shake = 10^{-8} s.
7. One torr = 1 mm of Hg pressure.
8. One barn = 10^{-28} m^2.
9. 1 pascal (Pa) = 1 N m^{-2}.
10. One mach number = $\dfrac{\text{Speed of moving object greater than 332 ms}^{-1}}{\text{Speed of sound at 0°C in air } i.e.\ 332\ \text{ms}^{-1}} = \dfrac{\upsilon_s}{\upsilon} \geq 1$
11. One attometre = 10^{-18} m.
12. One nanometre = 10^{-9} m.
13. One atmosphere = 10^5 N/m^2.
14. One atomic mass-unit (1 a.m.u.) = $1{\cdot}66 \times 10^{-27}$ kg.

Key Point

1 Pa = 1 N m^{-2}
= 10 dyne cm^{-2}

Key Point

The word 'second' in case of '*parallactic second*' refers to the angular measurement and not second of time

Key Point

The measure of a physical quantity is independent of system of units.

13. Dimensional Analysis. Basic units of mass, length and time are denoted by [M], [L] and [T] respectively.

(*i*) **Dimensions of a Physical Quantity.** Dimensions of a physical quantity are the powers to which the basic units of mass, length and time are to be raised in order to obtain its units. *e.g.* $\text{speed} = \dfrac{\text{distance}}{\text{time}} = \dfrac{[L]}{[T]} = [M^0LT^{-1}]$

∴ Dimensions of speed are (0, 1, –1).

(*ii*) **Dimensional formula.** Dimensional formula of a physical quantity is an expression which tells which of the basic units of mass, length and time enter into its derived units and with what powers. *e.g.* dimensional formula of momentum = [M L T^{-1}].

(*iii*) **Dimensional Equation.** The equation obtained by equating a physical quantity to its dimensional formula is called dimensional equation.

e.g. Area, A = Length × Length

$A = [M^0L^2T^0]$

Key Point

Mach number is purely a **number** and has no units or any dimensions. It is simply a multiplier *e.g.* a body is morning with 20 times the speed of souand at 0°C in air *i.e.* 332 ms^{-1}

DIMENSIONAL FORMULAE OF SOME IMPORTANT PHYSICAL QUANTITIES AND THEIR SI UNITS

S.No.	Physical quantity	Relation with basic quantities	Dimensional formula	SI units
1.	Area	Length × Breadth	$[M^0L^2T^0]$	m^2
2.	Volume	Length × Breadth × Height	$[M^0\ L^3\ T^0]$	m^3
3.	Density	Mass/Volume	$\dfrac{M}{L^3} = [ML^{-3}T^0]$	km m^{-3}
4.	Relative or specific Density	$\dfrac{\text{Density of substance}}{\text{Density of water at 4°C}}$	$\dfrac{ML^{-3}T^0}{ML^{-3}T^0} = [M^0L^0T^0]$	No units
5.	Speed or velocity	$v = \dfrac{\text{Distance}}{\text{time}}$	$\dfrac{L}{T} = [M^0LT^{-1}]$	ms^{-1}

S.No.	Physical quantity	Relation with basic quantities	Dimensional formula	SI units
6.	Velocity gradient	$\frac{\text{Velocity}}{\text{distance}}$	$\frac{LT^{-1}}{L} = M^0L^0T^{-1}$	s^{-1}
7.	Acceleration or Acceleration due to gravity	$a = \frac{\text{Velocity}}{\text{time}}$	$\frac{LT^{-1}}{T} = [M^0LT^{-2}]$	ms^{-2}
8.	Momentum	p = mass × velocity	$M \times LT^{-1} = [MLT^{-1}]$	kg ms^{-1}
9.	Force	F = mass × acceleration	$M \times LT^{-2} = [MLT^{-2}]$	kg ms^{-2} or newton
10.	Work or Energy	W = Force × distance	$MLT^{-2} \times L = [ML^2T^{-2}]$	kg m^2 s^{-2} or joule
11.	Stress or Pressure	$p = \frac{\text{Force}}{\text{Area}}$	$\frac{MLT^{-2}}{L^2} = [ML^{-1}T^{-2}]$	kg m^{-1} s^{-2} or N/m^2 or pascal
12.	Impulse	I = Force × time	$MLT^{-2} \times T = [MLT^{-1}]$	kg ms^{-1} or Ns
13.	(*a*) Torque or Moment of force	τ = Force × ⊥ distance	$MLT^{-2} \times L = [ML^2T^{-2}]$	kg m^2s^{-2} or Nm
	(*b*) Torque	$\tau = I\alpha$	$ML^2\ T^{-2}$	kg m^2 sec^{-2}
	(*c*) Angular Impulse	$\tau\ t$	$ML^2\ T^{-1}$	kg m^2 sec^{-1}
14.	Gravitational constant	$G = \frac{\text{Force} \times (\text{distance})^2}{\text{mass} \times \text{mass}}$	$\frac{MLT^{-2} \times L^2}{M \times M}$ = $[M^{-1}L^3T^{-2}]$	kg^{-1} m^3s^{-2} or Nm^2/kg^2
15.	Surface tension	$T = \frac{\text{Force}}{\text{Length}}$	$\frac{MLT^{-2}}{L} = [ML^0T^{-2}]$	kg s^{-2} or Nm^{-1}
16.	Spring constant or Force constant	$K = \frac{\text{Restoring force}}{\text{displacement}}$	$\frac{MLT^{-2}}{L} = ML^0T^{-2}$	kg s^{-2} or Nm^{-1}
17.	(*a*) Intensity of Gravitational field	$E = \frac{\text{Force}}{\text{Mass}}$	$\frac{MLT^{-2}}{M} = [M^0LT^{-2}]$	ms^{-2} or N/kg
	(*b*) Gravitational potential	$= \frac{\text{Work}}{\text{Mass}}$	$M^\circ L^2\ T^{-2}$	m^2 sec^{-2}
	(*c*) Gravitational potential energy	$= \frac{-GMm}{r}$	$ML^2\ T^{-2}$	joule
18.	Coefficient of Viscosity	$\eta = \frac{\text{Force}}{\text{area} \times \text{velocity gradient}}$	$\frac{MLT^{-2}}{L^2 \times T^{-1}} = [ML^{-1}T^{-1}]$	kg $m^{-1}s^{-1}$ or $Nm^{-2}s$ or Deca poise.
19.	Coefficient of Restitution	$= \frac{\text{R.V. of separation}}{\text{R.V. of approach}}$	$M^\circ L^\circ T^\circ$	No units
20.	Power	$P = \frac{\text{Work}}{\text{Time}}$	$\frac{ML^2T^{-2}}{T} = [ML^2T^{-3}]$	kg m^2 s^{-2} or watt
21.	Strain	$\frac{\text{Change in dimensions}}{\text{Original dimension}}$	Dimensionless	—
22.	Modulus or coefficient of elasticity	$\frac{\text{Stress}}{\text{Strain}}$	$\frac{ML^{-1}T^{-2}}{M^\circ L^\circ T^\circ} = [ML^{-1}T^{-2}]$	kg m^{-1} s^{-2} or N/m^2

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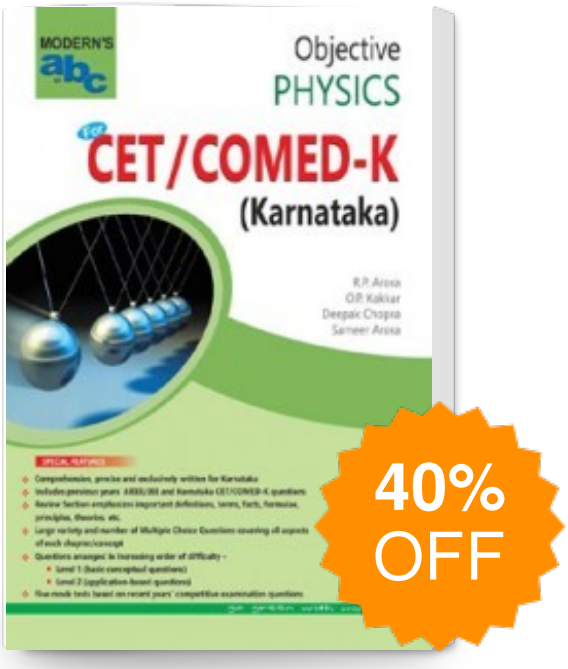

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