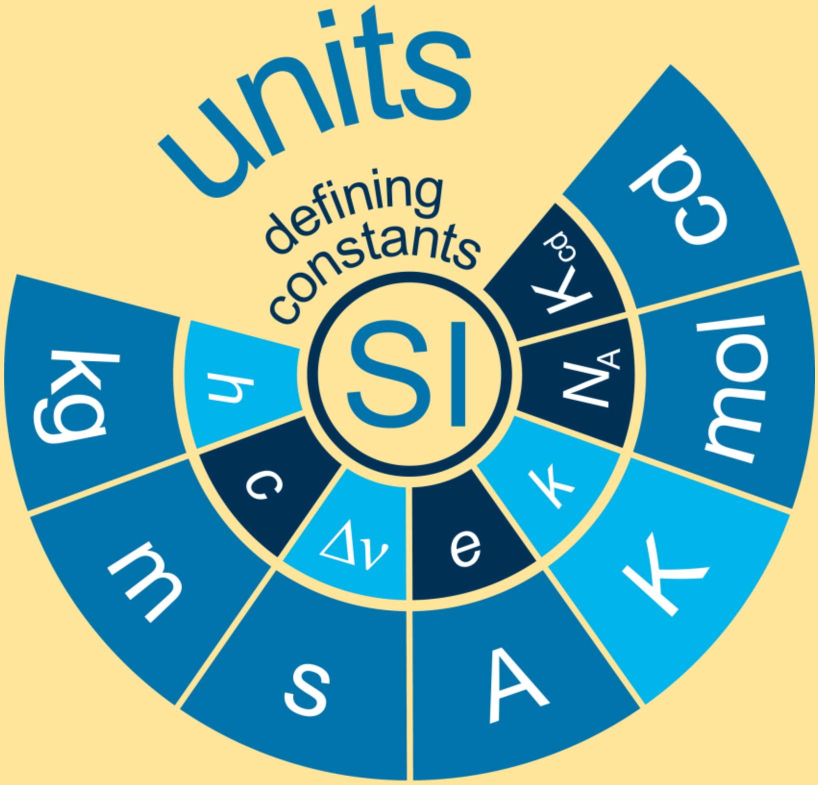
02.Physical World, Units and Measurements



Physics Smart Booklet

Theory + NCERT MCQs + Topic Wise Practice MCQs + NEET PYQs

Units And Measurments

Physical Quantity

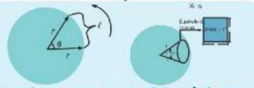
- Quantities which can be measured by an instrument and used to describe laws of physics are physical quantities
- Physical quantity = Numerical value (N) × Unit (U)

45 kg — Numerical Value, Unit

TYPES

Fundamental quantities do not depend upon other quantities:
(1) Length (2) Mass (3) Time
(4) Temperature
(5) Amount of substance
(6) Electric current
(7) Luminous intensity

- Derived quantities are formed by combining more than one fundamental physical quantities
- Area, volume, velocity and acceleration are some derived quantities



Two supplementary S.I units are:-

(1) Radian(plane angle)
. $Q = \dfrac{arc}{radius}$

(2) Steradian (solid angle).
$\Omega = \dfrac{arc}{(radius)^2}$

UNITS

(1) Unit is defined as the reference standard used for measurements.
(2) Measurements consists of a numerical value along with a relevant unit.
(3) Example: meter, newton, joule, seconds etc.

MKS (m, kg, s)	CGS (m, gm, s)	FPS (ft, pound, s)

S.I Units

- The system of units accepted internationally
- S.I units of time is 'sec' is the example of S.I system

Dimensional Analysis

Dimension formula is the expression for the unit of a physical quantity in terms of the fundamental quantities

Dimensional formula is expressed in terms of power of M, L and T.

Principle of Homogenity

Principle of homogeneity states that the dimension of each term on both sides of dimensional equation should be same.

Primary or fundamental Dimensional formula

There are seven fundamental dimensional formulas:
(1) Mass = [M], (2) Length = [L], (3) Time = [T],
(4) Temperature = [K] or [Q], (5) Electric Current = [I], (6) Luminous intensity = [cd],
(7) amount of matter = [mol]

Secondary or derived dimensional formula

(i) Other than fundamental formula all other are derived dimensional formula
(ii) example: (1) [speed] = [MoLIT-1],
(2) [Acceleration) = [MoLIT2]

Conversion of units from are system to another

$$N_2 = N_1 \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$$

N1 = Numerical part of one system
N2 = Numerical part of another system

Know your LCROS (Significant Figures)

The number of digits in the measured values about the correctness are known as significant figures.

Trailing zero digits are significant only when they appear after decimal 4.00 - 3 Sf: 0.043010 - 5 Sf

All non - zero digits are significant
4.125 - 4 Sf:
123 - 3 Sf

Leading zeroes i.e . are never significant placed to the left of the number
0.0403 - 3 Sf:
0.04030 - 4 Sf

10.9 - 3 Sf:
400.001 - 4 Sf
All zero lie in between the non - zero digits are significant

Order of magnitude is not considered
38.3 × 104 - 3 Sf:
38.30 × 10-9 - 4 Sf

Constants and pure numbers have infinite significant figures:

Some other units

(1) mass:- 1 quintal = 100 kg. 1 ton = 1000 kg
(2) length:- 1 light year = 9.46 × 1015 m
1 au = 1.496 × 1011 m
(3) Temperature: 0o C = 273 K 1o F = 255.928 K

Order of Magnitude

It is defined as the power of 10 which is closest to its magnitude

N = N × 10x: x = order of magnitude.

6.022×10^{23} — coefficient, exponent, base

Rule of Rounding off

- Rules of rounding off the uncertain digits (up to 3 significant figures)

If digit > 5 then, preceding digit +1

If digit <5 then, preceding digit remain same

If insignificant digit = 5:
(a) Preceding digit remain same when rounded off digit is even.:
(b) Preceding digit +1 when rounded off digit is odd

Accuracy

Accuracy is degree of closeness of measured value to the true value: shows that how closely the results with the standard value.

Preccision

Precision is the range of variation of true value during several observation

Errors

The uncertainty in measurement is called errors
- Error = true value – measured value

Types of Error

Absolute Error. = true value – measured value

Mean absolute errors

$$\Delta\alpha_{mean} = \frac{|\Delta\alpha_1| + |\Delta\alpha_2| + \ldots\ldots\ldots\ldots + |\Delta\alpha_n|}{n}$$

Relative error

$$\frac{\Delta\alpha_{mean}}{\alpha_{mean}}$$

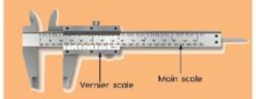
Percentage error.

is difference the measured value and the true value as a percentage of true value
Percentage error

$$\frac{\Delta\alpha_{mean}}{\alpha_{mean}} \times 100$$

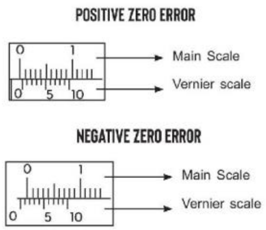
Vernier Callipers

Least Count (L.C) = 1 MSD – 1 VSD: MSD = main scale division: VSD = vernier scale division



Total reading = Main Scale Reading +(Vernier Coincidence × least count)

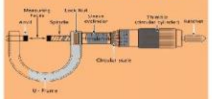
Zero error = N × L.C:
N = No. of coinciding division:
L.C = least count of an instrument.



Pitch =

$$\text{Pitch} = \frac{\text{displacement of screw}}{\text{no. of rotations}}$$

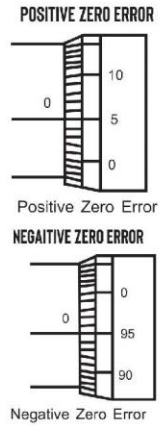
$$\text{L.C.} = \frac{\text{Pitch}}{\text{total no. of divisions}}$$



Zero error = N × L.C

N = No. of circular scale division that coincides with the reference line

L.C = Least Count



PHYSICAL WORLD

Physics

- Physics deals with the study of the basic laws of nature and their manifestation in different phenomena. The basic laws of physics are universal and are applied in widely different contexts and conditions.

Physics, Technology and Society

- Science, Technology and Society have strong relationships among one on other. Science is the mother of technology and both of them are the reasons for the creation and development of the society.
- Science and technology issues are actually discussed worldwide today. Progress in this has led to produce the ability to integrate different types of physical products.
- Physics is a basic discipline in the category of natural sciences which also includes other disciplines like Chemistry and Biology. The word physics comes from a Greek word meaning nature.

Fundamental forces in nature :

- There are four fundamental forces in nature. They are the 'gravitational force', the 'electromagnetic force', the 'strong nuclear force', and the 'weak nuclear force'. Unification of different forces/domains in nature is a basic quest in physics.

Nature of physical laws :

- (i) The physical quantities that remain unchanged in a process are called conserved quantities. Some of the general conservation laws in nature include the laws of conservation of mass, energy, linear momentum, angular momentum, charge, etc. Some conservation laws are true for one fundamental force but not for the other.

  (ii) Conservation laws have a deep connection with symmetries of nature. Symmetries of space and time, and other types of symmetries play a central role in modern theories of fundamental forces in nature.

1.Some physicists from different countries of the world and their major contributions

Name	Major contribution /Discovery	Country of Origin
Archimedes	Principle of buoyancy; Principle of the lever	Greece
Galileo Galilei	Law of inertia	Italy
Christiaan Huygens	Wave theory of light	Holland
Isaac Newton	Universal law of gravitation ; Laws of motion ; Reflecting telescope	U.K.
Michael Faraday	Laws of electromagnetic induction	U.K.
James Clerk Maxwell	Electromagnetic theory; Light - an electromagnetic wave	U.K.
Heinrich Rudolf Hertz	Generation of electromagnetic waves	Germany
J.C. Bose	Short radio waves	India
W.K.Roentgen	X-rays	Germany
J.J. Thomson	Electron	U.K.
Marie sklodowska Curie	Discovery of radium and polonium; Studies on natural radio activity	poland
Albert Einstein	Explanation of photoelectric effect;Theory of relativity	Germany
Victor Francis Hess	Cosmic radiation	Austria
R.A. Millikan	Measurement of electronic charge	U.S.A.
Ernest Rutherford	Nuclear model of atom	New Zealand
Niels Bohr	Quantum model of hydrogen atom	Denmark
C.V. Raman	Inelastic scattering of light by molecules	India
Louis Victor de Broglie	Wave nature of matter	France
M.N. Saha	Thermal ionisation	India
S.N. Bose	Quantum statistics	India

Wolfgang Pauli	Exclusion principle	Austria
Enrico Fermi	Controlled nuclear fission	Italy
Werner Heisenberg	Quantum mechanics; Uncertainity principle	Germany
Paul Dirac	Relativistic theory of electron; Quantum statistics	U.K.
Edwin Hubble	Expanding universe	U.S.A.
Ernest Orlando Lawrence	Cyclotron	U.S.A.
James Chadwick	Neutron	U.K.
Hideki Yukawa	Theory of nuclear forces	Japan
Homi Jehangir Bhabha	Cascade process of cosmic radiation	India
Lev Davidovich Landau	Theory of condensed matter; Liquid helium	Russia
S.Chandrasekhar	Chandrasekhar limit, structure and evolution of stars	India
John Bardeen	Transistors ; Theory of super conductivity	U.S.A.
C.H. Townes	Maser; Laser	U.S.A.
Abdus Salam	Unification of weak and electromagnetic interactions	Pakistan

2) Link between technology and physics

Technology	Scientific principle (s)
Steam engine	Laws of thermodynamics
Nuclear reactor	Controlled nuclear fission
Radio and Television	Generation, propagation and detection of electromagnetic waves
Computers	Digital logic
Lasers	Light amplification by stimulated emission of radiation
Production of ultra high magnetic fields	Superconductivity
Rocket propulsion	Newton's laws of motion
Electric generator	Faraday's laws of electromagnetic induction
Hydroelectric power	Conversion of gravitational potential energy into electrical energy
Aeroplane	Bernoulli's principle in fluid dynamics
Particle accelerators	Motion of charged particles in electromagnetic fields
Sonar	Reflection of ultrasonic waves
Optical fibres	Total internal reflection of light
Non-reflecting coatings	Thin film optical interference
Electron microscope	Wave nature of electrons
Photocell	Photoelectric effect
Fusion test reactor (Tokamak)	Magnetic confinement of plasma
Giant Metrewave Radio Telescope (GMRT)	Detection of cosmic radio waves
Bose-Einstein condensate	Trapping and cooling of atoms by laser beams and magnetic fields

Units and Measurements

2.1 Units

Fundamental quantities

The physical quantities which are independent of other quantities are called fundamental quantities.

Example: Mass, length, time etc.

Quantities are those which can be measured using an instrument. Any physical phenomenon or observation that can be measured using an instrument is called **quantity.**

Derived quantities

The physical quantities which are derived from fundamental quantities are known as derived quantities.

Example: Density, volume, speed, force etc.

The SI system of units

In 1971, General conference of weights and measures introduced a logical and rationalized system of units known as international system of units, abbreviated as SI in all languages. In this system, there are seven fundamental quantities and two supplementary quantities.

Fundamental quantities and their units

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

Supplementary quantities and their units

S. No.	Physical quantity	Unit	Symbol
1.	Plane angle	radian	rad
2.	Solid angle	Steradian	Sr

Rules of writing unit

1. In writing the unit of any quantity, small letters must be used for symbol of unit. Eg., m, ms^{-1} etc.
2. Symbols are not followed by full stop.
3. If any unit is named after a scientist, its symbol should be initial capital letter. Eg., N(newton), W(watt), K(kelvin) etc.
4. The full name of a unit always begins with a small letter, even if it is named after a scientist.
   Eg., 5 N or 5 newton.
5. Symbols do not take plural form.

Some practical units

There are some practical units which are simultaneously used with SI units.

(i) 1 fermi = 10^{-15} m

(ii) 1 angstrom $(\overset{0}{A})$ = 10^{-10} m

(iii) 1 nanometer (nm) = 10^{-9} m

(iv) 1 micron (μm) = 10^{-6} m

(v) 1 light year = 9.46×10^{15} m

(vi) 1 astronomical unit (AU) = 1.496×10^{11} m

(vii) 1 parsec = 3.03×10^{18} m

(viii) 1 amu = 1.66×10^{-27} kg

(ix) 1 quintal = 100 kg

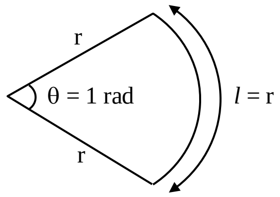
(x) 1 tonne = 1000 kg

(xi) 1 lunar month = 27.3 days

(xii) 1 Shake = 10^{-8} s

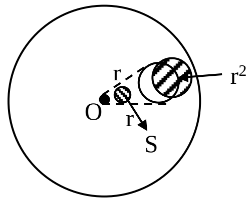
The two supplementary SI units are defined as follows

(i) Radian (rad) : 1 radian is the angle subtended at the centre of a circle by an arc equal in length to the radius of the circle.

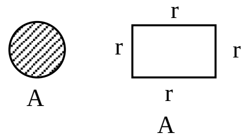


Thus, $\theta = \dfrac{\text{Arc}}{\text{radius}} = \dfrac{r}{r} = 1 \text{ rad}$

(ii) Steradian (Sr) : 1 steradian is the solid angle subtended at the centre of a sphere by a surface of the sphere equal in area to that of a square, having each side equal to the radius of sphere.



Thus, $\omega = \dfrac{\text{Surface area}}{(\text{Radius})^2} = \dfrac{r^2}{r^2} = 1 \text{ Sr}$



2.2 Dimensions of a physical quantity

The dimensions of a physical quantity are the powers to which the unit of fundamental quantities are raised to represent that quantity.

Dimensions of fundamental quantities

S. No.	Quantity	Dimensional formula
1.	Length	[L]
2.	Mass	[M]
3.	Time	[T]
4.	Electric current	[A]
5.	Temperature	[K]
6.	Luminous intensity	[Cd]
7.	Amount of substance	[mol]

The supplementary quantities i.e., plane angle and solid angle have no dimensions.

Dimensional equation

The equation obtained by equating a physical quantity with its dimensional formula is called dimensional equation of the given physical quantity. *Example*: Force = $[MLT^{-2}]$

∴ Dimensions of force are 1, 1 and –2 in mass, length and time respectively. Dimensional formula of force is $[MLT^{-2}]$.

"Force = $[MLT^{-2}]$" is called dimensional equation.

Dimensional formulas of some physical quantities

S. No.	Physical quantity	Relation with other quantities	Unit	Dimensional formula
1.	Force	Mass × acceleration	N	$[MLT^{-2}]$
2.	Work	Force × displacement	J	$[ML^2T^{-2}]$
3.	Pressure	Force/area	Nm^{-2}	$[ML^{-1}T^{-2}]$
4.	Force constant	Force/length	Nm^{-1}	$[ML^0T^{-2}]$
5.	Gravitational constant, G	$\text{Force} \times \dfrac{\text{distance}^2}{\text{mass}^2}$	$Nm^2\ kg^{-2}$	$[M^{-1}L^3T^{-2}]$
6.	Impulse	Force × time	Ns	$[MLT^{-1}]$
7.	Stress	Force/area	Nm^{-2}	$[ML^{-1}T^{-2}]$

8.	Strain	$\frac{\text{Change in dimension}}{\text{original dimension}}$	–	$[M^0L^0T^0]$
9.	Modulus of elasticity	Stress/strain	Nm^{-2}	$[ML^{-1}T^{-2}]$
10.	Surface tension	Force/length	Nm^{-1}	$[ML^0T^{-2}]$
11.	Coefficient of viscosity	$\frac{\text{Force} \times \text{distance}}{\text{Area} \times \text{velocity}}$	$Ns\ m^{-2}$	$[ML^{-1}T^{-1}]$
12.	Latent heat	$\frac{\text{Heat}}{\text{Mass}}$	$J\ kg^{-1}$	$[M^0L^2T^{-2}]$
13.	Electric charge	Current × time	C	$[M^0L^0TA]$
14.	Electric potential	Work/charge	JC^{-1} or V	$[ML^2T^{-3}A^{-1}]$
15.	Resistance	Potential/current	ohm(Ω)	$[ML^2T^{-3}A^{-2}]$
16.	Capacitance	$\frac{\text{Charge}}{\text{Potential}} = \frac{\text{Current} \times \text{time}}{\text{Potential}}$	Farad (F)	$[M^{-1}L^{-2}T^4A^2]$
17.	Inductance, L	$\frac{\text{Potential}}{\text{Current / time}}$	Henry (H)	$[ML^2T^{-2}A^{-2}]$
18.	Magnetic field, B	$\frac{\text{Force}}{\text{Charge} \times \text{velocity}}$	Tesla (T)	$[ML^0T^{-2}A^{-1}]$
19.	Planck's constant, h	$\frac{\text{Energy}}{\text{freqency}}$	Js	$[ML^2T^{-1}]$

Four types of physical quantities

(1) Dimensional constants: These are the physical quantities whose values are constant but they possess dimensions. Eg., Gravitational constant (G), Stefan's constant (σ) etc.

(2) Dimensional variables: These are the quantities whose values are variable and they possess dimensions. Eg., Volume, acceleration, force etc.

(3) Dimensionless constants: These are the physical quantities whose values are constant but they do not possess dimensions. Eg., 1, 2, 3, …… π etc.

(4) Dimensionless variables: These are quantities whose values are variable and they do not have dimensions. Eg., Angle, strain, relative density etc.

Principle of homogeneity of dimensions

According to this principle, the dimensions of all the terms occurring on both sides of the equations must be same.

Uses of Dimensional Analysis

(1) Conversion of unit of a derived physical quantity from one system of unit to another system of unit is based on the fact that product of numerical value contained in and the unit of physical quantity remains constant i.e., larger unit has smaller magnitude.

or

$Q = n_1u_1 = n_2u_2$

where n_1, n_2 are numeric values and u_1, u_2 are the two units of measurement of the physical quantity Q.

(2) To check the correctness of a physical relation. This is based on the principle of homogeneity of dimensions.

(3) Deriving the relation among the physical quantities: We can derive an expression of a physical quantity if we know the various factors on which it depends, by using the principle of homogeneity.

Let physical quantity X depends on other quantities P, Q and R, then we can write $X = K\ P^a\ Q^b\ R^c$.

Where K is a dimensionless constant, whose value can be determined by experiment or otherwise, but not by dimensions. By equating dimensions of both sides of equation, we can get required relation among the quantities.

Limitations of the dimensional analysis

1. By the method of dimensions, we cannot get any information about the dimensionless constant.
2. If a physical quantity depends on more than three factors, all having dimensions, the formula cannot be derived.
3. We cannot derive the formulas containing trigonometric functions, exponential functions, logarithmic functions etc.
4. The method of dimensions can't be used to derive the relation like $S = ut + \frac{1}{2}at^2$. [i.e., equations containing more than one term with + or – symbol on right side].
5. It gives no information whether a physical quantity is a scalar or vector.

Order of magnitude

It gives an idea about how big or how small a magnitude is. A number N can be expressed as:

$N = n \times 10^x$

If $0.5 < n \leq 5$, then N will be the order of magnitude of x.

Illustrations

1. The speed of light c, gravitational constant G and Planck's constant h are taken as the fundamental units in a system. Find the dimensional formulas of length and time in this new system of units.

Solution

$c = [LT^{-1}]$ ... (i)

$G = [M^{-1}L^3T^{-2}]$ ... (ii)

$h = [ML^2T^{-1}]$ ... (iii)

From equation (i), $c^3 = [L^3\,T^{-3}]$

From equations (ii) and (iii) $Gh = [L^5T^{-3}]$

$$\therefore \frac{Gh}{c^3} = L^2 \Rightarrow L = G^{\frac{1}{2}}\, h^{\frac{1}{2}}\, c^{\frac{-3}{2}}$$

$Gh = [L^5\,T^{-3}]$

$c^5 = [L^5\,T^{-5}]$

$$\frac{Gh}{c^5} = T^2 \Rightarrow T = G^{\frac{1}{2}}\, h^{\frac{1}{2}}\, c^{\frac{-5}{2}}$$

2. Check the equation $v^2 = u^2 + 2as$ is dimensionally correct or not. [Symbols have their usual meanings]

Solution

$v^2 = u^2 + 2as$

Dimensions of LHS $= [LT^{-1}]^2 = [L^2T^{-2}]$ . . . (i)

Dimensions of RHS $= [LT^{-1}]^2 + [LT^{-2}]\,[L] = [L^2\,T^{-2}] + [L^2\,T^{-2}]$

$= [L^2\,T^{-2}]$ . . . (ii)

From (i) and (ii) it is clear that the given equation is dimensionally correct.

3. If the centripetal force depends on the mass (m), velocity (v) and radius of path (r) for an object, find the formula for it.

Solution

Let force $F = k\,(\text{mass})^a\,(\text{velocity})^b\,(\text{radius})^c$

Writing dimensions on both the sides,

$[MLT^{-2}] = k\,[M]^a\,[LT^{-1}]^b\,[L]^c$

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

Comparing the powers on both the sides

$a = 1,\ b + c = 1$ and $-b = -2$

$b = 2 \Rightarrow 2 + c = 1 \Rightarrow c = -1$

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

$\therefore$ $F = k\,m^1\,v^2\,r^{-1}$ or $F = k\left(\frac{mv^2}{r}\right)$, k is a dimensionless constant.

4. The value of gravitation constant is $G = 6.67 \times 10^{-11}$ Nm^2 kg^{-2} in SI units. Convert it into units of CGS system.

Solution

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

Let $n_1\left[M^{-1}\,L_1^3\,T_1^{-2}\right] = n_2\left[M_2^{-1}\,L_2^3\,T_2^{-2}\right]$

Let 1 corresponds to SI system and 2 to CGS system

$n_1 = 6.67 \times 10^{-11}$, $M_1 = 1$ kg, $L_1 = 1$ m, $T_1 = 1$ s, $M_2 = 1$g $= 10^{-3}$ kg, $L_2 = 1$ cm $= 10^{-2}$ m and $T_2 = 1$ s

Now, $n_2 = n_1\left[\frac{M_1}{M_2}\right]^{-1}\left[\frac{L_1}{L_2}\right]^{3}\left[\frac{T_1}{T_2}\right]^{-2} = 6.67\times10^{-11}\left[\frac{1\text{ kg}}{10^{-3}\text{ kg}}\right]^{-1}\left[\frac{1\text{ m}}{10^{-2}\text{ m}}\right]^{3}\left[\frac{1\text{ s}}{1\text{ s}}\right]^{-2}$

$\therefore$ $n_2 = 6.67 \times 10^{-11}\,[10^{-3}]\,[10^{6}]\,[1] = 6.67 \times 10^{-8}$

Thus, value of G in CGS system is 6.67×10^{-8} dyne cm^2 g^{-2}.

5. The velocity v of a particle depends upon the time t according to the equation $v = a + bt + \frac{c}{d+t}$. Write the dimensions of a, b, c and d.

Solution

From principle of homogeneity, $[a] = [v]$

or $[a] = [LT^{-1}]$

$[bt] = [v]$

or $[bT] = [LT^{-1}]$

or $[b] = [LT^{-2}]$

$[d] = [t]$

or $[d] = [T]$

$\left[\frac{c}{d+t}\right] = [v]$

$[c] = [v]\,[d + t] = [LT^{-1}]\,[T]$

$[c] = [L]$

Aliter

$[a] = [v] = LT^{-1}$

$[bt] = [v] = LT^{-1}$

$\therefore\ b = \left[\frac{LT^{-1}}{T^0}\right] = [LT^{-2}]$

$V = \frac{c}{d} = \frac{L}{T}$

$\therefore$ $C = [L]$

$D = [T]$

6. The frequency (f) of a stretched string depends upon the tension F (force, length l of the string and the mass per unit length μ of string. Derive the formula for frequency.

Solution

Let $f = k\,F^a\,l^b\,\mu^c$

$[T^{-1}] = k\,[MLT^{-2}]^a\,[L]^b\,[ML^{-1}]^c$

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

Comparing the powers $a + c = 0$, $a + b - c = 0$, $-2a = -1$

Solving these equations we get $a = +\frac{1}{2}$, $b = -1$ and $c = \frac{-1}{2}$

$\therefore\ f = k\, F^{\frac{1}{2}}\, l^{-1}\, \mu^{\frac{-1}{2}}$ or $f = k\frac{1}{l}\sqrt{\frac{F}{\mu}}$, where k is a dimensionless constant.

7. Write the dimensions of a and b in the relation $P = \frac{b - x^2}{at}$

Where P is power, x is distance and t is time

Solution

$[x] = [L] \Rightarrow [x^2] = [L^2]$

$\therefore\ [b] = [L^2]$ [From principle of homogeneity]

$[P] = [ML^2T^{-3}]$

$[at] = \frac{[b - x^2]}{[P]} = \frac{[L^2]}{[ML^2T^{-3}]} = [M^{-1}T^3]$ $[a] = [M^{-1}\ T^2]$

8. Find the dimensions of $\frac{L}{R}$ where L is inductance and R is the resistance.

Solution

We know that $[L] = [ML^2T^{-2}A^{-2}]$ and $[R] = [ML^2T^{-3}A^{-2}]$

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

$\therefore$ Dimensions of $\frac{L}{R}$ is same as that of time.

9. Express 1 parsec in terms of meter. Write its order of magnitude.

Solution

1 parsec = 3.08×10^{16} m ; Here $0.5 < 3.08 < 5$ $\therefore$ order of magnitude = 16

a. Write the order of magnitude of the following measurements

(i) 45,710,000 m (ii) 92,850,000 (iii) 0.00000532 kg

Solution

(i) 45,710,000 m = 4.571×10^7 m

$0.5 < 4.571 < 5$ $\therefore$ order of magnitude = 7

(ii) 92,820,000 = 0.92×10^8 m

$0.5 < 0.92 < 5$ $\therefore$ order of magnitude = 8

(iii) 0.00000532 kg = 0.532×10^{-5}

$0.5 < 0.532 < 5$ $\therefore$ order of magnitude = – 5

2.3 Significant Figures

Significant figures in the measured value of a physical quantity tell the number of digits in which we have confidence. Larger the number of significant figures obtained in a measurement, greater is the accuracy of the measurement.

"All accurately known digits in a measurement plus the first uncertain digit together form significant figures".

For example, when we measure the length of a straight line using a meter scale and it lies between 8.6 cm and 8.7 cm, we may estimate it as 8.64 cm. This expression has three significant figures, out of these 8 and 6 are precisely known but last digit 4 is only approximately known.

Rules for counting significant figures

For counting significant figures, we use the following rules:

Rule 1 : All non-zero digits are significant. For example x = 2567 has four significant figures.

Rule 2 : The zeroes appearing between two non-zero digits are counted in significant figures. For example 6.028 has 4 significant figures.

Rule 3 : The zeroes occurring to the left of last non-zero digit are NOT significant. For example 0.0042 has 2 significant figures.

Rule 4 : In a number without decimal, zeroes to the right of non-zero digit are NOT significant. However when some value is recorded on the basis of actual measurement the zeroes to the right of non-zero digit become significant. For example L= 20 m has two significant figures but x = 200 has only one significant figure.

Rule 5 : In a number with decimal, zeroes to the right of last non-zero digit are significant. For example x = 14.00 has four significant digits.

Rule 6 : The powers of ten are NOT counted as significant digit. For example 1.4×10^7 has only two significant digits 1 and 4.

Rule 7 : Change in the units of measurement of a quantity does not change the number of significant figures. For example, suppose distance between two stations is 4067 m. It has four significant figures. The same distance can be expressed as 4.067 km or 4.067×10^5 cm. In all these expressions, number of significant digits is four.

See the following table

Measured value	Number of significant digits	Rule number
12376	5	1
6024.7	5	2
0.071	2	3
410 m	3	4
720	2	4
2.40	3	5
1.6×10^{-17}	2	6

Rounding off a digit

Certain rules are applied in order to round off the measurement.

Rule 1 : If the number lying to the right of digit to be rounded off is less than 5, then the rounded digit is retained as such. However if it is more than 5, then the digit to be rounded is increased by 1.
For example, x = 6.24 is rounded off to 6.2 to two significant digits and x = 8.356 is rounded off to 8.36 to three significant digits.

Rule 2 : If the digit to be dropped is 5 followed by digits other than zero then the preceding digit is increased by 1.
For example, x = 14.252 is rounded off to x = 14.3 to three significant digits.

Rule 3 : If the digit to be dropped is simply 5 or 5 followed by zero, then the preceding digit is left unchanged if it is even.
For example, x = 6.250 or x = 6.25 becomes x = 6.2 after rounding off to two significant digits.

Rule 4 : If the digit to be dropped is 5 or 5 followed by zero, then the preceding digit is raised by one if it is odd.
For example, x = 6.350 or x = 6.35 becomes x = 6.4 after rounding off to two significant digits.

See the following table

Measured value	After rounding off to three significant digits	Rule number
7.364	7.36	1
7.367	7.37	1
8.3251	8.33	2
9.445	9.44	3
9.4450	9.44	3
15.75	15.8	4
15.7500	15.8	4

Algebraic operations with significant figures

In addition, subtraction, multiplication or division, inaccuracy in the measurement of any one variable affects the accuracy of final result. Hence, in general, the final result has significant figures according to the rules given below.

(i) **Addition and Subtraction:** The number of decimal places in the final result (of any of these two operations) has to be equal to the SMALLEST NUMBER OF DECIMAL PLACES in any of the terms involved in calculation.

Example: $1.2 + 3.45 + 6.789 = 11.439 \approx 11.4$

Here, the least number of significant digits after the decimal is one. Hence the result will be 11.4 (when rounded off to smallest number of decimal places).

Example: $12.63 - 10.2 = 2.43 \approx 2.4$

(ii) **Multiplication and Division:** In these operations, the number of significant figures in the result is same as the SMALLEST NUMBER OF SIGNIFICANT FIGURES in any of the factors.

Example: $1.2 \times 1.3 = 1.56 \approx 1.6$

The least number of significant digits on the measured values is 2. Hence the result is 1.6 (when rounded off to smallest number of significant digits)

Example: $1.2 \times 36.72 = 44.064 \approx 44$

Example: $\dfrac{1100\ \text{ms}^{-1}}{10.2\ \text{ms}^{-1}} = 107.8431 \approx 108$

2.4 Errors in measurement

"Resolution" stands for least count or the minimum reading which an instrument can read.

Accuracy: An instrument is said to be accurate if the physical quantity measured by it resembles very closely to its true value.

Precision: An instrument is said to have high degree of precision, if the measured value remains unchanged, howsoever, large number of times it may have been repeated.

There are many causes of errors in measurement. Errors may be due to instrumental defects, ignoring certain facts, carelessness of experimenter, random change in temperature, pressure, humidity, etc. When an experimentar tries to reach accurate value of measurement by doing large number of experiments, the mean of a large number of the results repeated experiments is close to the true value.

Calculation of Magnitude of Errors

(i) **True value**: If a_1, a_2, a_3 ……… a_n are the observed values of a measurement, then true value of measurement is the mean of these observed values.

$$\therefore\ a_{true} = a_{mean} = a_0 = \frac{a_1 + a_2 + a_3 + ... + a_n}{n} = \frac{1}{n}\sum_{i=1}^{n} a_i$$

(ii) **Absolute error:** The absolute errors in various individual measured values are found by subtracting the observed value from true value. Thus,

$\Delta a_1 = a_0 - a_1$, $\Delta a_2 = a_0 - a_2$, $\Delta a_3 = a_0 - a_3$ ……… $\Delta a_n = a_0 - a_n$

The absolute error may be positive or negative or zero.

(iii) Mean absolute error: The arithmetic mean of the magnitudes of different values of absolute errors is known as the mean absolute error

$\therefore$ Mean absolute error is $\Delta a_{mean} = \dfrac{|\Delta a_1| + |\Delta a_2| + |\Delta a_3| + ...+ |\Delta a_n|}{n}$

Δa_{mean} is also represented as $\overline{\Delta a}$

The final result of a measurement can be written as $a = a_0 \pm \overline{\Delta a}$

This implies that value of 'a' is likely to lie between $a_0 + \overline{\Delta a}$ and $a_0 - \overline{\Delta a}$

(iv) Relative error or fraction error: The ratio of the mean value of absolute error to the true value is known as the 'mean relative error'.

$$\therefore \quad \text{Mean relative error} = \frac{\text{Mean absolute error}}{\text{Mean value of measurement}} = \frac{\overline{\Delta a}}{a_0}$$

When expressed in terms of percentage, relative error is called "relative percentage error". Hence

$$\text{Percentage error} = \frac{\Delta a_{mean}}{a_{mean}} \times 100 = \frac{\overline{\Delta a}}{a_0} \times 100$$

Propagation of Errors

Suppose we want to get the volume of a sphere, $v = \frac{4}{3}\pi r^3$. This involves multiplication of radius three times. The measurement of radius has some error, then what will be error in calculating the volume of sphere? The error in final result depends on the individual measurement as well as the mathematical operations involved in calculating the result. To calculate the net error in the result, we should study the propagation of errors in the several mathematical operations.

(1) Error in addition

Let x = a + b. suppose $\pm \Delta a$ is absolute error in a and $\pm \Delta b$ is absolute error in b, then we have

$$x + \Delta x = (a \pm \Delta a) + (b \pm \Delta b)$$
$$= (a + b) \pm (\Delta a + \Delta b)$$
$$\Delta x = (a + b) \pm (\Delta a + \Delta b) - x$$
$$\therefore \Delta x = \pm (\Delta a + \Delta b) \qquad [\because x = a + b]$$

Thus, "The maximum possible error in the addition of quantities is equal to the sum of their absolute errors".

% error in x is $\dfrac{\Delta x}{x} \times 100 = \pm \left[\dfrac{\Delta a + \Delta b}{a + b}\right] \times 100$

(2) Error in subtraction

Let x = a – b

$$x + \Delta x = (a \pm \Delta a) - (b \pm \Delta b)$$
$$= (a - b) \pm (\Delta a \mp \Delta b)$$
$$\Delta x = (a - b) \pm (\Delta a \mp \Delta b) - x$$
$$\therefore \Delta x = \pm (\Delta a \mp \Delta b)$$

But for maximum possible error Δa and Δb must be of same sign. $\therefore \Delta x = \pm(\Delta a + \Delta b)$

Thus, the maximum possible error in subtraction of quantities is equal to the sum of their absolute errors.

% error in x is $\dfrac{\Delta x}{x} \times 100 = \pm \left(\dfrac{\Delta a + \Delta b}{a - b}\right) \times 100$

(3) Error in product

Let x = ab

$x + \Delta x = (a \pm \Delta a)(b \pm \Delta b)$

$= ab \pm a\Delta b \pm b\Delta a \pm \Delta a\,\Delta b$

If Δa and Δb are small, then $\Delta a\,\Delta b$ will be very small and thus can be ignored.

$\therefore\ x + \Delta x = ab \pm a\,\Delta b \pm b\,\Delta a$

$\Delta x = \pm(a\,\Delta b + b\,\Delta a) = \pm(b\,\Delta a + a\,\Delta b)$

The maximum fractional error in x is $\frac{\Delta x}{x} \times 100 = \pm\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right) \times 100$. Thus the maximum fractional error in the product is equal to the sum of fractional errors in the individual quantities.

(4) Error in quotient (or division)

Let $x = \frac{a}{b}$

$$x + \Delta x = \frac{a \pm \Delta a}{b \pm \Delta b} = \frac{a\left(1 \pm \frac{\Delta a}{a}\right)}{b\left(1 \pm \frac{\Delta b}{b}\right)}$$

$$= \frac{a}{b}\left(1 \pm \frac{\Delta a}{a}\right)\left(1 \pm \frac{\Delta b}{b}\right)^{-1}$$

$$= \frac{a}{b}\left(1 \pm \frac{\Delta a}{a}\right)\left(1 \mp \frac{\Delta b}{b}\right) \qquad \text{or,} \qquad x + \Delta x = x\left(1 \pm \frac{\Delta a}{a}\right)\left(1 \mp \frac{\Delta b}{b}\right)$$

$$1 + \frac{\Delta x}{x} = 1 \pm \frac{\Delta a}{a} \mp \frac{\Delta b}{b} \pm \frac{\Delta a}{a} \cdot \frac{\Delta b}{b}$$

As the terms $\frac{\Delta a}{a}$ and $\frac{\Delta b}{b}$ are small, their product $\frac{\Delta a}{a} \cdot \frac{\Delta b}{b}$ can be neglected. Thus maximum fractional error is given by $\frac{\Delta x}{x} = \pm\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right)$

And maximum possible percentage error in x is

$$\frac{\Delta x}{x} \times 100 = \pm\left(\frac{\Delta a}{a} + \frac{\Delta b}{b}\right) \times 100$$

(5) Error in the power of quantity

Let $x = a^p$

$$x + \Delta x = (a \pm \Delta a)^p = a^p\left(1 \pm \frac{\Delta a}{a}\right)^p$$

$$= a^p\left(1 \pm p\frac{\Delta a}{a}\right) \qquad \text{or} \qquad \frac{x + \Delta x}{x} = 1 \pm p\frac{\Delta a}{a}$$

$$1 + \frac{\Delta x}{x} = 1 \pm p\frac{\Delta a}{a}$$

$$\frac{\Delta x}{x} = \pm p\frac{\Delta a}{a}$$

Maximum percentage error in x is $\frac{\Delta x}{x} \times 100 = \pm p\left(\frac{\Delta a}{a} \times 100\right)$

The fractional error in the quantity raised to power ‘p’ is p times the fractional error in that quantity.

(6) General case

If $x = \frac{a^p b^q}{c^r}$, then the maximum possible fractional error in x is $\frac{\Delta x}{x} = \pm\left[p\frac{\Delta a}{a} + q\frac{\Delta b}{b} + r\frac{\Delta c}{c}\right]$

And the maximum possible percentage error is $\frac{\Delta x}{x}\times 100=\pm\left[p\frac{\Delta a}{a}\times 100+q\frac{\Delta b}{b}\times 100+r\frac{\Delta c}{c}\times 100\right]$

Illustrations

10. State the number of significant figures in the following

(i) 0.007 m^2 (ii) 2.64 × 10^{24} kg (iii) 0.2370 g cm^{-3} (iv) 6.320 J

(v) 6.032 Nm^{-2} (vi) 0.0006032 m^2 (vii) 2.000 m (viii) 5100 kg (ix) 0.050 cm

Solution

(i) one : 7 (ii) three : 2, 6, 4 (iii) four : 2, 3, 7, 0 (iv) four : 6, 3, 2, 0

(v) four : 6, 0, 3, 2 (vi) four : 6, 0, 3, 2 (vii) four : 2, 0, 0, 0 (viii) four : 5, 1, 0, 0

(ix) two : 5, 0

5100 kg is a measured value, and so it has four significant figures. If it is simply a numerical value, 5100, then number of significant digits would be two.

11. Solve the following and express the result to an appropriate number of significant figures.

(i) Add 6.2 g, 4.33 g and 17.456 g

(ii) Subtract 63.54 kg from 187.2 kg

(iii) 75.5 × 125.2 × 0.51

(iv) $\frac{2.13\times 24.78}{458.2}$

(v) $\frac{2.51\times 10^{-4}\times 1.81\times 10^{7}}{0.4463}$

Solution

(i) 6.2 g + 4.33 g + 17.456 g = 27.986 g

The result should be rounded off to first decimal place due to 6.2 g

= 28.0 g

(ii) 187.2 kg – 63.54 kg = 123.66 kg

The result should be rounded off to first decimal place due to 187.2 kg

= 123.7 kg

(iii) 75.5 × 125.2 × 0.51 = 4820.826

The result should be rounded off to two significant digits due to 0.51

= 4800

(iv) $\frac{2.13\times 24.78}{458.2}=0.115193$

The result should be rounded off to three significant digits because of 2.13

= 0.115

(v) $\frac{2.51\times 10^{-4}\times 1.81\times 10^{7}}{0.4463}=10179.48$

The result should be rounded off to three significant digits because of 1.81 = 1.02 × 10^4

12. If L = 2.5 × 10^4 and B = 3.9 × 10^5 then B – L =

(A) 1.4 × 10^4 (B) 1.4 × 10^5 (C) 3.6 × 10^4 (D) 3.6 × 10^5

Solution

Given L = 2500 and B = 390000

Now B – L = 390000 – 25000 = 365000

= 3.65 × 10^5

= 3.6 × 10^5 (rounded to one place of decimal)

13. The area enclosed by a circle of diameter 1.06 m to correct number of significant figures is [take π = 3.14]

(A) 0.88 m^2 (B) 0.088 m^2 (C) 0.882 m^2 (D) 0.530 m^2

Ans (C)

$$r = \frac{1.06}{2} = 0.530 \text{ m}$$

Area is $A = \pi r^2 = 3.14(0.530)^2 = 0.882026 \text{ m}^2$

$= 0.882 \text{ m}^2$ (rounded to three significant digits)

14. Object distance, u = (50.1 ± 0.5) cm and image distance, v = (20.1 ± 0.2) cm then focal length is

(A) (12.4 ± 0.4) cm (B) (12.4 ± 0.1) cm

(C) (14.3 ± 0.4) cm (D) (14.3 ± 0.1) cm

Ans (C)

Focal length is given by $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ or $f = \frac{uv}{u+v} = \frac{(50.1)(20.1)}{50.1+20.1}$ or f = 14.345 cm = 14.3 cm

$$\frac{\Delta f}{f} = \pm\left[\frac{\Delta u}{u} + \frac{\Delta v}{v} + \frac{\Delta u + \Delta v}{u+v}\right] = \pm\left[\frac{0.5}{50.1} + \frac{0.2}{20.1} + \frac{0.5+0.2}{50.1+20.1}\right] = \pm(0.0299)$$

$\Delta f = 0.0299 \times 14.3 = 0.428 = 0.4$ cm

So focal length = (14.3 ± 0.4) cm

NCERT LINE BY LINE QUESTIONS

1. Natural sciences does not include [NCERT Pg. 2]
(a) Physics (b) Chemistry (c) Biology (d) Social Science

2. Principal thrusts in Physics are [NCERT Pg. 2]
(a) Unification (b) Reduction (c) Both (a)and (b) (d) None of the above

3. Attempt to explain diverse physical phenomenon in terms of a few concepts and laws is called [NCERT Pg. 2]
(a) Unification (b) Reduction (c) Fusion (d) All of the above

4. Classical Physics mainly deals with [NCERT Pg. 3]
(a) Microscopic phenomenon (b) Macroscopic phenomenon
(c) Atomic phenomenon (d) Heisenberg's uncertainty principle

5. Among the following, choose the incorrect statement [NCERT Pg. 3]
(a) The microscopic domain of physics deals with the constitution and structure of matter at the minute scales of atoms and nuclei
(b) Classical Physics deals mainly with macroscopic phenomena and includes subjects like Mechanics, Electrodynamics, Optics and Thermodynamics
(c) Both of the above (d) None of the above

6. Phenomenon of neutron induced fission of uranimum, which serves as a basis of nuclear power reactors and nuclear weapons, was discovered by
(a) Hahn and Meitner (b) Einstein
(c) Neils Bohr (d) Nicholas Tesla

7. Among the following, the scientists are matched with their major contribution or discovery. Which among the following is incorrectly matched? [NCERT Pg. 5]

A) Archimedes	Principle of Buoyancy
B) Christiaan Huygens	Wave Theory of Light
C) JCBose	X-rays
D) Albert Einstein	Theory of Relativity

(a) A (b)B (c)C (d)D

8. Among the following scientists, the one who is credited for the contribution to theory of condensed matter is [NCERT Pg. 6]
(a) Ernest Orlando Lawrence (b) C-V. Raman
(c) Ernest Rutherford (d) Lev Davidovich Landau

9. Full form of LASER is [NCERT Pg. 7]
(a) Light amplification by shorted extraction of rays
(b) Light amplification by stimulated emission of radiation
(c) Long absorption of silent extraction of radiation
(d) None of the above

10. Choose the incorrect statement among the following in relation to the electromagnetic waves. [NCERT Pg. 8]
(a) Electromagnetic force do not require intervening medium
(b) They act over large distances
(c) Electromagnetic force is weaker than the gravitational forces
(d) Etectromagnetc forces may be attractive or repulsive

11. Choose the correct option. [NCERT Pg. 22]
(1)A most precise measurement may be most accurate
(2) A most precise measurement will necessarily be most accurate
(3) A most precise measurement will be less accurate
(4) A most accurate measurement will necessarily be most precise

12. 1 metre is the length of path travelled by light in vacuum during a time interval of of a second of a second of a second of a second [NCERT Pg. 17]
1) $\frac{1}{299,972,458}$ of a second
2) $\frac{1}{299,792,548}$ of a second
3) $\frac{1}{299,792,458}$ of a second
4) $\frac{1}{299,792,854}$ of a second

13. The kelvin is the fraction [NCERT Pg. 17]
1) $\frac{1}{273}$ of the thermodynamic temperature of triple point of water
2) $\frac{1}{312}$ of the thermodynamic temperature of triple point of water
3) $\frac{1}{273.16}$ of the thermodynamic temperature of triple point of water **i**
4) $\frac{1}{273}$ of the thermodynamic temperature of triple point of mercury

14. 1" (second of arc) in radian is (approximately) [NCERT Pg. 19]
(1) 5.85×10^{-6} rad
(2) 8.55×10^{-6} rad
(3) 5.85×10^{-5} rad
(4) 4.85×10^{-6} rad

15. The diameter of sun is 1.39×10^{9} m. The distance of sun from earth is 1.496×10^{11} m. The angular diameter of sun is [NCERT Pg. 19]
(1) 1290"
(2) 9210"
(3) 2190'
(4) 1920"

16. The measured length of two rods are l_1 = 30 cm ± 0-5 cm and l_2= 20 cm + 0.1 cm. The percentage error in difference of length of rods is [NCERT Pg. 261
(1) 6%
(2) 4%
(3) 5%
(4) 3%

17. Two resistors of resistances R_1 = 300 ± 3 ohm and R_2 = 200 ± 2 ohm are connected in parallel. The equivalent resistance of parallel combination with error is [NCERT Pg. 37]
(1) [120 ± 1.8] ohm
(2) (120 ± 1]ohm
(3) [120 ±1.6] ohm
(4) [120 ±2.0] ohm

18. If percentage error in measurement of quantities A, B. C and D are 1 %, 2%. 3% and 4% respectively, then percentage error in measurement of $z=\frac{A^2B^{1/2}}{C^{1/3}D^{1/4}}$ is [NCERT Pg. 27]
(1) 5%
(2) 4%
(3) 6%
(4) 8%

19. The number of insignificant zeros in 0.0048050 [NCERT Pg. 28]
(1) 1
(2)2
(3)3
(4)4

20. The value of $(3.8\times10^{3}+3.5\times10^{2})$ with regards to significant figure is [NCERT Pg, 30]
(1) 7.3×10^{5}
(2) 4.2×10^{3}
(3) 4.15×10^{3}
(4) 7.3×10^{3}

21. The value of gravitational constant is $G = 6.67\times10^{-11}\frac{N\times m^2}{kg^2}$ Suppose we employ a new system of units in which unit of mass is **u** kg, the unit of length β m and the unit of time is γ s. The value of gravitational constant in terms of new units is [NCERT Pg. 35]
(1) $6.67\times10^{-11}\alpha\beta^{-3}\gamma^2$ (2) $6.67\times10^{-11}\alpha^{-1}\beta^3\gamma^{-2}$
(3) $6.67\times10^{-11}\alpha\beta^3\gamma^2$ (4) $6.67\times10^{-11}\alpha^{-1}\beta^{-3}\gamma^2$

22. In Cesium clock 1 second is the time in which cesium - 133 atom, vibrate between two hyperfine levels [NCERT Pg. 22]
(1) 9,292, 631, 770 times (2) 9, 192, 361, 770 times
(3) 9, 192, 136, 770 times (4) 9,192, 631,770 times

23. Least count error belongs to the category of [NCERT Pg. 24]
(1) Random error only (2) Systematic error only
(3) Neither systematic error nor-random error
(4) Systematic and random error both

24. A student measures the period of oscillation of a simple pendulum in successive measurements, the reading turn out to be 1.93 s, 1.99 s, 2.06 s, 2.08 s and 1.95 s. A more accurate way to write the measurement with error is [NCERT Pg. 25]
(1) (2.00 ± 0.05) s (2) (2.03 + 0.06) s (3) (2.0 ± 0.06) s (4) (2.03 ± 0.1) s

25. Each side of a cube is measured to be 6.372 m. The total surface area of cube with appropriate significant figures is [NCERT Pg. 32]
(1) $2.5\times10^2 m^2$ (2) $2\times10^2 m^2$ (3) 243.6 m^2 (4) 251.3207 m^2

26. Choose the correct statement [NCERT Pg. 33]
(1) A dimensionally correct equation need not be an actually correct equation
(2) A dimensionally correct equation may be an actually correct equation
(3) A dimensionally incorrect equation may be correct (4) Both (i)and (2)

27. A famous relation in physics with many printing errors, relates the moving mass *'m'* with rest mass for a moving object with speed v is printed as $m = \frac{n_0^2}{\sqrt{1-\frac{b}{c^2}}}$. The dimensional formula of n_0 and b are respectively (c is speed of light) [NCERT Pg. 36]
(1) $[M],[LT^{-1}]$ (2) $[M],[L^{-2}T^{-2}]$ (3) $[M^{1/2}],[L^2T^2]$ (4) $[M^{1/2}],[LT^{-1}]$

28. Parsec is a unit of (NCERT Pg. 21]
(1) Distance (2) Velocity (3) Time (4) Angle

29. If the size of atom is in the range of 10^{-10} m to 10^{-9} m is scaled up to the tip of sharp pin (assume tip of pin to be in the range of 10^{-6} to 10^{-5}m), Roughly, size of nucleus is [NCERT Pg. 20]
(1) 0.1 A (2) 0.01 A (3) 0.001 A (4) 10 A

30. In a screw gauge, each main scale division is 1 mm and there are 200 divisions on the circular scale. The least count of screw gauge is [NCERT Pg. 35]
(1) 0.05 mm (2) 0.005 mm (3) 0.05 cm (4) 0.005 cm

NCERT BASED PRACTICE QUESTIONS

1. Angle is a
(a) fundamental quantity (b) derived quantity
(c) supplementary quantity (c) None of these

2. Parallax method is used for measurement of
(a) length (b) time (c) mass (d) speed

3. 1 astronomical unit (AU) is equal to
(a) 1.496×10^{18}m (b) 1.496×10^{15}m
(c) 1.496×10^{11}m (d) 1.496×10^{9}m

4. Parsec is a unit for measurement of
(a) Time (b) Length (c) Mass (d) none of these

5. Light year is used to measure
(a) time (b) length (c) mass (d) None of these

6. 1atomic mass unit (1 amu) is equal to
a) 1.66×10^{-27}kg (b) 1.66×10^{-24}kg
(c) 1.66×10^{-22}kg (d) 1.66×10^{-23}kg

7. 0.002308 has significant figure
(a) 4 (b) 6 (c) 7 (d) 3

8. Significant figure in 0.06900 are
(a) 2 (b) 3 (c) 4 (d) 5

9. Dimension of $\frac{1}{2}\in oE^2$ is ($\in_0 \rightarrow$ permittivity of free space, E- electric field)
(a) $ML^{-1}T^{-2}$ (b) ML^2T^{-2} (c) $ML^{-1}T^{-1}$ (d) ML^2T^{-1}

10. Dimension of $\frac{B^2}{2\mu_0}$ is (B$\rightarrow$ magnetic field, $\mu_0 \rightarrow permiability\ of\ frees\ pace$)
(a) ML^2T^{-2} (b) $ML^{-1}T^{-1}$ (c) ML^2T^{-1} (d) $ML^{-1}T^{-2}$

11. Dimension of $\frac{1}{\sqrt{\mu_0\in_0}}$ is
(a) $[MLT^{-2}]$ (b) $M^0L^1T^{-2}$ (c) $M^0L^1T^{-1}$ (d) $M^0L^{-1}T^{-1}$

12. Dimension of $\frac{\upsilon^2}{rg}$ is same as of, υ (υ is velocity, r $\rightarrow$ radius, g-acceleration due to gravity)
(a) angle (b) acceleration (c) length (d) speed

13. Dimension of coefficient of viscosity is
(a) $[ML^2T^{-1}]$ (b) $ML^{-1}T^{-1}$ (c) MLT^{-2} (d) $M^{-1}L^{-1}T^{-1}$

14. Dimension of planck constant is
(a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}$ (c) ML^2T^{-1} (d) None of these

15. Dimension of strain is:.
(a) $[M^0LT^0]$ (b) $[M^0L^{-1}T^0]$ (c) $[M^1L^0T^0]$ (d) $[M^0L^0T^0]$

16. Dimension of surface tension is
(a) $[MLT^{-2}]$ (b) $[ML^0T^{-2}]$ (c) $[ML^0T^{-1}]$ (d) $[MLT^{-1}]$

17. Dimension of efficiency is
(a) $[M^0LT^0]$ (b) $[M^0L^{-1}T^0]$ (c) $[M^0L^0T^{-0}]$ (d) $[M^1L^0T^0]$

18. Dimension of $\frac{1}{2}Li^2$ is
(a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}]$ (c) $[ML^2T^{-1}]$ (d) $[ML^{-1}T^{-2}]$

19. Dimension of $\frac{1}{2}Cv^2$
(a) $[ML^2T^{-2}]$ (b) $[MLT^{-2}]$ (c) $[ML^2T^{-1}]$ (d) $[ML^{-1}T^{-2}]$

20. Dimension of $\frac{Q_2}{2C}$ is $\begin{matrix} Q \rightarrow charge \\ C \rightarrow capacitance \end{matrix}$
(a) $[MLT^{-2}]$ (b) $[ML^2T^{-2}]$ (c) $[ML^2T^{-1}]$ (d) $[ML^{-1}T^{-2}]$

21. A physical quantity P is related to four observables a,b,c and d as follows P$\frac{a^3b^2}{\sqrt{cd}}$ percentage error in a,b,c,d are 1%,3%,4% and 2% respectively. Percentage error in quantity P is.
(a) 10% (b) 15% (c) 13% (d) 8%
22. Area enclosed by a circle of diametric 1.06m is
(a) 0.88 2026 m^2 (b) 0.882 m^2 (c) 0.88 m^2 (d) none of these
23. A body travels uniformly a distance of (13.8± 0.2)m in time (4.0 ± 0.3) S. Percentage error in measurement of velocity is
(a) 9% (b) 7% (c) 5% (d) 3%
24. One shake is equal to
(a) 10^8sec (b) 10^{-9}sec (c) 10^{-8}sec (d) 10^{-10}sec
25. Ratio of SI to c.g.s units of KE is
(a) 10^6 (b) 10^{-7} (c) 10^7 (d) 10^8
26. Which of the following have same dimensions?
(a) specific heat
(b) Momentum and impulse
(c) Moment of inertia and angular momentum
(d) Tension and surface tension
27. The dimensions of magnetic moment are
(a) L^2A^{-1} (b) $L^2 A^1$ (c) LA^2 (d) L^2A^{-3}
28. The unit of reduction factor of tangent of galvanometer is
(a) gauss (b) tesla (c) radian (d) ampere
29. The dimensions of the gravitational constant G are
(a) $[ML^{-1} T^{-1}]$ (b) $[MLT^2]$ (c) $[M^{-1}L^3T^{-2}]$ (d) $[M^2 L^{-1}T^2]$
30. If L and R denote inductance and resistance respectively, which of the following dimensions of frequency?
(a) $\frac{R}{L}$ (b) $\frac{L}{R}$ (c) $\sqrt{\frac{R}{L}}$ (d) $\sqrt{\frac{L}{R}}$
31. The dimensional formula of magnetic flux is
(a) $[M^1L^2T^{-2}A^{-1}]$ (b) $[M^1L^0T^{-2}A^{-2}]$ (c) $[M^0L^{-2}T^{-2}A^{-2}]$ (d) $[M^1L^2T^{-1}A^3]$
32. Which one of the following has the dimension of pressure?
(a) $\frac{ML}{T^2}$ (b) $\frac{M}{L^2T^2}$ (c) $\frac{M}{LT^2}$ (d) $\frac{M}{LT}$
33. Which of the following has metre Kelvin as the unit?
(a) Rydberg constant (b) wein's constant
(c) Solar constant (d) gas constant
34. Dimension of $\frac{L}{RCV}$ are
(a) A^{-1} (b) A^{-2} (c) A (d) A^2
35. The dimension of intensity are
(a) $L^0M^1T^{-3}$ (b) $L^1M^2T^{-2}$ (c) $L^2M^1T^{-2}$ (d) $M^2L^2T^{-3}$
36. The dimension of RC, R is resistance and C is capacitances are same as that of
(a) inverse time (b) time
(c) square of time (d) square root of time
37. Which of the following is a dimensional constant?
(a) refractive index (b) dielectric constant
(c) relative density (d) gravitational constant

38. The length of a rod is (11.05 ± 0.05) cm. What is the total length of 2 such rods?
(a) (22.1 ± 0.05)cm (b) (22.10 ± 0.05)cm
(c) (22.100 ± 0.05)cm (d) (22.10 ± 0.10)cm

39. Which of the following quantity can be written in SI unit Kg m^2 A^{-2} S^{-3}
(a) Resistance (b) Inductance
(c) Capacitance (d) magnetic flux

40. The dimension of $\frac{L}{R}$ is same as that of
(a) Time (b) Speed (c) Inverse of time (d) square of time

TOPIC WISE PRACTICE QUESTIONS

Topic 1: Units of Physical Quantities

1. Unit of specific resistance is
1) ohm/m^2 2) ohm m^3 3) ohm – m 4) ohm/m

2. Temperature can be expressed as derived quantity in terms of
1) Length and mass 2) mass and time 3) length, mass and time 4) none of these

3. Potential is measured in
1) joule/coulomb 2) watt/coulomb 3) newton-second 4) none

4. The siemen is the SI unit of
1) Resistivity 2) Resistance 3) conductivity 4) conductance

5. What is the unit of magnetic permeability?
1) Wb A-1 m^{-1} 2) Wb^{-1} Am 3) Wb A m^{-1} 4) Wb A^{-1} m

6. The SI unit of coefficient of mutual inductance of a coil is
1) henry 2) volt 3) farad 4) weber

7. Surface tension of a liquid is 70 dyne/cm. Its value in SI is
1) 70 N/m 2) 7 x 10^{-2} N/m 3) 7 x 10^2 N/m 4) 7 X 10^3 N/m

8. Joule - second is a unit of
1) energy 2) torque 3) power 4) angular momentum

9. The unit of the Stefan-Boltzmann's constant is
1) W/m^2K^4 2) W/m^2 3) W/m^2K 4) W/m^2K^2

10. Young's modulus of steel is 1.9 x 10^{11} N/m^2. When expressed in CGS units of dyne/cm^2, it will be equal to ($1N = 10^5$ dyne, $1\ m^2 = 10^4\ cm^2$)
1) 1.9x10^{10} 2) 1.9 x 10^{11} 3) 1.9x10^{12} 4) 1.9x10^{13}

11. Which one of the following pairs of quantities and their units is a proper match?
1) Impulse – N/sec 2) Magnetic flux – weber 3) Power – farad 4) Capacitance – henry

12. The numerical values of young's modulus in S.I. unit is β. What is its numerical value in cgs system?
1) β 2)10 β 3) β/10 4) 100 β

13. In the eqn. $\left(P+\frac{a}{V^2}\right)(V-b)$ = constant, the unit of a is
1) Dyne × cm^5 2) dyne × cm^4 3) dyne/cm^3 4) dyne × cm^2

14. In C.G.S. system the magnitude of the force is 100 dynes. In another system where the fundamental physical quantities are in kilogram, metre and minute, the magnitude of the force is
1) 0.036 2) 0.36 3) 3.6 4) 36

15. If e is the charge, V the potential difference, T the temperature, then the units of $\frac{eV}{T}$ are the same as that of
1) Planck's constant 2) Stefan's constant 3) Boltzmann's constant 4) gravitational constant

16. In equation, r = m^2 sin π t, where t represents time, If the unit of m is N. Then the unit of r is
1) N 2) N^2 3) Ns 4) N^2s

17. If $x = at + bt^2$, where x is the distance travelled by the body in kilometres while T is the time in seconds, then the unit of B is
1) km/s 2) kms 3) km/s^2 4) kms^2

18. Which of the following quantities has not been expressed in proper unit?
(a) torque : newton metre
(b) stress : newton $metre^{-2}$
(c) modulus of elasticity : newton $metre^{-2}$
(d) surface tension : newton $metre^{-2}$

19. If unit of length and force are increased 4 times. The unit of energy
1) is increased by 4 times 2) is increased by 16 times
3) is increased by 8 times 4) remains unchanged

20. The density of a material in CGS system is 8 g / cm^3. In a system of a unit in which unit of length is 5 cm and unit of mass is 20 g, the density of material is
1) 8 2) 20 3) 50 4) 80

Topic 2: Errors in Measurements and Significant Figures

21. The random errors can be reduced by
1) Taking more number of observation 2) eliminating the error
3) not taking more care 4) None of these

22. Error in the measurement of radius of a sphere is 1%. Then error in the measurement of volume is
1) 1% 2) 5% 3) 3% 4) 8%

23. If x = a - b, then the maximum percentage error in the measurement of x will be
1) $\left(\frac{\Delta a}{a}+\frac{\Delta b}{b}\right)\times 100\%$ 2) $\left(\frac{\Delta a}{a}-\frac{\Delta b}{b}\right)\times 100\%$ 3) $\left(\frac{\Delta a}{a-b}+\frac{\Delta b}{a-b}\right)\times 100\%$ 4) $\left(\frac{\Delta a}{a-b}-\frac{\Delta b}{a-b}\right)\times 100\%$

24. Number of significant figures in expression $\frac{4.327g}{2.51cm^3}$ is
1) 2 2) 4 3) 3 4) 5

25. If the percentage errors of A, B and C are a, b and c respectively, then the total percentage error in the product ABC is
1) abc 2) a + b + c 3) $\frac{1}{a}+\frac{1}{b}+\frac{1}{c}$ 4) $ab+bc+ca$

26. The maximum error in the measurement of mass and density of a cube are 3% and 1% respectively. The maximum error in the measurement of volume will be
1) 1% 2) 2% 3) 3% 4) 4%

27. The value of resistance is 10.845 Ω and the value of current is 3.23 A. The potential difference is 35.02935 volt. Its value in significant number would be

1) 35 V 2) 35.0 V 3) 35.03 V 4) 35.029 V

28. A body of mass m = 3.513 kg is moving along the x-axis with a speed of 5.00 ms^{-1} . The magnitude of its momentum is recorded as

1) 17.6 kg ms-1 2) 17.565 kg ms-1 3) 17.56 kg ms-1 4) 17.57 kg ms-1

29. What is the fractional error in g calculated from $T = 2\pi\sqrt{l/g}$? Given fraction errors in T and l are $\pm$ x and $\pm$ y respectively.

1) x + y 2) x - y 3) 2x + y 4) 2x - y

30. The dimensions of a rectangular block measured with callipers having least count of 0.01 cm are 5 mm x 10 mm x5 mm. The maximum percentage error in the measurement of the volume of the block is

1) 5% 2) 10% 3) 15% 4) 20%

31. The length of one rod l_1 = 3.323 cm and the other is l_2 = 3.321 cm. Both rods were measured with one measuring instrument with least count 0.001 cm then $(l_1 - l_2)$ is

1) (0.002 0.001) cm 2) (0.002 0.000) cm 3) (0.002 0.002) cm 4) None of these

32. Relative density of a metal may be found with the help of spring balance. In air the spring balance reads (5.00 ± 0.05) N and in water it reads (4.00 ± 0.05) N. Then, the relative density along with the maximum permissible percentage error is

1) (5.00 ± 0.05)N 2) (5.00 ± 11%) 3) (5.00 ± 0.10) 4) (5.00 ± 6%)

33. A physical quantity X is represented by X = ($M^x L^{-y} T^{-z}$). The maximum percentage errors in the measurement of M, L and T respectively are a%, b% and c%. The maximum percentage error in the measurement of X will be

1) (ax + by - cz)% 2) (ax - by - cz)% 3) (ax + by + cz)% 4) (ax - by + cz)%

34. The percentage errors in the measurement of mass and speed are 2% and 3% respectively. The error, in kinetic energy obtained by measuring mass and speed, will be

1) 12 % 2) 10 % 3) 8 % 4) 2 %

35. The least count of a stop watch is1/5 s. The time of 20 5 oscillations of a pendulum is measured to be 25 s. What is the maximum percentage error in this measurement?

1) 8 % 2) 1 % 3) 0.8 % 4) 16 %

36. The internal and external diameter of a hollow cylinder are measured with the help of vernier callipers. Their values are 4.23 ± 0.01 cm and 3.87 ± 0.01 cm respectively. The thickness of the wall of the cylinder is

1) 0.36 ± 0.02 cm 2) 0.18 ± 0.02 cm 3) 0.36 ± 0.01 cm 4) 0.18 ± 0.01 cm

37. The diameter of a sphere is measured with an instrument having least count 0.001 cm. The diameter is 1.933 cm. The radius to correct significant figures will be

1) 0.965 cm 2) 0.966 cm 3) 0.967 cm 4) None of these

38. A physical quantity is given by X = $M^a L^b T^c$. The percentage error in measurement of M, L and T are , and respectively. Then maximum percentage error in the quantity X is

1) a + b + c 2) a + b -c 3) a b 2 4) None of these

39. In a simple pendulum experiment for the determination of acceleration due to gravity, time period is measured with an accuracy of 0.1% while length was measured with an accuracy of 0.3%. The percentage accuracy in the value of g so obtained is

1) 0.8% 2) 0.7% 3) 0.5% 4) 0.6%

40. The relative error in the determination of the surface area of a sphere is α. Then the relative error in the determination of its volume is

1) $\frac{2}{3}\alpha$ 2) $\frac{2}{3}\alpha$ 3) $\frac{3}{2}\alpha$ 4) α

41. The density of a cube is measured by measuring its mass and length of its sides. If the maximum error in the measurement of mass and length are 4% and 3% respectively, the maximum error in the measurement of density will be
1) 7% 2) 9% 3) 12% 4) 13%

42. The refractive index of water measured by the relation $\mu = \frac{real\ depth}{apparent\ depth}$ is found to have values of 1.34, 1.3 8, - apparent depth 1.32 and 1.36; the mean value of refractive index with percentage error is
1) 1.35 ± 1.48 % 2) 1.35 ± 0 % 3) 1.36 ± 6 % 4) 1.36 ± 0 %

43. A wire has a mass 0.3 ± 0.003 g, radius 0.5 ± 0.005 mm and length 6 ± 0.06 cm. The maximum percentage error in the measurement of its density is
1) 1 2) 2 3) 3 4) 4

44. The pressure on a square plate is measured by measuring the force on the plate and length of the sides of the plate by F using the formula $P = \frac{F}{l^2}$. If the maximum errors in the 2 measurement of force and length are 4% and 2% respectively, then the maximum error in the measurement of pressure is
1) 1% 2) 2% 3) 8% 4) 10%

45. A thin copper wire of length l metre increases in length by 2% when heated through 10°C. What is the percentage increase in area when a square copper sheet of length l metre is heated through 10°C?
1) 4% 2) 8% 3) 16% 4) 12%

46. Intensity observed in an interference pattern is $I = I_O \sin^2\theta$ at $\theta = 30^0$ intensity $I = 5 \pm 0.0020 W/m^2$. Find percentage error in angle, if I_0 = 20 W/m2.
1) $\frac{4}{\pi}\sqrt{3}\times 10^{-2}\%$ 2) $\frac{2}{\pi}\sqrt{3}\times 10^{-2}\%$ 3) $\frac{1}{\pi}\sqrt{3}\times 10^{-2}\%$ 4) $\frac{3}{\pi}\sqrt{3}\times 10^{-2}\%$

47. If $f = x^2$, then the relative error in f is
1) $\frac{2\Delta x}{x}$ 2) $\frac{(\Delta x)^2}{x}$ 3) $\frac{\Delta x}{x}$ 4) $(\Delta x)^2$

48. Mass of a body is 210 gm and its density is 7.981 g/cm^3 what will be its volume, with regard to significant digits?
1) 26.312 cm^3 2) 26 cm^3 3) 27 cm^3 4) 26.3cm^3

Topic 3: Dimensions of Physical Quantities

49. Which of the following set have different dimensions?
(1) Pressure, Young's modulus, Stress (2) EMF, Potential difference, Electric potential
(3) Heat, Work done, Energy (4) Dipole moment, Electric flux, Magnetic field

50. Which of the following is a dimensional constant?
(1) Refractive index (2) Dielectric constant (3) Relative density (4) Gravitational constant

51. Let Q denote the charge on the plate of a capacitor of capacitance C. The dimensional formula for $\frac{Q^2}{C}$ is
1) $\left[L^2M^2T\right]$ 2) $\left[LMT^2\right]$ 3) $\left[L^2MT^{-2}\right]$ 4) $\left[L^2M^2T^2\right]$

52. Dimensions of 'resistance' are same as (where h is Planck's constant and e is charge)
1) h/e 2) h^2/e 3) h/e^2 4) h^2/ e^2

53. The Solar constant is defined as the energy incident per unit area per second. The dimensional formula for solar constant is

1) $\left[M^0L^0T^0\right]$ 2) $\left[MLT^{-2}\right]$ 3) $\left[ML^2T^{-2}\right]$ 4) $\left[ML^0T^{-3}\right]$

54. The dimensions of physical quantity X in the equation Force$=\dfrac{X}{Density}$ is given by

1) $\left[ML^4T^{-2}\right]$ 2) $\left[M^2L^{-2}T^{-1}\right]$ 3) $\left[M^2L^{-2}T^{-2}\right]$ 4) $\left[ML^{-2}T^{-1}\right]$

55. Which of the following units denotes the dimension $\dfrac{ML^2}{Q^2}$, where Q denotes the electric charge?

1) Wb/m^2 2) Henry (H) (3) H/m2 (4) Weber (W2)

56. Which of the following has the same dimensions?

(1) Impulse and momentum (2) Specific heat and latent heat

(3) Moment of inertia and force (4) Thrust and surface tension

57. The dimensions of voltage in terms of mass (M), length (L) and time (T) and ampere (1) are

1) $\left[ML^2T^{-2}A^{-2}\right]$ 2) $\left[ML^2T^3A^{-1}\right]$ 3) $\left[ML^2T^{-3}A^1\right]$ 4) $\left[ML^2T^{-3}A^{-1}\right]$

58. If L denotes the inductance of an inductor through which a current i is flowing, the dimensions of Li^2 are

1) $\left[ML^2T^{-2}\right]$ 2) $\left[MLT^{-2}\right]$ 3) $\left[M^2L^2T^{-2}\right]$ 4) not expressible in M, L, T

59. The displacement of a body at a particular second n is given by the expression $S_{nth}=u+\dfrac{a}{2}(2n-1)$. The dimensional formula of S_{nth} in this equation is

1) $\left[M^1L^0T^1\right]$ 2) $\left[M^0L^1T^0\right]$ 3) $\left[M^0L^1T^{-1}\right]$ 4) $\left[M^0L^0T^0\right]$

60. In the equation $P=\dfrac{RT}{V-b}e^{\frac{aV}{RT}}$ V = volume, P = pressure, R = universal gas constant, and T = temperature. The dimensional formula of a is same as that of

(1) V (2) P (3) T (4) R

61. Time (T), velocity (3) and linear momentum (h) are chosen as fundamental quantities instead of mass, length and time. In terms of these, the dimensions of mass would be:

1) $[M]=\left[C^{-1}h\right]$ 2) $[M]=\left[T^{-1}C^2h\right]$ 3) $[M]=\left[T^{-1}C^{-2}h^{-1}\right]$ 4) $[M]=\left[C^{-2}h\right]$

62. Suppose the kinetic energy of a body oscillating with amplitude A and at a distance x is given by $K=\dfrac{Bx}{x^2+A^2}$ the dimensions of B are the same as that of

(1) work/time (2) work × distance (3) work/distance (4) work × time

63. The dimensions of universal gas constant are

1) $\left[L^2M^1T^{-2}K^{-1}mol^{-1}\right]$ 2) $\left[L^1M^2T^{-2}K^{-1}mol^{-1}\right]$ 3) $\left[L^1M^1T^{-2}K^{-1}mol^{-1}\right]$ 4) $\left[L^2M^2T^{-2}K^{-1}mol^{-1}\right]$

64. The volume V of water passing any point of a uniform tube during t seconds is related to the cross – sectional area A of the tube and velocity u of water by the relation $V\propto A^\alpha u^\beta t^\gamma$. Which one of the following will be true?

1) $\alpha=\beta=\gamma$ 2) $\alpha\neq\beta=\gamma$ 3) $\alpha=\beta\neq\gamma$ 4) $\alpha\neq\beta\neq\gamma$

65. Given that $(\alpha/p\beta)=az/K_B\theta$ where p is pressure, z is distance, KB is Boltzmann constant and θ is temperature, the dimensions of β are

1) $\left[L^0M^0T^0\right]$ 2) $\left[L^1M^{-1}T^2\right]$ 3) $\left[L^2M^0T^0\right]$ 4) $\left[L^{-1}M^1T^{-2}\right]$

66. The position x of a particle at time t is given by $x=\frac{V_0}{a}\left(1-e^{-at}\right)$, where V_0 is constant and a > 0. The dimensions of V_0 and a are

1) M^0LT^{-1} and T^{-1} 2) M^0LT^0 and T^{-1} 3) M^0LT^{-1} and LT^{-2} 4) M^0LT^{-1} and T

67. Given as : h = $\frac{2S\cos\theta}{r\rho g}$ where S is the surface tension of liquid, r is the radius of capillary tube, ρ is density and g is acceleration due to gravity then dimensional formula for S is:

1) $\left[ML^0T^{-2}\right]$ 2) $\left[M^0LT^{-2}\right]$ 3) $\left[ML^2T^{-2}\right]$ 4) $\left[M^0L^0T^{-3}\right]$

68. The velocity v of a particle at time t is given by $v=at+\frac{b}{t+c}$ The dimensions of a, b c are respectively

1) $\left[LT^{-2}\right][L][T]$ 2) $\left[L^2\right],[T]$ and $\left[LT^2\right]$ 3) $\left[LT^2\right],[LT]$ and $[L]$ 4) $[L],[LT]$ and $\left[T^2\right]$

69. In the equation X = $3YZ^2$, X and Z are dimensions of capacitance and magnetic induction respectively. In MKSQ system, the dimensional formula for Y is

1) $\left[M^{-3}L^{-2}T^{-2}Q^{-4}\right]$ 2) $\left[ML^{-2}\right]$ 3) $\left[M^{-3}L^{-2}Q^4T^8\right]$ 4) $\left[M^{-3}L^{-2}Q^4T^4\right]$

70. The frequency of vibration f of a mass m suspended from a spring of spring constant k is given by a relation of the type $f=cm^xk^y$, where c is a dimensionless constant. The values of x and y are

1) $x=\frac{1}{2},y=\frac{1}{2}$ 2) $x=-\frac{1}{2},y=-\frac{1}{2}$ 3) $x=\frac{1}{2},y=-\frac{1}{2}$ 4) $x=-\frac{1}{2},y=\frac{1}{2}$

NEET PREVIOUS YEARS QUESTIONS

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

1) 0.521cm 2) 0.525cm 3) 0.529cm 4) 0.053 cm

2. 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) (2017)

1) $c^2\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$ 2) $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\varepsilon_0}\right]^{1/2}$ 3) $\frac{1}{c}G\frac{e^2}{4\pi\varepsilon_0}$ 4) $\frac{1}{c^2}\left[G\frac{e^2}{4\pi\varepsilon_0}\right]^{1/2}$

3. If dimensions of critical velocity υ_c of a liquid flowing through a tube are expressed as $\left[\eta^x\rho^yr^x\right]$, where η,ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by (2015)

1) -1,-1,1 2) -1,-1,-1 3) 1,1,1 4) 1,-1,-1

4. If energy (E), velocity (V) and time (T) are chosen as the fundamental quantities the dimensional formula of surface tension will be (2015)

1) $\left[EV^{-1}T^{-2}\right]$ 2) $\left[EV^{-2}T^{-2}\right]$ 3) $\left[E^{-2}V^{-1}T^{-3}\right]$ 4) $\left[EV^{-2}T^{-1}\right]$

5. If force (F), velocity (V) and time (T) are taken as fundamental units, then the dimensions of mass are : (2014)

1) $\left[FVT^{-1}\right]$ 2) $\left[FVT^{-2}\right]$ 3) $\left[FV^{-1}T^{-1}\right]$ 4) $\left[FV^{-1}T\right]$

6. In an experiment, the percentage of error occurred in the measurement of physical quantities A, B, C and D are 1%, 2%, 3% and 4% respectively. Then the maximum percentage of error in the measurement X, where $X = \dfrac{A^2B^{1/2}}{C^{1/3}D^3}$, will be: **(NEET-2019)**

(1) $\left(\dfrac{3}{13}\right)\%$ (2) 16% (3) –10% (4) 10%

7. The main scale of a vernier calliper has n divisions/cm. n divisions of the vernier scale coincide with (n – 1) divisions of main scale. The least count of the vernier calliper is, **[NEET – 2019 (ODISSA)]**

1) $\dfrac{1}{(n+1)(n-1)}cm$ 2) $\dfrac{1}{n}cm$ 3) $\dfrac{1}{n^2}cm$ 4) $\dfrac{1}{n(n+1)}cm$

8. The angle of 1' (minute of arc) in radian is nearly equal to **(NEET-2020 COVID-19)**

(1) 2.91×10^{-4} rad (2) 4.85×10^{-4} rad (3) 4.80×10^{-6} rad (4) 1.75×10^{-2} rad

9. Time intervals measured by a clock give the following readings:
1.25 s, 1.24 s, 1.27 s, 1.21 s and 1.28 s.
What is the percentage relative error of the observations? **(NEET-2020 COVID-19)**
(1) 2 % (2) 4 % (3) 16 % (4) 1.6 %

10. Dimensions of stress are: (NEET-2020)
1) $\left[ML^{-1}T^{-2}\right]$ 2) $\left[MLT^{-2}\right]$ 3) $\left[ML^2T^{-2}\right]$ 4) $\left[ML^0T^{-2}\right]$

11. Taking into account of the significant figures, what is the value if 9.99m – 0.0099m? **(NEET-2020)**
1) 9.9 m 2) 9.9801m 3) 9.98m 4) 9.980m

12. If force [F], acceleration [A] and time [T] are chosen as the fundamental physical quantities. Find the dimensions of energy. **[NEET-2021]**
1) $[F][A][T^2]$ 2) $[F][A][T^{-1}]$ 3) $[F][A^{-1}][T]$ 4) $[F][A][T]$

13. A screw gauge gives the following readings when used to measure the diameter of a wire
Main scale reading: 0 nm
Circular scale reading: 52 divisions
given that 1 mm on main scale corresponds to 100 divisions on the circular scale. The diameter of the wire from the above data is **[NEET-2021]**
1) 0.026 cm 2) 0.26 cm 3) 0.052 cm 4) 0.52 cm

14. If E and G respectively denote energy and gravitational constant, then $\dfrac{E}{G}$ has the dimensions of: **[NEET-2021]**

1. $[M][L^{-1}][T^{-1}]$ 2. $[M][L^0][T^0]$ 3. $[M^2][L^{-2}][T^{-1}]$ 4. $[M^2][L^{-1}][T^0]$

15. The dimensions $\left[MLT^{-2}A^{-2}\right]$ belong to the: **[NEET-2022]**

1) Magnetic flux 2) Self inductance
3) Magnetic permeability 4) Electric permittivity

16. Plane angle and solid angle have: **[NEET-2022]**
1) Units but no dimensions 2) Dimensions but no units
3) No units and no dimensions 4) Both units and dimensions

17. The area of a rectangular field (in m2) of length 55.3 m and breadth 25 m after rounding ff the value for correct significant digits is: **[NEET-2022]**

(1) 138×10^1 (2) 1382 (3) 1382.5 (4) 14×10^2

18. Match List-I with List-II **[NEET-2022]**

List-I	List-II
a) Gravitational constant (G)	(i) $\left[L^{2}T^{-2}\right]$
b) Gravitational Potential energy	(ii) $\left[M^{-1}L^{3}T^{-2}\right]$
c) Gravitational Potential	(iii) $\left[LT^{-2}\right]$
d) Gravitational intensity	(iv) $\left[ML^{2}T^{-2}\right]$

Choose the correct answer from the options given below

	a	b	c	d
1)	ii	i	iv	iii
2)	ii	iv	i	iii
3)	ii	iv	iii	i
4)	iv	ii	i	iii

NCERT LINE BY LINE QUESTIONS – ANSWERS

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

NCERT BASED PRACTICE QUESTIONS- ANSWERS

1) c	2) a	3) c	4) b	5) b	6) a	7) a	8) c	9) a	10) d
11) c	12) b	13) b	14) c	15) d	16) b	17) c	18) a	19) a	20) b
21) c	22) b	23) a	24) c	25) c	26) b	27) d	28) d	29)c	30) a
31) a	32)c	33)b	34)a	35)a	36) b	37)d	38)d	39)a	40)a

TOPIC WISE PRACTICE QUESTIONS – ANSWERS

1) 3	2) 4	3) 3	4) 4	5) 1	6) 1	7) 2	8) 4	9) 1	10)3
11)2	12)2	13)2	14)3	15)3	16)2	17)3	18)4	19)2	20)3
21)1	22)3	23)3	24)3	25)2	26)4	27)2	28)3	29)3	30)1
31)3	32)2	33)3	34)3	35)3	36)2	37)2	38)1	39)3	40)3
41)4	42)1	43)4	44)3	45)1	46)1	47)1	48)2	49)4	50)4
51)3	52)3	53)4	54)3	55)2	56)1	57)4	58)1	59)3	60)2
61)1	62)2	63)1	64)2	65)3	66)1	67)1	68)1	69)4	70)4

NEET PREVIOUS YEARS QUESTIONS-ANSWERS

1) 3	2) 4	3) 4	4) 2	5) 4	6) 2	7) 3	8) 2	9) 4	10) 1
11) 3	12) 1	13) 3	14) 4	15) 3	16) 1	17) 4	18) 2		

TOPIC WISE PRACTICE QUESTIONS – SOLUTIONS

1) 3) $R = \rho \frac{l}{A} \therefore \rho = \frac{RA}{l}$

2) 4) Temperature is one of the basic physical quantities

3) 1) Potential is work done per unit charge

4) 4) conductance, $G = \frac{1}{resistance} = mho\left(\Omega^{-1}\right) or\ Siemen(S)$

5) 1) From Biot Savart's law

$$B = \frac{\mu_0}{4\pi}\frac{idl\sin\theta}{r^2}$$

$$\mu_0 = \frac{4\pi Br^2}{i\,dl\sin\theta} = \frac{Wbm^{-2}m^2}{Am} = WbA^{-1}m^{-1}$$

6) 1) The henry (symbolized H) is the Standard International (SI) unit of coefficient of mutual inductance of a coil

7) 2) 1 Dyne = 10^{-5}N and 1 cm = 10^{-2}m so, S = 70 dyne/cm= $\frac{70\times10^{-5}\,N}{10^{-2}\,m} = 70\times10^{-3}\,N/m \Rightarrow S = 7\times10^{-2}\,N/m$

8) 4) Joule second is the unit of angular momentum

9) 1) Stefan – Boltzman constant = $Wm^{-2}k^{-4}$ = w/m^2k^4

10) 3) It is given that Young's modulus (Y) is

$Y = 1.9\times10^{11}\,N/m^2$

1N = 10^5 dyne

So, $Y = 1.9\times10^{11}\times10^5\,dyne/m^2$

Convert meter to centimeter $\because 1m = 100cm$

$Y = 1.9\times10^{11}\times10^5\,dyne/(100)^2\,cm^2 = 1.9\times10^{12}\,dyne/cm^2$

11) 2) the unit of the Electric field is N/C or V/m.

The unit of the magnetic field is Weber.

The unit of power is Watt.

The unit of the Capacitance is Farad.

12) 2) $\frac{N}{m^2} = \frac{10^5\,dynes}{10^4\,cm^2} = 10dynes/cm^2 = 10\beta$

13) 2) As $\frac{a}{V^2} = P$

$\therefore a = PV^2 = \frac{dyne}{cm^2}\left(cm^3\right)^2 = dyne\times cm^4$

14) 3) $n_2 = 100\left(\frac{gm}{10^3\,gm}\right)^1\left(\frac{cm}{m}\right)^1\left(\frac{\sec}{\min}\right)^{-2} = 100\left(\frac{gm}{10^3\,gm}\right)^1\left(\frac{cm}{10^2\,cm}\right)^1\left(\frac{\sec}{60\sec}\right)^{-2}$

$n_2 = \frac{3600}{10^3} = 3.6$

15. 3) $\frac{eV}{T} = \frac{W}{T} = \frac{PV}{T} = R$ and $\frac{R}{N} =$ Boltzmann constant

16. 2) Trigonometric ratios are a number and hence unit less

17. 3) Unit of x = bt^2. Hence unit of b = x/t^2 = km/s^2

18. 4) the correct unit of surface tension is newton/metre

19. 2) The work done = force $\times$ displacement

$\therefore unit, u_1 = Fs$ and $u_2 = 4F\times4s = 16u$

20. 3) $n_1u_1 = n_2u_2$; $\therefore n_2 = n_1\frac{u_1}{u_2} = 8\left[\frac{1}{20}\right]\left[\frac{5}{1}\right]^3 = 50$

21. 1) Random errors cannot be eliminated altogether even after taking utmost care. It can only be reduced by taking more number of observations

22. 3) $V = \frac{4}{3}\pi r^3; \frac{\Delta V}{V}\times100 = 3\left(\frac{\Delta r}{r}\right)\times100 = 3\times1\% = 3\%$

23. 3) Maximum absolute error is $\Delta a + \Delta b$. Therefore the percentage error = $\frac{absolute\ error}{actual\ value}\times100$

24. 3) In multiplication or division the final result should return as many significant figures as there are in the original number with the least significant figures.

25. 2) in a product, percentage errors are added up

26. 4) $V = \frac{m}{d} \Rightarrow \frac{\Delta V}{V}\times100 = \frac{\Delta m}{m}\times100 + \frac{\Delta d}{d}\times100 = 3\% + 1\% = 4\%$

27. 2)The significant number in the potential, V = iR; should be the minimum of either i or R. So corresponding to
i=3.23A, we have only three significant numbers in V = 35.02935V. Thus the result is V = 35.0V

28. 3) Momentum of the body is mv = $3.513kg \times 5.00m/s = 17.565kgm/s$
However, the accuracy of the result would be determined by the most inaccurate observation, which is speed with three significant digits. Thus the answer would be expressed in three significant digits, that is, 17.6 kgm/s

29. 3) From $T = 2\pi\sqrt{\frac{l}{g}}; g = 4\pi^2 \frac{l}{T^2}$
$$\frac{\Delta g}{g} = \frac{\Delta l}{l} + \frac{2\Delta T}{T} = (y + 2x)$$

30) 1) % error = $\frac{0.01}{0.5}\times 100 + \frac{0.01}{1.0}\times 100 + \frac{0.01}{0.5}\times 100 = 2 + 1 + 2 = 4 + 1 = 5$

31. 3) $l_1 - l_2 = (3.323 \pm 0.001) - (3.321 \pm 0.001) = (0.002 \pm 0.002)cm$

32. 2) Relative density = $\frac{\text{Weight of body in air}}{\text{Loss of weight in water}} = \frac{5.00}{5.00 - 4.00} = \frac{5.00}{1.00}$
$$\frac{\text{Weight of body in air}}{\text{Loss of weight in water}} = \frac{5.00}{5.00 - 4.00} = \frac{5.00}{1.00}$$
$$\frac{\Delta\rho}{\rho}\times 100 = \left(\frac{0.05}{5.00} + \frac{0.05}{1.00}\right)\times 100 = (0.01 + 0.05)\times 100 = 0.06 \times 100 = 6\%$$
$\therefore$ Relative density = $5.00 \pm 6\%$

33. 3) $X = M^x L^{-y} T^{-z}$
$$\therefore \frac{\Delta X}{X}\times 100 = x\left(\frac{\Delta M}{M}\times 100\right) + y\left(\frac{\Delta L}{L}\times 100\right) + z\left(\frac{\Delta T}{T}\times 100\right)$$
(Errors are always added)
$$\therefore \frac{\Delta X}{X}\times 100 = (ax + by + cz)\text{ per cent}$$

34. 3) $E = \frac{1}{2}mv^2$
$$\therefore \frac{\Delta E}{E}\times 100 = \frac{\Delta m}{m}\times 100 + 2\frac{\Delta V}{V}\times 100 = 2\% + 2\times 3\% = 8\%$$

35. 3) The percentage error $= \frac{1}{5}\times\frac{100}{25} = 0.8\%$

36. 2) thickness of wall = $= \frac{1}{2}(4.23 - 3.87) \pm (0.01 + 0.01)$

37. 2) $r = \frac{1.933}{2} = 0.9665 \approx 0.966cm$

38. 1) percentage error in X = $a\alpha + b\beta + c\gamma$

39. 3) $T = 2\pi\sqrt{\frac{l}{g}}, g \propto \frac{l}{T^2}$
$$\therefore \frac{\Delta g}{g}\times 100 = 0.3\% + 2\times 0.1\% = 0.5\%$$

40. 3) Relative error in surface area, $\frac{\Delta s}{s} = 2\times\frac{\Delta r}{r} = \alpha$ and relative error in volume, $\frac{\Delta v}{v} = 3\times\frac{\Delta r}{r}$
$\therefore$ relative error in volume w.r.t relative error in area

$$\frac{\Delta v}{v}=\frac{3}{2}\alpha$$

41. 4) Density = Mass/Volume

$$\rho=\frac{M}{L^3},\frac{\Delta\rho}{\rho}=\frac{\Delta M}{M}+3\frac{\Delta L}{L}$$

% error in density = % error in Mass + 3 (% error in length) = 4+3(3) = 13%

42. 1)The mean value of refractive index, $\mu=\frac{1.34+1.38+1.32+1.36}{4}=1.35$ and

$$\Delta\mu=\frac{|(1.35-1.34)|+|(1.35-1.38)|+|(1.35-1.32)|+|(1.35-1.36)|}{4}=0.02 \text{ thus}$$

$$\frac{\Delta\mu}{\mu}\times100=\frac{0.02}{1.35}\times100=1.48$$

43. 4)density, $\rho=\frac{M}{V}=\frac{M}{\pi r^2 l}$

$$\therefore\frac{\Delta\rho}{\rho}\times100=\left[\frac{\Delta M}{M}+\frac{2\Delta r}{r}+\frac{\Delta l}{l}\right]\times100=\left[\frac{0.003}{0.3}+2\frac{0.005}{0.5}+\frac{0.06}{6}\right]\times100=4$$

44. 3) $\frac{\Delta P}{P}\times100=\frac{\Delta F}{F}\times100+2\frac{\Delta l}{l}\times100=4\%+2\times2\%=8\%$

45. 1) Since percentage increase in length = 2% Hence, percentage increase in area of square sheet = $2\times2\%=4\%$

46. 1) $\sin\theta=\sqrt{\frac{I}{I_0}}$

Differentiating the above equation,

$\cos\theta d\theta=\frac{1}{2}\frac{1}{I^{3/2}I_0^{1/2}}$ thus $d\theta=\frac{1}{2I}\tan\theta dI\Rightarrow\frac{d\theta}{\theta}=\frac{\tan\theta dI}{2\theta I}$ put $\theta=30\times\frac{\pi}{180}$ radians, $dI=0.002, I=5,$

percentage error in angle = $\frac{d\theta}{\theta}\times100\%=\frac{4\sqrt{3}}{\pi}\times10^{-2}\%$

47. 1)

Given that: $f = x^2$

Hence, $\frac{df}{dx} = 2x$

Therefore: $\Delta f = \frac{df}{dx}\Delta x = 2x\Delta x$

The relative error in f is:

$$\frac{\Delta f}{f} = \frac{2x\Delta x}{x^2}$$

$$\frac{\Delta f}{f} = \frac{2\Delta x}{x}$$

48. 2) Density is the ratio of mass and volume
D = m/V

V = m/d
V = 210/7.981
V= 26.312cm^3
The LEAST number of significant figures in any number of the problem determines the number of significant figures in the answer. So the answer is 26.3

49. 4) Electric flux $\phi_E = \vec{E}.\vec{S}$ $\therefore$ dimensionally $\phi_E \neq E$

50. 4) Gravitational constant also known as universal gravitational constant has a symbol G and has a dimension $\left[M^{-1}L^{3}T^{-2}\right]$ while others are dimensionless constant.

51. 3)We know that $\frac{Q^2}{2C}$ is energy of capacitor so it represent the dimension of energy $=\left[ML^2T^{-2}\right]$

52. 3) $\frac{h}{e^2} = \frac{ML^2T^{-1}}{(AT)^2} = ML^2T^{-3}A^{-2} =$ Resistance (ohm)

53. 4) Energy incident per unit area per second
$= \frac{Energy}{area \times second} = \frac{ML^2T^{-2}}{L^2T} = MT^{-3}$

54. 3) $X = Force \times density$
$\left[MLT^{-2}\right]\frac{[M]}{\left[L^3\right]} = \left[M^2L^{-2}T^{-2}\right]$

55. 2) Mutual inductance = $\frac{\phi}{I} = \frac{BA}{I}$
$[Henry] = \frac{\left[MT^{-1}Q^{-1}L^2\right]}{\left[QT^{-1}\right]} = ML^2Q^{-2}$

56. 1) Impulse = change in momentum

57. 4) $[V] = \left[\frac{W}{Q}\right] = \frac{ML^2T^{-2}}{AT} = ML^2A^{-1}T^{-3}$

58. 1) Energy stored in an inductor = $\frac{1}{2}Li^2 = \left[ML^2T^{-2}\right]$

59. 3) u = initial velocity = $\left[M^0L^1T^{-1}\right]$ The dimension of $S_{n^{th}}$ is same as that of $u \times 1sec$ .Hence, $\left[M^0L^1T^0\right]$

60 2) $\frac{aV}{RT} =$ dimensionless $\Rightarrow a \propto \frac{RT}{V}$.............(1)
Now, $\frac{RT}{v-b} \propto \frac{RT}{v} \propto p$ (dimensionally)............(2)Hence, from (1) and (2) dimension of a is same as P.

61. 1) Let mass, related as $M \propto T^xC^yh^z$
$M^1L^0T^0 = \left(T^{'}\right)^x\left(L^1T^{-1}\right)^y\left(M^1L^1T^{-1}\right)^z$
$M^1L^0T^0 = M^zL^{y+z} + T^{x-y-z}$
$z = 1, y + z = 0, y = -1$
$x - y - z = 0 \ x = 0$
$M = \left[C^{-1}h\right]$

62. 2)From $K = \frac{Bx}{x^2 + A^2} = \frac{Bx}{x^2} = \frac{B}{x}$
$\therefore B = K \times x = K.E. \times$ distance = work $\times$ distance

63. 1) $R = \frac{PV}{\mu T} = \frac{W}{\mu T} = \frac{ML^2T^{-2}}{mol\,K} = \left[M^1L^2T^{-2}K^{-1}mol^{-1}\right]$

64. 2) The dimensions of the two sides of pro portionality are $L^3 = L^{2\alpha}\left(LT^{-1}\right)^{\beta} T^{\gamma} = L^{2\alpha+\beta}T^{\gamma-\beta}$

Equating the powers of dimensions on both sides, we have $2\alpha+\beta=3\gamma-\beta=0$

which gives β □ γ and α = 1/2 (3 – β), i.e. α ≠ β = γ.

65. 3)

66. 1) Here, at is dimensionless

$$\Rightarrow a = \frac{1}{t} = \left[\frac{1}{T}\right] = \left[T^{-1}\right] \text{and } V_0 = xa = \left[LT^{-1}\right] = \left[M^0LT^{-1}\right]$$

67. 1) $S = \frac{F}{l} = \frac{mLT^{-2}}{L} = m^1L^0T^{-2}$

68. 1) As c is added to t, $\therefore c = [T]$

$$a = \frac{v}{t} = \frac{LT^{-1}}{T} = \left[LT^{-2}\right], b = v(t+c) = LT^{-1}\times T = [L]$$

69. 4) $[Y] = \frac{[X]}{\left[Z^2\right]} = \frac{M^{-1}L^{-2}T^4A^2}{M^2T^{-4}A^{-2}} = M^{-3}L^{-2}Q^4T^4$

70. 4) $f = cm^xk^y$;

Spring constant k = force/length.

$$\left[M^0L^0T^{-1}\right] = \left[M^x\left(MT^{-2}\right)^y\right] = \left[M^{x+y}T^{-2y}\right] \Rightarrow x+y=0, -2y=-1 \text{or } y=\frac{1}{2} \text{and } x = -\frac{1}{2}$$

NEET PREVIOUS YEARS QUESTIONS-EXPLANATIONS

1. 3) Diameter of the ball = MSR + CSR × ($l$east count) – zero error

= 0.5cm + 25 ×0.001 – (-0.004)= 0.5 + 0.025 + 0.004 = 0.529 cm

2. 4) Let dimensions of length is related as,

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

$$\frac{e^2}{4\pi\varepsilon_0} = ML^3T^{-2}$$

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

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

Comparing both sides

-y + z = 0 $\Rightarrow y = z$ ……(i)

x + 3y + 3z = 1 ……..(ii)

-x – 4z = 0 $(\because y = z)$…….(iii)

From (i), (ii), (iii)

Z = y = 1/2, x = -2

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

3. (4) Applying dimensional method:

$v_c = \eta^x \rho^y r^z$

$$\left[M^0LT^{-1}\right] = \left[ML^{-1}T^{-1}\right]^x \left[ML^{-3}T^0\right]^y \left[M^0LT^0\right]^z$$

Equating power both sides

$x + y = 0; -x = -1 \therefore x = 1$

$1+y=0 \therefore y=-1$; $-x-3y+z=1$

$-1-3(-1)+z=1$; $-1+3+z=1$

$\therefore z=-1$

4) b) let surface tension

$s=E^aV^bT^c$

$$\frac{MLT^{-2}}{L}=\left(ML^2T^{-2}\right)^a\left(\frac{L}{T}\right)^b(T)^C$$

Equating the dimension of LHS and RHS

$ML^0T^{-2}=M^aL^{2a+b}T^{-2a-b+c}$

$\Rightarrow a=1, 2a+b=0, -2a-b+c=-2 \Rightarrow a=1, b=-2, c=-2$

Hence, the dimensions of surface tension are $\left[EV^{-2}T^{-2}\right]$

5. 4) Force = mass $\times$ acceleration $\Rightarrow [Mass]=\left[\frac{force}{acceleration}\right]=\left[\frac{force}{velocity/time}\right]=\left[FV^{-1}T\right]$

6.

$$x=\frac{A^2B^{1/2}}{C^{1/3}D^3}$$

$$\frac{\Delta x}{x}=\frac{2\Delta A}{A}+\frac{1}{2}\frac{\Delta B}{B}+\frac{1}{3}\frac{\Delta C}{C}+3\frac{\Delta D}{D}$$

$$\frac{\Delta x}{x}\times 100=2(1\%)+\frac{1}{2}(2\%)+\frac{1}{3}(3\%)+3(4\%)=16\%$$

7.

$$n(VSD)=(n-1)MSD$$

$$\Rightarrow 1VSD=\frac{(n-1)}{n}MSD$$

$$\text{Least count}=1MSD-1VSD=[1-\frac{(n-1)}{n}]$$

$$MSD=\frac{1}{n}MSD$$

$$=\frac{1}{n}(\frac{1}{n})cm$$

$$=\frac{1}{n^2}cm$$

8. 1) $1'=\left(\frac{1}{60}\right)^0=\frac{1}{60}\times\frac{\pi}{180}$ radian

9. 4) Mean of observation $=\frac{1.25+1.24+1.27+1.21+1.28}{5}=1.25s$

Mean absolute error $=\frac{0+0.01+0.02+0.04+0.03}{5}=0.02s$

% Error $=\frac{0.02}{1.25}\times 100=1.6\%$

10. 1) DF of stress $=\frac{F}{A}=\frac{MLT^{-2}}{L^2}$; Stress = $[ML^{-1}T^{-2}]$

11. 3) 9.99 – 0.0099= 9.99 – 0.009 = 9.981

Here minimum number of decimal places = 2
So other numbers should be rounded off up to 3 decimal places.
Answer should be rounded off up to '2' decimal places.
Ans = 9.98

12. 1)E = F.S$\Rightarrow S = \frac{1}{2}at^2$; E$=[FAT^2]$

13. 3)Reading = M.S.R +[C.S.R(L.C)] =0+ 52 $\times \frac{1mm}{100}$ =0.052 cm

14. 4)

$$E = \frac{Gm_1m_2}{R}$$

$$\left[\frac{E}{G}\right] = \left[\frac{m^2}{R}\right] = \left[M^2L^{-1}T^0\right]$$

15.: Magnetic permeability $\rho = MLT^{-2}A^{-2}$

16. Plane angle and sound angle have unit but no dimension

17. $A = L \times 6$

$= 55.3 \times 25$

$= 1382.5\,m^2$

$= 14 \times 10^2\,m^2$

18. Gravitational Constant $G\left(M^{-1}L^3T^{-2}\right)$

Gravitational PE $\left(M^1L^2T^{-2}\right)$

Gravitational Potential $\left(M^0L^2T^{-2}\right)$

Gravitational Intensity $\left(L^1T^{-2}\right)$