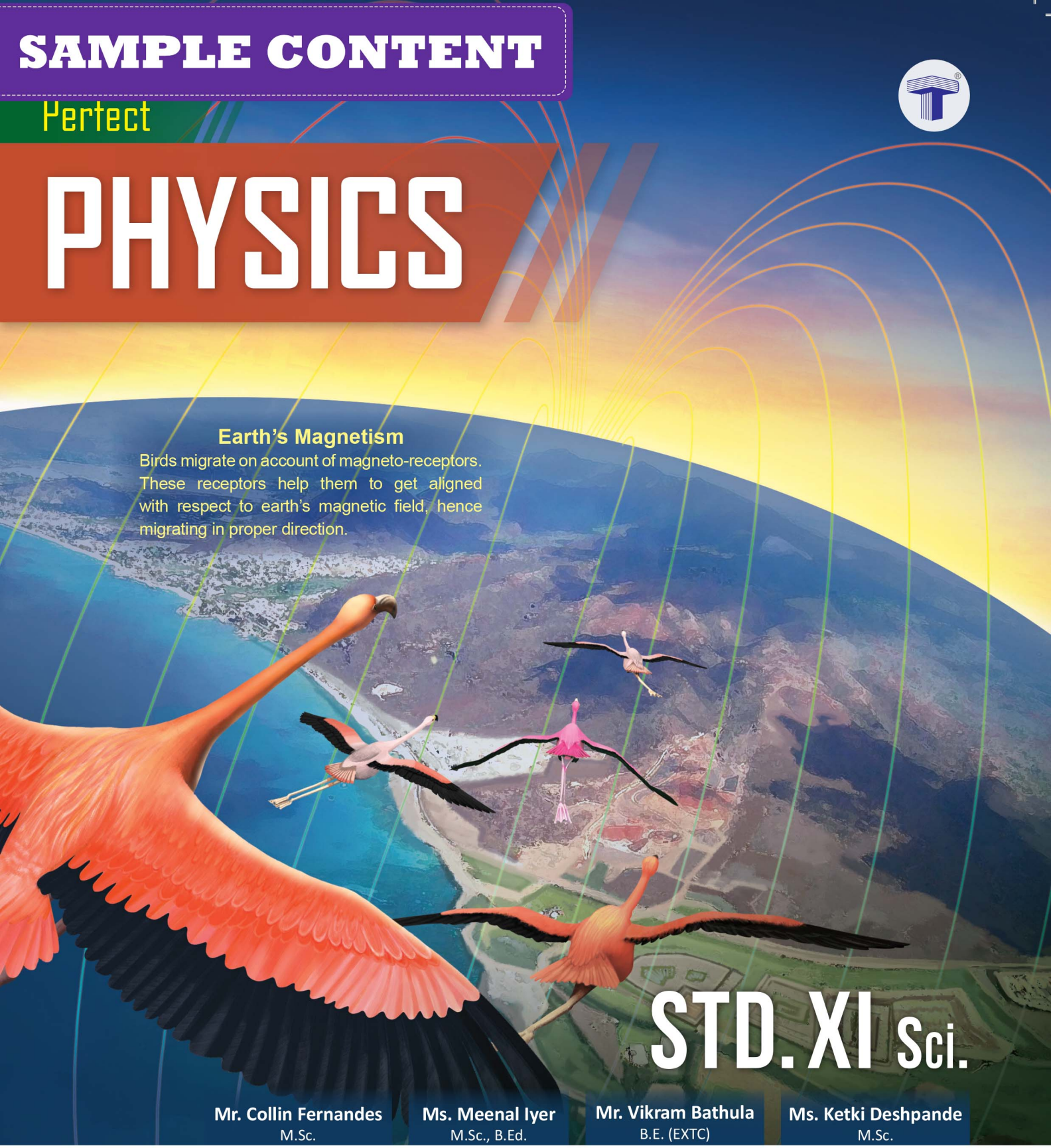
SAMPLE CONTENT

Pertect

PHYSICS



STD. XI Sci.

Mr. Collin Fernandes
M.Sc.

Ms. Meenal Iyer
M.Sc., B.Ed.

Mr. Vikram Bathula
B.E. (EXTC)

Ms. Ketki Deshpande
M.Sc.

Target Publications® Pvt. Ltd.

Written as per the latest textbook prescribed by the Maharashtra State Bureau of Textbook Production and Curriculum Research, Pune.

PERFECT PHYSICS

Std. XI Sci.

Salient Features

- Written as per the latest textbook
- Subtopic-wise segregation for powerful concept building
- Complete coverage of Textual Exercise Questions, Intext Questions, Activities and Textual Examples
- 'Solved Examples' provided to cover numerical aspect of the topic in detail.
- 'Apply Your Knowledge' section for application of concepts
- 'Quick Review' facilitates quick revision
- 'Important Formulae' at the end of every chapter compiles all formulae
- 'Competitive Corner' presents questions from prominent competitive examinations
- About the chapter, Reading Between the Lines, Enrich Your Knowledge, Gyan Guru, Strategy, Connections, Caution, NCERT Corner are designed to impart holistic education
- Includes Theory questions, Numericals and MCQs for practice
- Topic test at the end of each chapter for effective preparation
- Video links provided via QR codes for boosting conceptual retention
- QR Code to access the Solutions of Numericals for Practice

Printed at: **India Printing Works,** Mumbai

Balbharati Registration No.: 2018MH0022 **TEID: 2808** P.O. No. 8173

PREFACE

"Everything should be made as simple as possible, but not simpler." - Albert Einstein.

Having this vision in mind we have created **"Perfect Physics: Std. XI"** as per the new textbook of Maharashtra State board. It focuses on not just preparing students from examination point of view but also equipping them to understand and appreciate the beauty of Physics as a subject.

Every chapter in this book begins with ***'About the Chapter'*** that offers a brief introduction of the chapter. The chapter is **segregated subtopic-wise** and encompasses all textual content in the format of Question-Answers. *Textual Exercise questions, Intext questions, 'Can you tell', 'Can you recall', 'Try this'* and *'Activity'* are placed aptly amongst various additional questions in accordance with the flow of subtopic. Numericals along with their step-wise solutions using log calculation (wherever necessary) are covered under heading of **Solved Examples** at the end of each subtopic. Marks are allotted to give students insight about weightage of a question.

Quick Review and **Important Formulae** are placed after covering last subtopic of the chapter. **Exercise** helps the students to gain insight on the various levels of theory and numerical-based questions.

Multiple Choice Questions and **Topic Test** (as per latest paper pattern) assess the students on their range of preparation and the amount of knowledge of each topic. QR code has been provided for students to access the 'Solutions to Numericals for practice' and 'Answer key' given for the Topic Test. **Additional Information** and **Notes** are introduced to cover additional bits of relevant information on each topic as seemed required. Log-table has been provided for students' use at the end of the book.

Perfect Physics, Std. XI Sci. adheres to our vision and achieves several goals: **building concepts**, **developing competence to solve numericals, recapitulation, self-study, self-assessment** and **student engagement**—all while encouraging students toward cognitive thinking.

The flow chart on the adjacent page will walk you through the key features of the book and elucidate how they have been carefully designed to maximize the student learning.

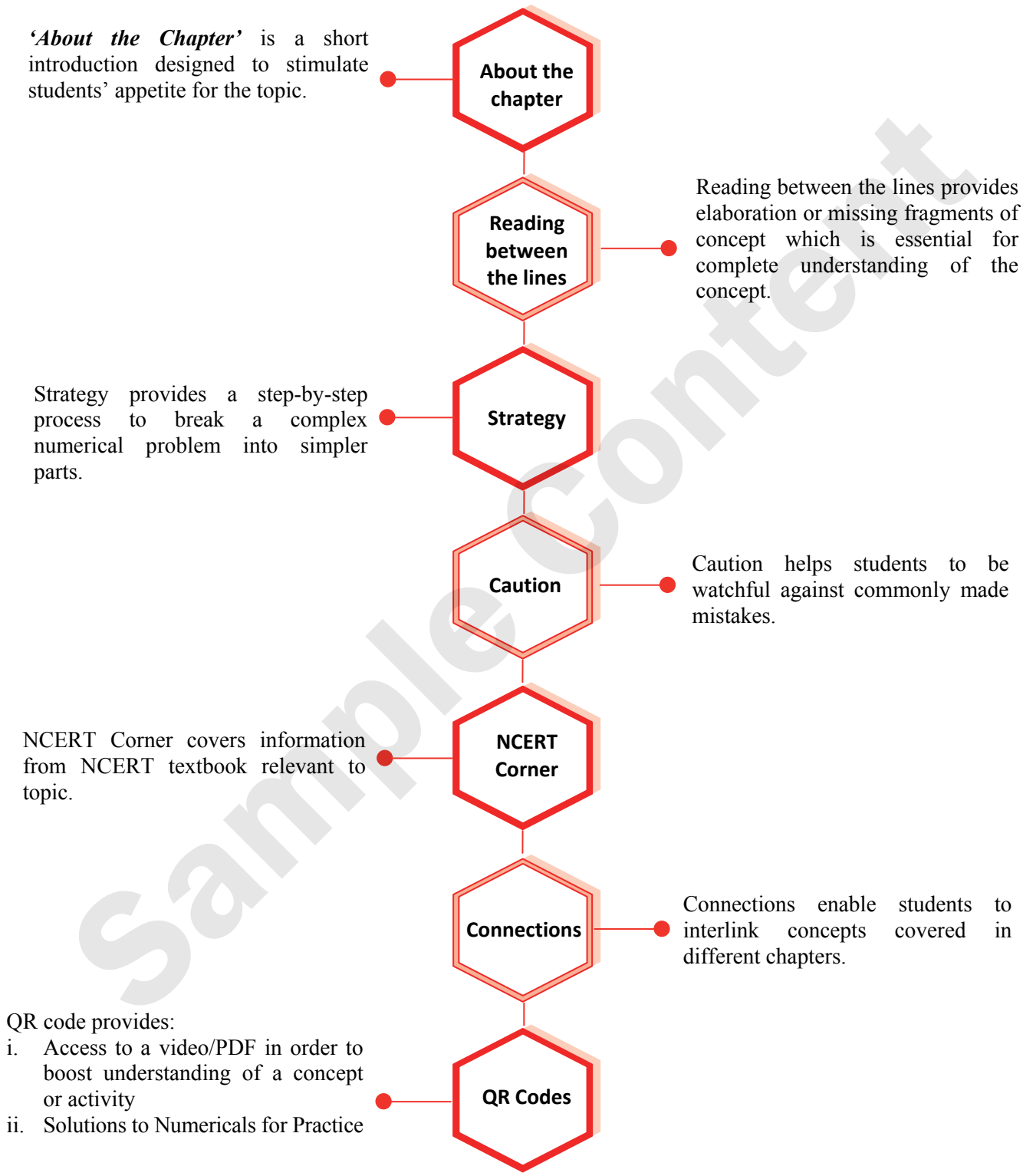
We hope the book benefits the learner as we have envisioned.

Publisher

Edition: Fourth

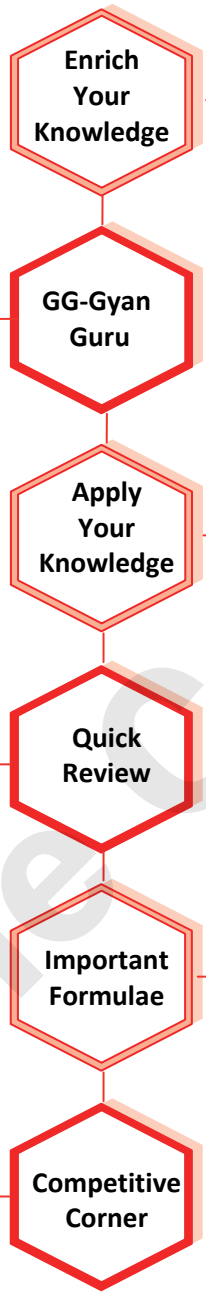
The journey to create a complete book is strewn with triumphs, failures and near misses. If you think we've nearly missed something or want to applaud us for our triumphs, we'd love to hear from you.
Please write to us on: mail@targetpublications.org

KEY FEATURES



Continued…

KEY FEATURES



Enrich Your Knowledge presents fascinating information about the concept covered.

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

Apply Your Knowledge includes challenging questions.

Quick review includes tables/ flow chart to summarize the key points in chapter.

Important Formulae includes all of the key formulae in the chapter.

Competitive Corner includes selective questions from prominent [NEET (UG), JEE (Main), NEET (ODISHA), MHT CET] competitive exams based entirely on the syllabus covered in the chapter.

CONTENTS

[Reference: Maharashtra State Board of Secondary and Higher Secondary Education, Pune - 04]

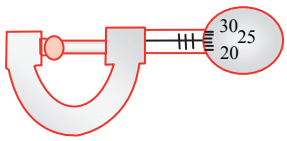
Note: 1. * mark represents Textual question.

2. # mark represents Intext question.

3. + mark represents Textual examples.

4. symbol represents textual questions that need external reference for an answer.

1 Units and Measurements



About the chapter…

In this chapter, students will study about the different types of system of units and also the method of dimensional analysis and their applications. Students will learn the basics of measuring time, length and mass. The chapter also describes about the various errors in measurement that occur while performing any experiment and the different techniques to minimize the errors.

The chapter is allotted weightage of 7 marks with option and 5 marks without option.

CONTENTS AND CONCEPTS

1.1 INTRODUCTION

Physics is the branch of science which deals with the study of nature and natural phenomena.

It is a quantitative science where various physical quantities are measured.

A quantity which can be measured and with the help of which, various physical happenings can be explained and expressed in the form of laws, is called a physical quantity.

Examples: length, mass, time, force etc.

Q.1. What is a measurement? How is measured quantity expressed? **[2 Marks]**

Ans:

i. A measurement is a comparison with internationally accepted standard measuring unit.

ii. The measured quantity (M) is expressed in terms of a number (n) followed by a corresponding unit (u) i.e., M = nu.

Example:

Length of a wire when expressed as 2 m, it means value of length is 2 in the unit of m (metre).

Q.2. State true or false. If false correct the statement and rewrite. **[1 Mark]**

Different quantities are measured in different units.

Ans: True.

***[Note:** Choice of unit depends upon its suitability for measuring the magnitude of a physical quantity under consideration. Hence, we choose different scales for same physical quantity.]*

Q.3. Can you recall? *(Textbook page no. 1)*

i. What is a unit? **[1 Mark]**

ii. Which units have you used in the laboratory for measuring **[2 Marks]**

a. length **b. mass**

c. time **d. temperature?**

iii. Which system of units have you used? **[1 Mark]**

Ans:

i. *The standard measure of any quantity is called the unit of that quantity.*

ii.

Physical quantity	Length	Mass	Time	Temperature
Units	millimetre, centimetre, metre	gram, kilogram	seconds minutes	Degree celsius degree fahrenheit

iii. I have used MKS or SI system mostly. At times, I have even used CGS system.

1.2 SYSTEM OF UNITS

Q.4. Describe briefly different types of systems of units. **[2 Marks]**

Ans: System of units are classified mainly into four types:

i. C.G.S. system:

It stands for Centimetre-Gram-Second system. In this system, length, mass and time are measured in centimetre, gram and second respectively.

ii. M.K.S. system:
It stands for Metre-Kilogram-Second system. In this system, length, mass and time are measured in metre, kilogram and second respectively.

iii. F.P.S. system:
It stands for Foot-Pound-Second system. In this system, length, mass and time are measured in foot, pound and second respectively.

iv. S.I. system:
It stands for System International. This system has replaced all other systems mentioned above. It has been internationally accepted and is being used all over world. As the SI units use decimal system, conversion within the system is very simple and convenient.

ENRICH YOUR KNOWLEDGE

The three systems namely CGS, MKS and FPS were used extensively till recently. In 1971, the 14th International general conference on weights and measures recommended the use of 'International system' of units.

Q.5. What are fundamental quantities? State two examples of fundamental quantities. Write their S.I. and C.G.S. units. [2 Marks]

Ans: Fundamental quantities:
The physical quantities which do not depend on any other physical quantity for their measurements i.e., they can be directly measured are called fundamental quantities.
Examples: mass, length etc.

Fundamental quantities	S.I. unit	C.G.S. unit
Mass	kilogram (kg)	gram (g)
Length	metre (m)	centimetre (cm)

Q.6. What are fundamental units? State the S.I. units of seven fundamental quantities. [3 Marks]

Ans: Fundamental units:
The units used to measure fundamental quantities are called fundamental units.
S.I. Units of fundamental quantities:

Fundamental quantity	SI Units	
	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

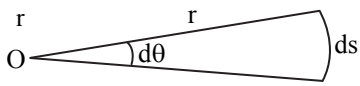
Q.7. State and describe the two supplementary units. [2 Marks]

Ans: The two supplementary units are:

i. Plane angle (dθ):

a. *The ratio of length of arc (ds) of a circle to the radius (r) of the circle is called as Plane angle (dθ)*

i.e., $d\theta = \frac{ds}{r}$



b. Thus, dθ is angle subtended by the arc at the centre of the circle.

c. Unit: radian (rad)

d. Denoted as θ^c

e. Length of arc of circle = Circumference of circle = $2\pi r$.

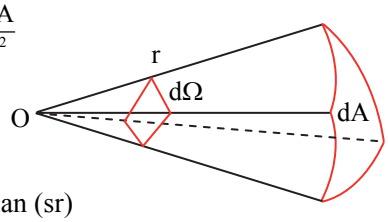
∴ plane angle subtended by entire circle at its centre is $\theta = \frac{2\pi r}{r} = 2\pi^c$

ii. Solid angle (dΩ):

a. solid angle is 3-dimensional analogue of plane angle.

b. *Solid angle is defined as area of a portion of surface of a sphere to the square of radius of the sphere.*

i.e., $d\Omega = \frac{dA}{r^2}$



c. Unit: Steradian (sr)

d. Denoted as (Ω)

e. Surface area of sphere = $4\pi r^2$

∴ solid angle subtended by entire sphere at its centre is $\Omega = \frac{4\pi r^2}{r^2} = 4\pi$ sr

Q.8. Derive the relation between radian and degree. Also find out 1″ and 1′ in terms of their respective values in radian. (Take π = 3.1416) [2 Marks]

Ans: We know that, $2\pi^c = 360°$

∴ $\pi^c = 180°$

∴ $1^c = \frac{180}{\pi} = \frac{180}{3.1416} = 57.296°$

Similarly, $1° = \frac{\pi}{180} = \frac{3.1416}{180}$

$= 1.745 \times 10^{-2}$ rad

As, $1° = 60'$

∴ $1' = \frac{1.745 \times 10^{-2}}{60} = 2.908 \times 10^{-4}$ rad.

As, $1' = 60''$

∴ $1'' = \frac{2.908 \times 10^{-4}}{60} \approx 4.847 \times 10^{-6}$ rad.

Students can scan the adjacent Q. R. Code in *Quill - The Padhai App* to get conceptual clarity about **degree and radian** with the aid of a linked video.

Q.9. What are derived quantities and derived units? State two examples. State the corresponding S.I. and C.G.S. units of the examples. [3 Marks]

Ans:

i. Derived quantities:

Physical quantities other than fundamental quantities which depend on one or more fundamental quantities for their measurements are called derived quantities.

ii. Derived units:

The units of derived quantities which are expressed in terms of fundamental units for their measurements are called derived units.

iii. Examples and units:

Derived quantity	Formula	S.I. unit	C.G.S. unit
Velocity	$\frac{\text{Unit of displacement}}{\text{Unit of time}}$	m/s	cm/s
Acceleration	$\frac{\text{Unit of velocity}}{\text{Unit of time}}$	m/s^2	cm/s^2
Momentum	Unit of mass × Unit of velocity	kg m/s	g cm/s

Q.10. Classify the following quantities into fundamental and derived quantities: [2 Marks]
Length, Velocity, Area, Electric current, Acceleration, Time, Force, Momentum, Energy, Temperature, Mass, Pressure, Magnetic induction, Density.

Ans: Fundamental Quantities: Length, Electric current, Time, Temperature, Mass.
Derived Quantities: Velocity, Area, Acceleration, Force, Momentum, Energy, Pressure, Magnetic induction, Density

Q.11. Classify the following units into fundamental, supplementary and derived units: [2 Marks]
newton, metre, candela, radian, hertz, square metre, tesla, ampere, kelvin, volt, mol, coulomb, farad, steradian.

Ans:

Fundamental units	Supplementary units	Derived units
metre	radian	newton
candela	steradian	hertz
ampere		square metre
kelvin		tesla
mol		volt
		coulomb
		farad

Q.12. List the conventions followed while using SI units. [4 Marks]

Ans: Following conventions should be followed while writing S.I. units of physical quantities:

i. Unit of every physical quantity should be represented by its symbol.

ii. Full name of a unit always starts with smaller letter even if it is named after a person, eg.: 1 newton, 1 joule, etc. But symbol for unit named after a person should be in capital letter, eg.: N after scientist Newton, J after scientist Joule, etc.

iii. Symbols for units do not take plural form.

iv. Symbols for units do not contain any full stops at the end of recommended letter.

v. The units of physical quantities in numerator and denominator should be written as one ratio. For example the SI unit of acceleration is m/s^2 or $m\ s^{-2}$ but not m/s/s.

vi. Use of combination of units and symbols for units is avoided when physical quantity is expressed by combination of two. For example, The unit J/kg K is correct while joule/kg K is not correct.

vii. A prefix symbol is used before the symbol of the unit.

a. Prefix symbol and symbol of unit constitute a new symbol for the unit which can be raised to a positive or negative power of 10.
For example,
1 ms = 1 millisecond = 10^{-3} s
1 µs = 1 microsecond = 10^{-6} s
1 ns = 1 nanosecond = 10^{-9} s

b. Use of double prefixes is avoided when single prefix is available
10^{-6} s = 1 µs and not 1 mms
10^{-9} s = 1 ns and not 1 mµs

viii. Space or hyphen must be introduced while indicating multiplication of two units e.g., m/s should be written as $m\ s^{-1}$ or $m\text{-}s^{-1}$.

SOLVED EXAMPLES

+Q.13. What is the solid angle subtended by the moon at any point of the Earth, given the diameter of the moon is 3474 km and its distance from the Earth 3.84×10^8 m?
(Example 1.1 of Textbook page no. 2) [3 Marks]

Solution:

Given: Diameter (D) = 3474 km
$\therefore$ Radius of moon (R) = 1737 km
$= 1.737 \times 10^6$ m
Distance from Earth r = 3.84×10^8 m

To find: Solid angle ($d\Omega$)

Formula: $d\Omega = \frac{dA}{r^2}$

Calculation:

From formula,

$$d\Omega = \frac{\pi R^2}{r^2} \quad \ldots.(\because \text{ cross-sectional area of disc of moon} = \pi R^2)$$

$$d\Omega = \frac{\pi \times (1.737 \times 10^6)^2}{(3.84 \times 10^8)^2}$$

$$= \frac{3.412 \times (1.737)^2 \times 10^{12}}{(3.84)^2 \times 10^{16}}$$

$$= \text{antilog}\{\log(3.142) + 2\log(1.737) - 2\log(3.84)\} \times 10^{-4}$$

$$= \text{antilog}\{0.4972 + 2(0.2397) - 2(0.5843)\} \times 10^{-4}$$

$$= \text{antilog}\{0.4972 + 0.4794 - 1.1686\} \times 10^{-4}$$

$$= \text{antilog}\{\bar{1}.8080\} \times 10^{-4}$$

$$= 6.428 \times 10^{-1} \times 10^{-4}$$

$$= \mathbf{6.43 \times 10^{-5}\ sr}$$

Ans: Solid angle subtended by moon at Earth is $\mathbf{6.43 \times 10^{-5}\ sr}$.

Q.14. Pluto has mean diameter of 2,300 km and very eccentric orbit (oval shaped) around the Sun, with a perihelion (nearest) distance of 4.4×10^9 km and an aphelion (farthest) distance of 7.3×10^9 km. What are the respective solid angles subtended by Pluto from Earth's perspective?
Assume that Earth's distance from the Sun can be neglected. **[3 Marks]**

Solution:

Given: Radius of Pluto, $R = \frac{2300}{2}$ km $= 1150$ km

Perihelion distance $r_p = 4.4 \times 10^9$ km

Aphelion distance $r_a = 7.3 \times 10^9$ km

To find: Solid angles ($d\Omega_p$ and $d\Omega_a$)

Formula: $d\Omega = \frac{dA}{r^2} = \frac{\pi R^2}{r^2}$

Calculation: From formula,

$$\therefore \quad d\Omega_p = \frac{\pi(1150)^2}{(4.4 \times 10^9)^2} = \frac{3.142 \times (1150)^2}{(4.4 \times 10^9)^2}$$

$$= \mathbf{2.146 \times 10^{-13}\ sr}$$

$$\text{and } d\Omega_a = \frac{\pi(1150)^2}{(7.3 \times 10^9)^2}$$

$$= \frac{3.142 \times (1150)^2}{(7.3 \times 10^9)^2} = \mathbf{7.798 \times 10^{-14}\ sr}$$

Ans: Solid angle at perihelion distance is $\mathbf{2.146 \times 10^{-13}\ sr}$ and at aphelion distance is $\mathbf{7.798 \times 10^{-14}\ sr}$.

1.3 MEASUREMENT OF LENGTH

Q.15. Define a metre. **[1 Mark]**

Ans: *The metre is the length of the path travelled by light in vacuum during a time interval of 1/299,792,458 of a second.*

Q.16. What is parallax? **[2 Marks]**

Ans:

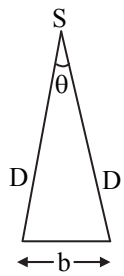
i. *Parallax is defined as the apparent change in position of an object due to a change in position of an observer.*

ii. **Explanation:** When a pencil is held in front of our eyes and we look at it once with our left eye closed and then with our right eye closed, pencil appears to move against the background. This effect is called parallax effect.

Q.17. What is parallax angle? **[2 Marks]**

Ans:

i. *Angle between the two directions along which a star or planet is viewed at the two points of observation is called parallax angle (parallactic angle).*



ii. It is given by $\theta = \frac{b}{D}$

where, b = Separation between two points of observation,

D = Distance of source from any point of observation.

***Q.18. Star A is farther than star B. Which star will have a large parallax angle?** **[2 Marks]**

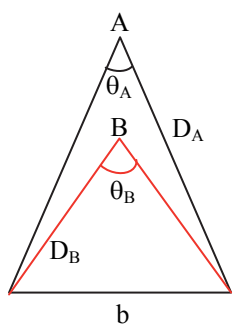
Ans:

i. Parallax angle is given by, $\theta = \frac{b}{D}$

ii. Here, 'b' is constant for the two stars.

$\therefore \quad \theta \propto \frac{1}{D}$

iii. As star A is farther i.e., $D_A > D_B \Rightarrow \theta_A < \theta_B$.



Hence, star B will have larger parallax angle than star A.

Q.19. Explain the method to determine the distance of a planet from the Earth. **[3 Marks]**

Ans:

i. Parallax method is used to determine distance of different planets from the Earth.

ii. To measure the distance 'D' of a far distant planet S, select two different observatories (E_1 and E_2).

iii. The planet should be visible from E_1 and E_2 observatories simultaneously i.e. at the same time.

Page no. **5 to 6** is purposely left blank.

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

iii. To measure mass of small entities such as atoms and nucleus, atomic mass unit (amu) is used.

It is defined as $\left(\frac{1}{12}\right)^{th}$ mass of an unexcited atom of carbon –12 (C^{12}).

1 amu ≈ 1.66×10^{-27} kg.

ENRICH YOUR KNOWLEDGE

For measurement of small masses of atomic or subatomic particles, mass spectrography is used. This method uses the property that mass of the charged particle is proportional to radius of the trajectory when particle is moving in uniform electric and magnetic field.

Large masses in the universe like planets, stars etc. can be measured by using Newton's law of gravitation.

Q.28. What can be the reason for choosing Carbon-12 to define atomic mass unit? [1 Mark]

Ans:

i. Unlike oxygen and hydrogen, which exhibit various isotopes in higher proportions, carbon-12 is the single most abundant (98% of available carbon) isotope of carbon.

ii. It is also very stable.

Hence, it makes more accurate unit of measuring mass and is used to define atomic mass unit.

1.5 MEASUREMENT OF TIME

Q.29. i. Define mean solar day. [1 Mark]

ii State the reason for replacing mean solar day by caesium atomic clock. [2 Marks]

iii. How is one second defined in terms of vibrations of radiation of caesium – 133 atom? [1 Mark]

Ans:

i. *A mean solar day is the average time interval from one noon to the next noon.*

ii. **Reason:**

a. The unit of time, the second, was considered to be $\frac{1}{86400}$ of the mean solar day, where

a mean solar day = 24 hours

= 24 × 60 × 60

= 86400 s

b. However, this definition proved to be unsatisfactory to define the unit of time precisely because solar day varies gradually due to gradual slowing down of the Earth's rotation. Hence, the definition of second was replaced by one based on atomic standard of time.

c. Atomic standard of time is now used for the measurement of time. In atomic standard of time, periodic vibrations of caesium atom is used.

d. The caesium atomic clocks are very accurate.

e. The national standard of time interval 'second' as well as the frequency is maintained through four caesium atomic clocks.

iii. One second is time required for 9,192,631,770 vibrations of the radiation corresponding to transition between two hyperfine energy states of caesium-133 (Cs - 133) atom.

1.6 DIMENSIONS AND DIMENSIONAL ANALYSIS

Q.30. Define dimensions and dimensional formula of physical quantities. Give two examples of dimensional formula. [3 Marks]

Ans:

i. Dimensions:

The dimensions of a physical quantity are the powers to which the fundamental units must be raised in order to obtain the unit of a given physical quantity.

ii. Dimensional formula:

When any derived quantity is represented with appropriate powers of symbols of the fundamental quantities, such an expression is called dimensional formula.

It is expressed by square bracket with no comma in between the symbols.

iii. Examples of dimensional formula:

a. Speed = $\frac{\text{Distance}}{\text{time}}$

∴ Dimensions of speed = $\frac{[L]}{[T]} = [L^1 M^0 T^{-1}]$

*[**Note:** As power of M is zero, it can be omitted from dimensional formula. Therefore, dimensions of speed can be written as $[L^1 T^{-1}]$]*

b. Force = Mass × acceleration = Mass × $\frac{\text{Distance}}{(\text{time})^2}$

∴ Dimensions of force = $[M] \times \frac{[L]}{[T^2]} = [L^1 M^1 T^{-2}]$

c. Kinetic energy = $\frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{\text{Distance}}{\text{Time}}\right)^2$

∴ Dimension of kinetic energy = $[M^1] \times \frac{[L^2]}{[T^2]}$

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

d. Temperature gradient = $\frac{\text{Temperature}}{\text{Distance}}$

∴ Dimension of temperature gradient

$= \frac{[K]}{[L]} = [L^{-1} M^0 T^0 K^1]$ *[Any two]*

Connections

In Chapter 7, you will study in detail about temperature gradient.

Some derived quantities with their SI units and dimensions:

Physical Quantities	Formula	S.I. units	Dimensions
Speed	$\frac{\text{Distance}}{\text{Time}}$	m/s	$[L^1 M^0 T^{-1}]$
Acceleration	$\frac{\text{Change in velocity}}{\text{Time}}$	m/s^2	$[L^1 M^0 T^{-2}]$
Force	Mass × Acceleration	N (newton)	$[L^1 M^1 T^{-2}]$
Pressure	$\frac{\text{Force}}{\text{Area}}$	$kg/m\text{-}s^2$	$[L^{-1} M^1 T^{-2}]$
Density	$\frac{\text{Mass}}{\text{Volume}}$	kg/m^3	$[L^{-3} M^1 T^0]$
Work	Force × distance	J (joule)	$[L^1 M^1 T^{-2}]\,[L^1] = [L^2 M^1 T^{-2}]$
Energy	Force × distance	J (joule)	$[L^1 M^1 T^{-2}]\,[L^1] = [L^2 M^1 T^{-2}]$
Power	$\frac{\text{Work}}{\text{Time}}$	W (watt)	$[L^2 M^1 T^{-3}]$
Momentum	Mass × Velocity	kg-m/s	$[L^1 M^1 T^{-1}]$
Impulse	Force × Time	N-s	$[L^1 M^1 T^{-1}]$
Temperature (T)	--	K (kelvin)	$[L^0 M^0 T^0 K^1]$
Charge	Current × Time	C (coulomb)	$[L^0 M^0 T^1 A^1]$
Resistance	$\frac{\text{Potential difference}}{\text{Current}}$	Ω (ohm)	$[L^2 M^1 T^{-3} A^{-2}]$
Frequency	$\frac{1}{\text{Time}}$	/s	$[L^0 M^0 T^{-1}]$
Planck's constant	$\frac{\text{Energy of Photon}}{\text{Frequency}}$	J-s	$[L^2 M^1 T^{-1}]$
Electric potential	$V = \frac{W}{q}$	V (volt)	$[L^2 M^1 T^{-3} A^{-1}]$

***[Note:** Students can write θ for temperature instead of K and I for current instead of A in dimensional formula.]*

***Q.31. What are the dimensions of the quantity $l\sqrt{l/g}$, l being the length and g the acceleration due to gravity? [2 Marks]**

Ans: Quantity $= l \times \sqrt{\frac{l}{g}}$ ....(i)

Gravitational acceleration, $g = \frac{\text{velocity}}{\text{time}}$

$\therefore$ $g = \frac{\text{distance}}{\text{time} \times \text{time}}$

Substituting in equation (i),

Quantity $= l \times \sqrt{\frac{l \times \text{time}^2}{\text{distance}}} = l \times \sqrt{\frac{l}{\text{distance}}} \times \text{time}$

$\therefore$ Dimensional formula of quantity

$= [L] \times \frac{[L^{1/2}]}{[L^{1/2}]}\,[T] = [L^1] \times [T^1] = [L^1 T^1]$

⚠ CAUTION

When power of symbol expressing fundamental quantity appearing in dimensional formula is not given, it is taken as 1.

Q.32. A book with many printing errors contains four different formulae for the displacement y of a particle undergoing a certain periodic function:

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

ii. $y = a \sin v\,t$

iii. $y = \frac{a}{T} \sin \frac{t}{a}$

iv. $y = \frac{a}{\sqrt{2}}\left[\sin\frac{2\pi t}{T} + \cos\frac{2\pi t}{T}\right]$

Here, a is maximum displacement of particle, v is speed of particle, T is time period of motion. Rule out the wrong formulae on dimensional grounds. [2 Marks] (NCERT)

Ans: The argument of trigonometrical function, i.e., angle is dimensionless. Now,

i. The argument, $\left[\frac{2\pi t}{T}\right] = \frac{[T]}{[T]} = 1 = [L^0 M^0 T^0]$

which is a dimensionless quantity.

Hence, formula (i) is correct.

Page no. **9** to **12** are purposely left blank.

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

1.7 ACCURACY, PRECISION AND UNCERTAINTY IN MEASUREMENTS

Q.51. What is accuracy? **[1 Mark]**

Ans: *Accuracy is how close a measurement is to the actual value of that quantity.*

GG - Gyan Guru

Results of Tata Mumbai Marathon 2019 saw Kenya's Cosmas Lagat as winner with race time. 2:09:15. Aychew Bante was at second position (2:10:05) and Shumet Akalnew (2:10:14) was a close third.

The result clearly marks necessity of accurate measurement of time. To achieve this, most timed races today use race bibs with a timing chip. When a runner moves past a special mat at starting line, chip registers beginning time and as runner crosses the finish line, it registers finishing time.

Q.52. What is precision? **[1 Mark]**

Ans: *Precision is a measure of how consistently a device records nearly identical values i.e., reproducible results.*

Q.53. A scale in a lab measures the mass of object consistently more by 500 g than their actual mass. How would you describe the scale in terms of accuracy and precision? **[2 Marks]**

Ans: The scale is precise but not accurate.

Explanation: Precision measures how consistently a device records the same answer; even though it displays the wrong value. Hence, the scale is precise.

Accuracy is how well a device measures something against its accepted value. As scale in the lab is always off by 500 g, it is not accurate.

***[Note:** The goal of the observer should be to get accurate as well as precise measurements.]*

Students can scan the adjacent Q. R. Code in *Quill - The Padhai App* to get conceptual clarity about **accuracy and precision** with the aid of a linked video.

Q.54. Can you tell? *(Textbook page no.8)*
If ten students are asked to measure the length of a piece of cloth upto a mm, using a metre scale, do you think their answers will be identical? Give reasons. **[2 Marks]**

Ans: Answers of the students are likely to be different. Length of cloth needs to be measured up to a millimetre (mm) length.
Hence, to obtain accurate and precise reading one must use measuring instrument having least count smaller than 1 mm.
But least count of metre scale is 1 mm. As a result, even smallest uncertainty in reading would vary reading significantly. Also, skill of students doing measurement may also introduce uncertainty in observation.
Hence, their answers are likely to be different.

Q.55. List reasons that may introduce possible uncertainties in an observation. **[2 Marks]**

Ans: Possible uncertainties in an observation may arise due to following reasons:

i. Quality of instrument used,
ii. Skill of the person doing the experiment,
iii. The method used for measurement,
iv. External or internal factors affecting the result of the experiment.

1.8 ERRORS IN MEASUREMENTS

ENRICH YOUR KNOWLEDGE

The difference between measured value and true value of a physical quantity is called error.

Q.56. Classify errors into different categories. What is systematic error? **[2 Marks]**

Ans:

i. **Classification of errors:**
Errors are classified into following two groups:
a. Systematic errors:
   1. Instrumental error (constant error)
   2. Error due to imperfection in experimental technique
   3. Personal error (human error).
b. Random error (accidental error)

ii. *Systematic errors are errors that are not determined by chance but are introduced by an inaccuracy (involving either the observation or measurement process) inherent to the system.*

Q.57. What is instrumental (constant) error? **[1 Mark]**

Ans: Instrumental error:

i. It arises due to defective calibration of an instrument.
ii. Example: If a thermometer is not graduated properly, i.e., one degree on the thermometer actually corresponds to 0.99°, the temperature measured by such a thermometer will differ from its value by a constant amount.

Page no. **14** to **21** are purposely left blank.

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

APPLY YOUR KNOWLEDGE

Q.91. Write the dimensions of a and b in the relation

$$E = \frac{b - x^2}{a}$$

Where E is energy, x is distance and t is time.

Ans: The given relation is $E = \frac{b - x^2}{a}$

As x is subtracted from b,

$\therefore$ dimensions of b are x^2;

i.e., **$b = [L^2]$**

$\therefore$ We can write equation as $E = \frac{L^2}{a}$

Or $a = \frac{L^2}{E} = \frac{L^2}{[L^2MT^{-2}]} = [L^0M^{-1}T^2]$

Q.92. What is the difference between 6.0 and 6.00? which is more accurate?

Ans: 6.0 indicates the measurement is correct up to first decimal place, whereas 6.00 indicates that the measurement is correct up to second decimal place. Thus, 6.00 is a more accurate value than 6.0.

Q.93. A child walking on a footpath notices that the width of the footpath is uneven. He reported this to his school principal and the complaint was forwarded to the municipal officer.

i. What is the possible error encountered?

ii. What is the relative error in width of footpath if width of footpath in 10 m length are noted as 5 m, 5.5 m, 5 m, 6 m and 4.5 m?

Ans:

i. The error encountered is **personal error**.

ii. Mean value of widths

$$w_{mean} = \frac{w_1 + w_2 + w_3 + w_4 + w_5}{5}$$

$$= \frac{5 + 5.5 + 5 + 6 + 4.5}{5}$$

$$= \frac{26}{5} = 5.2 \text{ m}$$

Mean absolute error of widths

$$\Delta w_{mean} = \frac{\Delta w_1 + \Delta w_2 + \Delta w_3 + \Delta w_4 + \Delta w_5}{5}$$

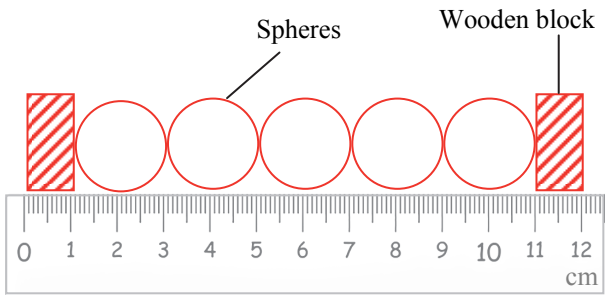
$$= \frac{0.2 + 0.3 + 0.2 + 0.8 + 0.7}{5}$$

$$= 0.44 \text{ m}$$

Relative error $= \frac{\Delta w_{mean}}{w_{mean}} = \frac{0.44}{5.2} =$ **0.084**

The relative error in width of footpath is **0.084**.

Q.94. A factory owner kept five identical spheres between two wooden blocks on a ruler as shown in figure. He called all his workers and told them to take reading, to check their efficiency and knowledge.



i. What is the area of central sphere?

ii. What is the absolute error in reading of diameter of second sphere?

Ans:

i. From above diagram radius of central sphere is r = 1 cm

$\therefore$ Area $= \pi r^2 = 3.142 \times (1)^2 =$ **3.142 cm^2**

The area of central sphere is **3.142 cm^2**.

ii. Mean value of all reading of diameters

$$d_{mean} = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5} = \frac{2 + 2 + 2 + 2 + 2}{5}$$

$$= \frac{10}{5} = 2 \text{ cm}$$

Absolute error in reading of second sphere.

$\Delta d_2 = |d_{mean} - d_2| = 2 - 2 = 0$

The absolute error in reading of diameter of second sphere is **zero.**

Q.95. A potential difference of V = 100 ± 2 volt, when applied across a resistance R gives a current of 10 ± 0.5 ampere. Calculate percentage error in R given by R = V/I.

Ans: Here, V = 100 ± 2 volt and I = 10 ± 0.5 ampere

Expressing limits of error as percentage error,

We have

$$V = 100 \text{ volt} \pm \frac{2}{100} \times 100\% = 100 \text{ volt} \pm 2\%$$

and $I = 10 \text{ ampere} \pm \frac{0.5}{10} \times 100\%$

$= 10 \text{ ampere} \pm 5\%$

$\therefore$ $R = \frac{V}{I}$

$\therefore$ % error in R = % error in V + % error in I

$= 2\% + 5\% =$ **7%**

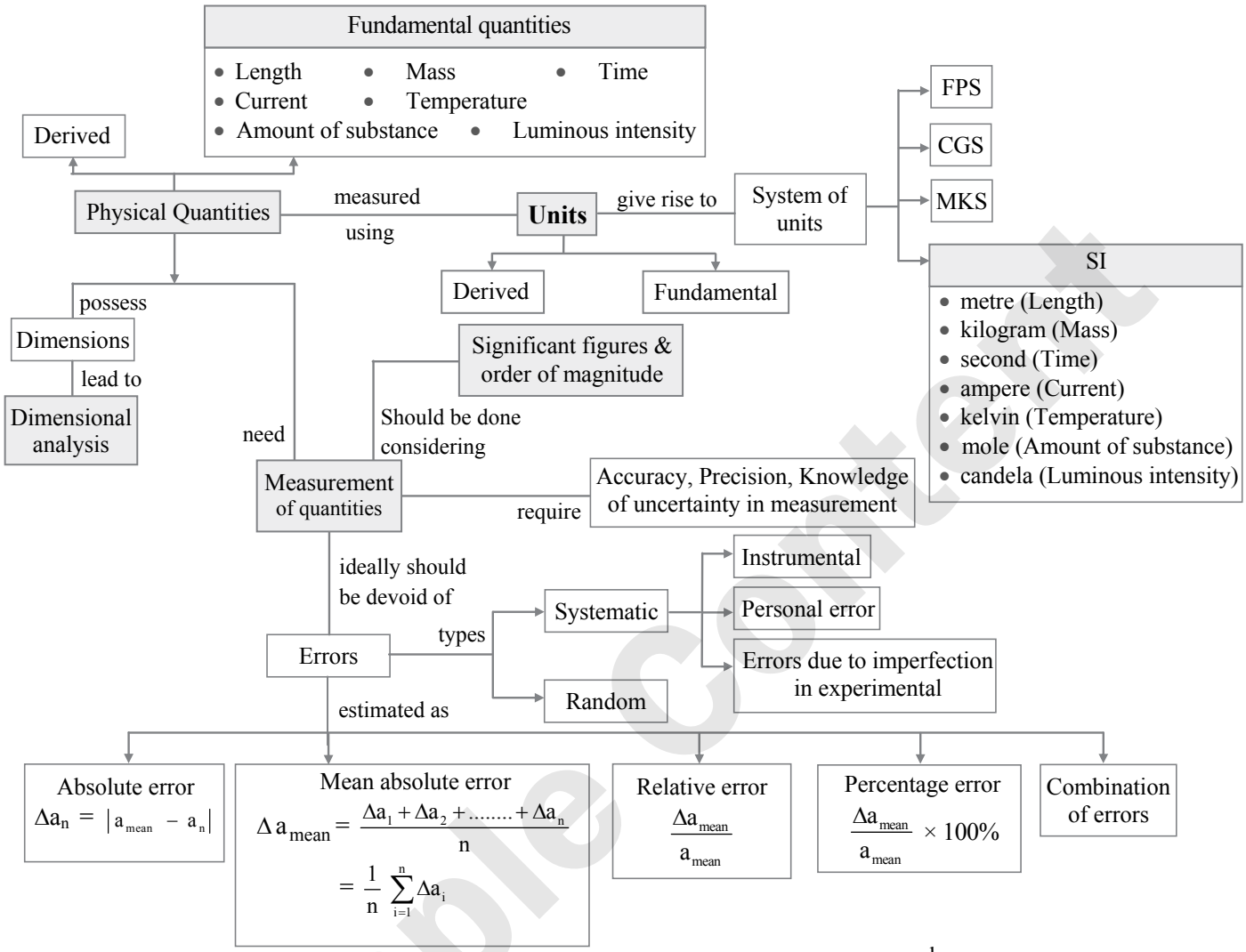
Q.96. Internet my friend *(Textbook page no.12)*

i. videolectures.net/mit801f99_lewin_lec01/

ii. hyperphysics.phy-astr.gsu.edu/hbase/hframe.html

[Students can use links given above as reference and collect information about units and measurements.]

QUICK REVIEW



IMPORTANT FORMULAE

1. **Measure of physical quantity:**
   $M = nu$
   where, n = numerical value, u = unit

2. **Relation between numerical value and size of unit:**
   $n_1u_1 = n_2u_2$

3. **Conversion factor of a unit in two system of units:**
   $$n = \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$$

4. **Plane angle:** $d\theta = \frac{ds}{r}$

5. **Solid angle:** $d\Omega = \frac{dA}{r^2}$

6. **Parallax angle:** $\theta = \frac{b}{D}$

7. **Diameter of planet/star:** $d = \alpha D$.

8. **Average value or mean value:**
   $$a_{mean} = \frac{a_1 + a_2 + a_3 + .. + a_n}{n} = \frac{1}{n}\sum_{i=1}^{n} a_i$$

9. **Absolute error**
   = | Average value – Measured value |
   $|\Delta a_n| = |a_{mean} - a_n|$

10. **Mean absolute error:**
    $$\Delta a_{mean} = \frac{\Delta a_1 + \Delta a_2 + ... + \Delta a_n}{n} = \frac{1}{n}\sum_{i=1}^{n}\Delta a_i$$

11. **Relative (fractional) error** $= \frac{\Delta a_{mean}}{a_{mean}}$

12. **Percentage error** $= \frac{\Delta a_{mean}}{a_{mean}} \times 100\,\%$

13. If $Z = A \pm B$, then maximum error:
$\Delta Z = \pm (\Delta A + \Delta B)$

14. If $Z = AB$ or $Z = \frac{A}{B}$ then,

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

15. If $Z = A^m \times B^n$, then error in measurement:

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

Various prefixes to express a physical quantity:

Prefix	Symbol	Power of 10	Prefix	Symbol	Power of 10
Tera	T	10^{12}	micro	μ	10^{-6}
Giga	G	10^{9}	nano	n	10^{-9}
Mega	M	10^{6}	angstrom	Å	10^{-10}
Kilo	k	10^{3}	pico	p	10^{-12}
milli	m	10^{-3}	femto	f	10^{-15}

EXERCISE

Theory Questions for Practice

1.1 Introduction

1. Define the term physical quantity. **[1 Mark]**
Ans: It is defined as a quantity that can be measured, e.g. mass, length, time, etc.

2. Define unit of physical quantity. **[1 Mark]**
Ans: *Refer Q.3. (i).*

1.2 System of Units

3. Describe F.P.S and M.K.S system. **[1 Mark]**
Ans: *Refer Q.4.*

4. Describe C.G.S and SI system. **[1 Mark]**
Ans: *Refer Q.4.*

5. Compare plane angle and solid angle. **[2 Marks]**
Ans: *Refer Q.7.*

6. State the values of A.U. and Å in terms of S.I. unit (metre). **[1 Mark]**
Ans: 1 A.U. = 1.496×10^{11} m and 1 Å = 10^{-10} m.

1.3 Measurement of Length

7. Explain the method to determine the distance of a planet from the Earth. **[3 Marks]**
Ans: *Refer Q.19.*

1.4 Measurement of Mass

8. What is atomic mass unit (amu)? Why is element carbon used to define it? **[2 Marks]**
Ans: *Refer Q.27 (iii) and Q.28.*

1.5 Measurement of time

9. Why was solar day rejected as a unit of time? **[2 Marks]**
Ans: *Refer Q.29.(ii)*

10. How many years forms a century? **[1 Mark]**
Ans: 100 years

11. Name the most accurate clock. **[1 Mark]**
Ans: Cesium atomic clock.

1.6 Dimensions and Dimensional Analysis

12. What are the dimensions of power? **[1 Mark]**
Ans: $[L^2M^1T^{-3}]$

13. What are the dimensions of frequency? **[1 Mark]**
Ans: $[L^0M^0T^{-1}]$

14. State the conversion factor between S.I. and CGS units of force using dimensional analysis. **[1 Mark]**
Ans: Conversion factor = 10^5 i.e., 1 N = 10^5 dyne.

15. Find the dimensional correctness of kinematical equations: $v = u + at$ **[2 Marks]**
Ans: *Refer Q.35.*

16. Check the correctness of $T = 2\pi\sqrt{\frac{l}{g}}$ **[3 Marks]**
Ans: *Refer Q.36.*

17. Find the conversion factor between the S.I. and the C.G.S. units of work using dimensional analysis. **[2 Marks]**
Ans: *Refer Q.37.*

18. State the principle of homogeneity of dimensions. **[1 Mark]**
Ans: *Refer Q. 33*

1.7 Accuracy, Precision and Uncertainty in Measurements

19. What are the reasons that may introduce possible uncertainties in an observation? **[2 Marks]**
Ans: *Refer Q.55.*

20. Define accurate measurement. **[1 Mark]**
Ans: A given mearurement is said to be accurate in relation to other measurement if the error involved is least.

21. Define precise measurement. **[1 Mark]**
Ans: A given mearurement is said to be precise in relation to other measurement if the measurement is recorded with the instruments having mimnimum least count.

1.8 Errors in Measurements

22. Explain:
i. Arithmetic mean ii. absolute error
iii. relative error iv. percentage error
v. mean absolute error **[1 Mark Each]**
Ans: *Refer Q.62.*

1.9 Significant figures

23. Define significant figures. **[1 Mark]**

Ans: *Refer Q.81. (only definition)*

24. What are the rules for determining significant figures? **[2 Marks]**

Ans: *Refer Q.81. (only rules)*

25. What is order of magnitude? Explain with two examples. **[2 Marks]**

Ans: *Refer Q.84.*

Numericals for Practice

1.3 Measurement of Length

1. A binary or double star system is 60.4 light years away. The angular separation between them is 0.20 mrad. Consider both the stars to be at the same distance from the earth. What is the distance between them? **[2 Marks]**

Ans: 0.01208 light year

1.6 Dimensions and Dimensional Analysis

2. The density of mercury is 13.6 g/cm^3. Calculate its density in kg/m^3 using dimensional analysis. **[2 Marks]**

Ans: 13.6×10^3 kg m^{-3}

3. Value of pressure exerted on a body is 1 dyne/cm^2 . What will be its value in S.I. unit? (Use dimensional analysis) **[2 Mark]**

Ans: 0.1 N/m^2

1.8 Errors in Measurements

4. Error in the measurement of radius of a sphere is 1%. Then error in the measurement of volume will be? **[1 Mark]**

Ans: 3%

5. The length of a rod as measured in an experiment was found to be 2.48 m, 2.46 m, 2.49 m, 2.50 m and 2.48 m. Find the mean absolute error, relative error and percentage error. **[3 Marks]**

Ans: i. 0.0104 m ii. 0.004 m
iii. 0.4%

6. The length of a metal plate was measured using Vernier callipers of least count 0.01 cm. The measurement made were 4.11 cm, 4.13 cm, 4.21 cm and 4.09 cm. Find the mean length, the mean absolute error, relative error and the percentage error in the measurement of length. **[3 Marks]**

Ans: i. 4.135 cm ii. 0.0375 cm
iii. 9.068×10^{-3} iv. 0.906%

1.9 Significant figures

7. Add 3.8×10^{-6} and 4.2×10^{-5} with due regards to significant figures. **[1 Mark]**

Ans: 4.6×10^{-5}

8. Two different masses are determined as (23.7 ± 0.5) g and (17.6 ± 0.3) g. What is the sum of their masses? **[1 Mark]**

Ans: 41.3 ± 0.8 g

9. If three measurements made are 18.425 cm, 7.21 cm and 5.0 cm. Write its addition up to proper significant figures. **[1 Mark]**

Ans: 31cm

10. The length, breadth and thickness of a rectangular sheet of metal are 4.658 m, 1.356 m and 2.04 cm respectively. Give the area and volume of the sheet to correct significant figures. **[3 Marks]**

Ans: i. 12.88 m^2 ii. 0.1288 m^3

11. The acceleration due to gravity at a place is 9.8 ms^{-2}. Find its value in km h^{-2} and its order of magnitude for that value. **[2 Marks]**

Ans: i. 127008 km/h^2 ii. 5

12. Find the order of magnitude of following data.
    i. Height of a tower 4325 m
    ii. Weight of a car 789 kg
    iii. Charge on electron 1.6×10^{-19} C

[3 Marks]

Ans: i. 3 ii. 3 iii. –19

13. Round off the following numbers as indicated
    i. 15.654 upto 3 digits
    ii. 1426 upto 5 digits
    iii. 5.996×10^5 upto 3 digits
    iv. 0.06218 upto 4 digits
    v. 2.663 upto 3 digits
    vi. 6.221 upto 2 digits

[1 Mark Each]

Ans: i. 15.6 ii. 1426.0
iii. 6.00×10^5 iv. 0.062
v. 2.66 vi. 6.2

14. Find the number of significant figures in the following numbers.
    i. 25.42 ii. 0.004567
    iii. 35.320 iv. 4.56×10^8
    v. 1.609×10^{19} vi. 91.000

[1 Mark Each]

Ans: i. 4 ii. 6 iii. 5
iv. 3 v. 4 vi. 5

15. What will be the kinetic energy of body if its mass is 2 kg and moving with a velocity of 2 m/s? Write its order of magnitude and significant figures. **[2 Marks]**

Ans: i. 4 J ii. 0 iii. 1

Scan the given Q. R. Code in *Quill - The Padhai App* to view the Solutions to the Numericals for Practice.

MULTIPLE CHOICE QUESTIONS

[1 Mark Each]

1. A physical quantity may be defined as
   (A) the one having dimension.
   (B) that which is immeasurable.
   (C) that which has weight.
   (D) that which has mass.

2. Which of the following is the fundamental unit?
   (A) Length, force, time
   (B) Length, mass, time
   (C) Mass, volume, height
   (D) Mass, velocity, pressure

3. Which of the following is NOT a fundamental quantity?
   (A) Temperature (B) Electric charge
   (C) Mass (D) Electric current

*4. Which of the following is not a fundamental unit?
   (A) cm (B) kg
   (C) centigrade (D) volt

5. The distance of the planet from the earth is measured by _____.
   (A) direct method
   (B) directly by metre scale
   (C) spherometer method
   (D) parallax method

6. The two stars S_1 and S_2 are located at distances d_1 and d_2 respectively. Also if $d_1 > d_2$ then following statement is true.
   (A) The parallax of S_1 and S_2 are same.
   (B) The parallax of S_1 is twice as that of S_2
   (C) The parallax of S_1 is greater than parallax of S_2
   (D) The parallax of S_2 is greater than parallax of S_1

7. Which of the following is NOT a unit of time?
   (A) Hour (B) Nano second
   (C) Microsecond (D) parsec

*8. Light year is a unit of
   (A) time (B) mass
   (C) distance (D) luminosity

9. An atomic clock makes use of _____.
   (A) cesium-133 atom (B) cesium-132 atom
   (C) cesium-123 atom (D) cesium-131 atom

10. S.I. unit of energy is joule and it is equivalent to
   (A) 10^6 erg (B) 10^{-7} erg
   (C) 10^7 erg (D) 10^5 erg

11. $[L^1M^1T^{-1}]$ is an expression for _____.
   (A) force (B) energy
   (C) pressure (D) momentum

12. Dimensions of sin θ is
   (A) $[L^2]$ (B) [M]
   (C) [ML] (D) $[M^0L^0T^0]$

*13. $[L^1M^1T^{-2}]$ is the dimensional formula for
   (A) velocity (B) acceleration
   (C) force (D) work

*14 Dimensions of kinetic energy are the same as that of
   (A) force (B) acceleration
   (C) work (D) pressure

15. Accuracy of measurement is determined by
   (A) absolute error (B) percentage error
   (C) human error (D) personal error

16. Zero error of an instrument introduces _____.
   (A) systematic error (B) random error
   (C) personal error (D) decimal error

17. The diameter of the paper pin is measured accurately by using _____.
   (A) vernier callipers
   (B) micrometer screw gauge
   (C) metre scale
   (D) a measuring tape

*18. The error in the measurement of the sides of a rectangle is 1%. The error in the measurement of its area is
   (A) 1%
   (B) 1/2%
   (C) 2%
   (D) None of the above.

19. The number of significant figures in 11.118×10^{-6} is
   (A) 3 (B) 4 (C) 5 (D) 6

20. 0.00849 contains _____ significant figures.
   (A) 6 (B) 5 (C) 3 (D) 2

21. 3.310×10^2 has _____ significant figures.
   (A) 6 (B) 4 (C) 2 (D) 1

22. The Earth's radius is 6371 km. The order of magnitude of the Earth's radius is
   (A) 10^3 m (B) 10^9 m
   (C) 10^7 m (D) 10^2 m

23. _____ is the smallest measurement that can be made using the given instrument
   (A) Significant number
   (B) Least count
   (C) Order of magnitude
   (D) Relative error

ANSWERS TO MULTIPLE CHOICE QUESTIONS

1.	(A)	2.	(B)	3.	(B)	4.	(D)
5.	(D)	6.	(D)	7.	(D)	8.	(C)
9.	(A)	10.	(C)	11.	(D)	12.	(D)
13.	(C)	14.	(C)	15.	(B)	16.	(A)
17.	(B)	18.	(C)	19.	(C)	20.	(C)
21.	(B)	22.	(C)	23.	(B)		

HINTS TO MULTIPLE CHOICE QUESTIONS

18. $A = l \times b$

$\therefore \quad \frac{\Delta A}{A} = \frac{\Delta l}{l} + \frac{\Delta b}{b} = 1\% + 1\% = 2\%$

COMPETITIVE CORNER

1. A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi\varepsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and e is charge]: **[NEET (UG) 2017]**

(A) $\frac{1}{c^2}\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$ (B) $c^2\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

(C) $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$ (D) $\frac{1}{c}G\frac{e^2}{4\pi\varepsilon_0}$

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

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

Now,
Dimensions of velocity of light $[c]^x = [LT^{-1}]^x$
Dimensions of universal gravitational constant $[G]^y = [L^3T^{-2}M^{-1}]^y$

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

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

2. The following observations were taken for determining surface tension T of water by capillary method: diameter of capillary, $D = 1.25 \times 10^{-2}$ m rise of water, $h = 1.45 \times 10^{-2}$ m. Using $g = 9.80\ m/s^2$ and the simplified relation $T = \frac{rhg}{2} \times 10^3$ N/m, the possible error in surface tension is closest to: **[JEE (Main) 2017]**

(A) 0.15 % **(B) 1.5 %**
(C) 2.4 % (D) 10 %

Hint: $D = 1.25 \times 10^{-2}$ m; $h = 1.45 \times 10^{-2}$ m
The maximum permissible error in D
$= \Delta D = 0.01 \times 10^{-2}$ m
The maximum permissible error in h
$= \Delta h = 0.01 \times 10^{-2}$ m
g is given as a constant and is errorless.

$$T = \frac{rhg}{2} \times 10^3 \text{ N/m}$$

$$= \frac{dhg}{4} \times 10^3 \text{ N/m}$$

$\therefore$ % error $\frac{\Delta T}{T} = \frac{\Delta d}{d} + \frac{\Delta h}{h}$

$\therefore \quad \frac{\Delta T}{T} \times 100 = \frac{\Delta d}{d} \times 100 + \frac{\Delta h}{h} \times 100$

$$= \left(\frac{0.01 \times 10^{-2}}{1.25 \times 10^{-2}} + \frac{0.01 \times 10^{-2}}{1.45 \times 10^{-2}}\right) \times 100$$

$$= \frac{100}{125} + \frac{100}{145}$$

$\therefore \quad \frac{\Delta T}{T} = 0.8\ \% + 0.7\ \% = 1.5\ \%$

3. A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and zero of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of – 0.004 cm, the correct diameter of the ball is **[NEET (UG) 2018]**

(A) 0.521 cm (B) 0.525 cm
(C) 0.053 cm **(D) 0.529 cm**

Hint: Least count of screw gauge = 0.001 cm
= 0.01 mm
Main scale reading = 5 mm,
Zero error = – 0.004 cm = – 0.04 mm
Zero correction = +0.04 mm

$$\text{Observed reading} = \text{Mainscale reading} + (\text{Division} \times \text{least count})$$

Observed reading = 5 + (25 × 0.01) = 5.25 mm

$$\text{Corrected reading} = \text{Observed reading} + \text{zero correction}$$

Corrected reading = 5.25 + 0.04
= 5.29 mm = 0.529 cm

4. The density of the material in the shape of a cube is determined by measuring three sides of the cube and its mass. If the relative errors in measuring the mass and length are respectively 1.5% and 1%, the maximum error in determining the density is: **[JEE (Main) 2018]**

(A) 4.5% (B) 6% (C) 2.5% (D) 3.5%

Page no. **28** are purposely left blank.

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

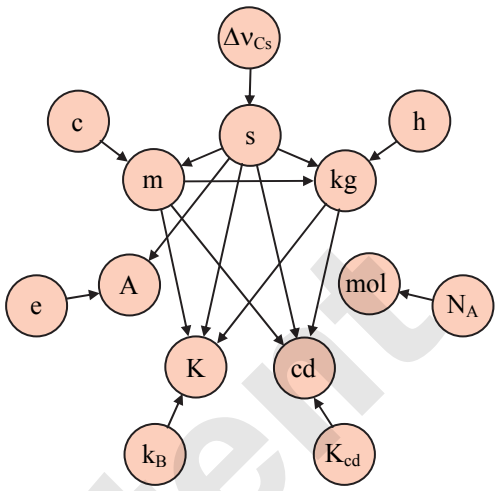
ENRICH YOUR KNOWLEDGE

(Textbook page no.13)

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 standardisation 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})



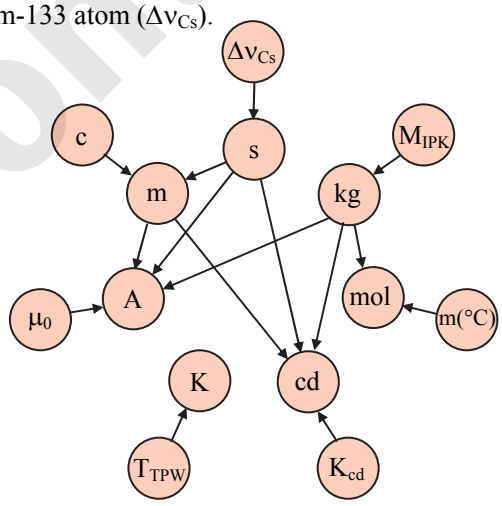
New SI

The figures show the dependency of various units upon their respective constants and other units (wherever used).

The arrows arriving at that unit refer to the constant and the fundamental unit (or units, wherever used) for defining that unit. The arrows going away from a unit indicate other units which use this unit for their definition.

For example, The newly defined unit *kilogram* uses Planck constant, the *metre* and the *second*, while the *kilogram* itself is used in defining the *kelvin* and the *candela*. This definition relates the *kilogram* to the equivalent mass of the energy of a photon given its frequency, via the Planck constant.

Given below, refers to the corresponding definitions before 20 May 2019 to offer quick comparision to know which definitions are modified and how.



Old SI

Time: 1 Hour 30 Min | **TOPIC TEST** | **Total Marks: 25**

SECTION A

Q.1. Select and write the correct answer: **[04]**

i. Dimensions of work are the same as that of
(A) force (B) acceleration (C) energy (D) pressure

ii. 0.00001028 contains _____ significant figures.
(A) 6 (B) 5 (C) 4 (D) 2

iii. Which of the following is not a fundamental unit?
(A) metre (B) ampere (C) candela (D) ohm

iv. The error in the measurement of the sides of a rectangle is 3%. The error in the measurement of its area is
(A) 1% (B) 1/2% (C) 6% (D) None of the above.

Q.2. Answer the following: **[03]**

i. Define mean absolute error.

ii. If the measured values of two quantities are A ± ΔA and B ± ΔB, ΔA and ΔB being the mean absolute errors. What is the maximum possible error in A ± B?

iii. State the order of magnitude of electron of mass 9.1×10^{-31} kg.

SECTION B

Attempt any Four: **[08]**

Q.3. What are the dimensions of the quantity $l\sqrt{l/g}$, l being the length and g the acceleration due to gravity?

Q.4. When the planet Jupiter is at a distance of 824.7 million kilometers from the Earth, its angular diameter is measured to be 35.72″ of arc. Calculate the diameter of the Jupiter.

Q.5. Star A is farther than star B. Which star will have the smaller parallax angle?

Q.6. If the formula for a physical quantity is $X = \frac{a^4 b^3}{c^{1/3} d^{1/2}}$ and if the percentage error in the measurements of a, b, c and d are 2%, 3%, 3% and 4% respectively. Calculate percentage error in X.

Q.7. $v = at + \frac{b}{t+c} + v_0$ is a dimensionally valid equation. Obtain the dimensional formula for a, b and c where v is velocity, t is time and v_0 is initial velocity.

Q.8. State the limitations of dimensional analysis.

SECTION C

Attempt any Two: **[06]**

Q.9. An electron with charge e enters a uniform magnetic field $\vec{B}$ with a velocity $\vec{v}$. The velocity is perpendicular to the magnetic field. The force on the charge e is given by $|\vec{F}| = B\ e\ v$. Obtain the dimensions of $\vec{B}$.

Q.10. Time period of a simple pendulum depends upon the length of pendulum (l) and acceleration due to gravity (g). Using dimensional analysis, obtain an expression for time period of a simple pendulum.

Q.11. In Ohm's experiments, the values of the unknown resistances were found to be 6.12 Ω, 6.09 Ω, 6.22 Ω, 6.15 Ω. Calculate the (mean) absolute error, relative error and percentage error in these measurements.

SECTION D

Attempt any One: **[04]**

Q.12. i. List reasons that may introduce possible uncertainties in an observation.

ii. The masses of two bodies are measured to be 15.7 ± 0.2 kg and 27.3 ± 0.3 kg. What is the total mass of the two and the error in it?

Q.13. i. Define what is meant by significant figures.

ii. The length, breadth and thickness of a rectangular sheet of metal are 4.234 m, 1.005 m and 2.01 cm respectively. Give the area and volume of the sheet to correct significant figures.

Scan the given Q. R. Code in *Quill - The Padhai App* to view the solutions of the Topic Test.

Give your XI[th] exam preparation the

TECHNOLOGY BOOST!

Practice more than
4,500 MCQs
for just ₹499/-

Use Coupon Code
QUILLPADHAI2023

Also available for X[th], XII[th], MHT-CET, NEET & JEE

- Practice chapter-wise & full syllabus MCQs in test format
- Get instant verification of your answer
- Detailed analysis of every test on completion
- Option to save questions for future reference

Scan QR Code to download the app

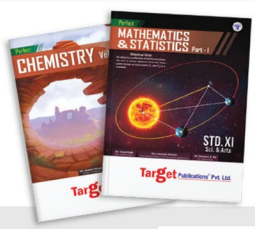
Visit our website to know more about our range of books for **X[th], XII[th], MHT-CET, NEET & JEE**

Visit Our Website

Target Publications® Pvt. Ltd.
Transforming lives through learning.

Address:
B2, 9th Floor, Ashar, Road No. 16/Z,
Wagle Industrial Estate, Thane (W)- 400604

Tel: 88799 39712 / 13 / 14 / 15
Website: www.targetpublications.org
Email: mail@targetpublications.org



Explore our range of **STD. XI Sci.** Books