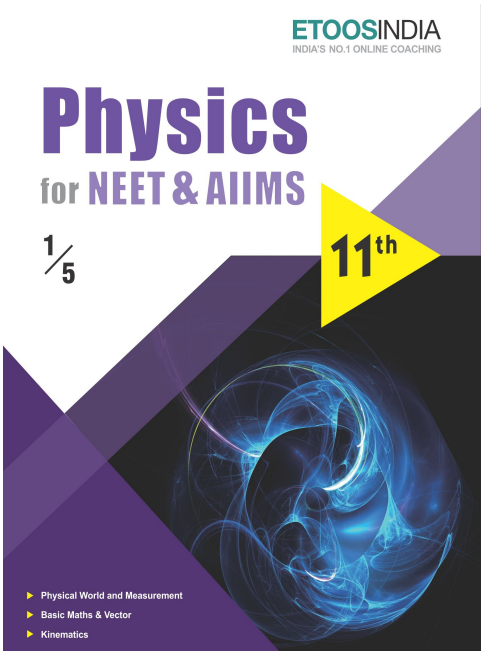
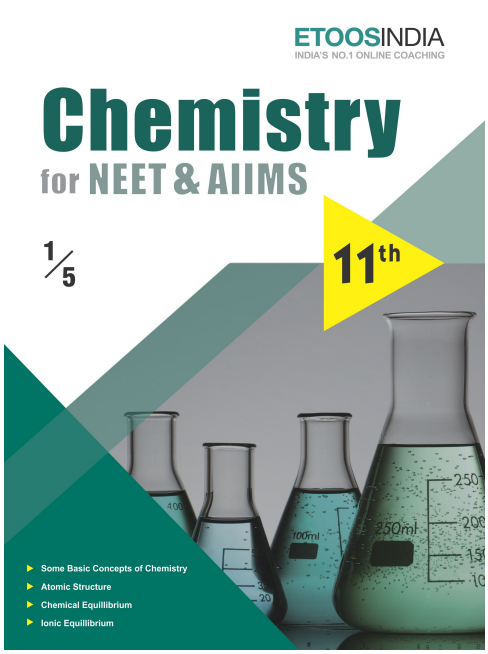
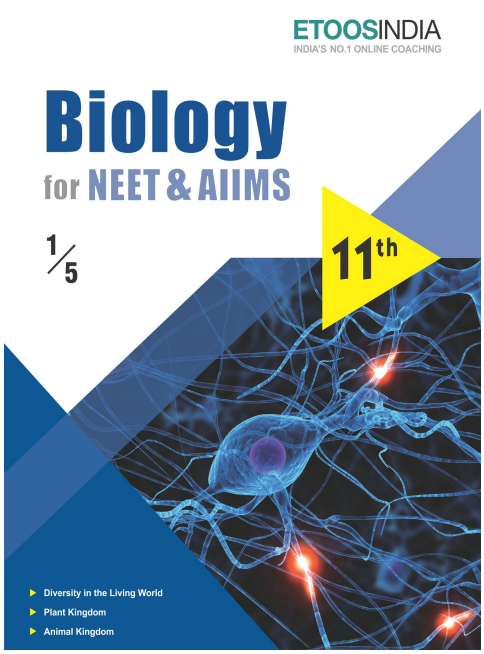
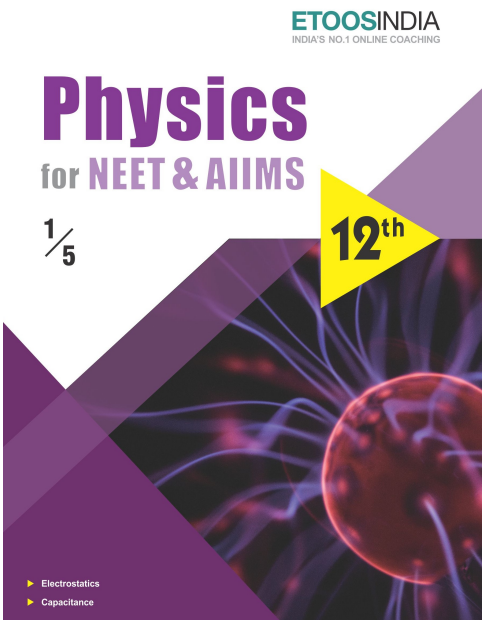
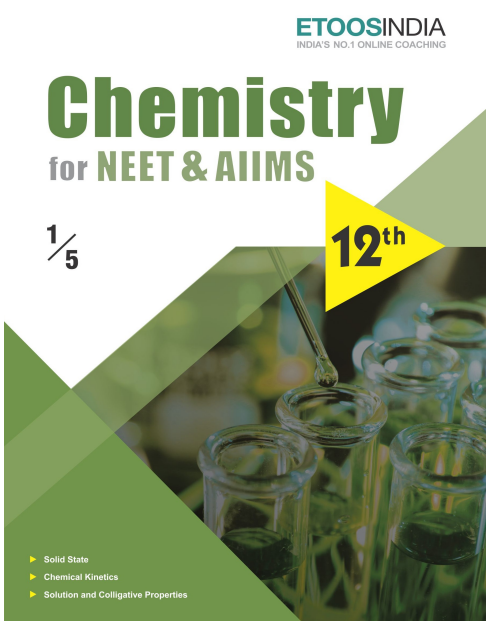
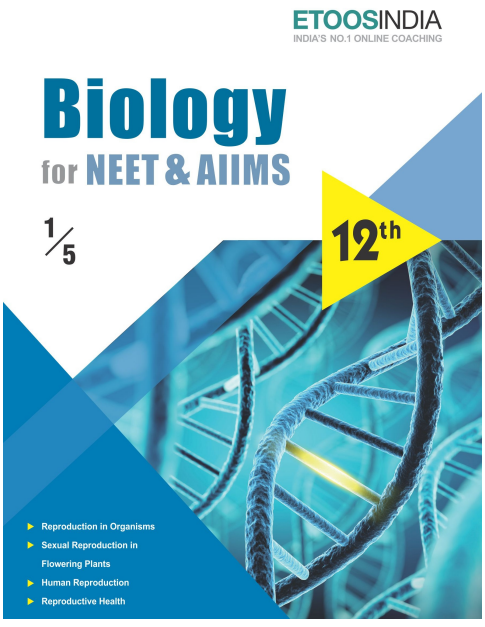












CHAPTER 01

PHYSICAL WORLD AND MEASUREMENT

Science is beautiful when it makes simple explanations of phenomena or connections between different observations. Examples include the double helix in biology and the fundamental equations of physics.

"STEPHEN HAWKING"

INTRODUCTION

Physics is sometimes called as 'science of measurement'. The acceleration produced by a force for the motion of a body can be known by measuring the magnitude of applied force and mass of the body. Similarly, the distance of a stone covered, when thrown horizontally, can be measured by knowing its initial speed, time taken by it to cover the distance and acceleration in its motion. As told by Lord Kelvin, "If we can measure what we are speaking about and express it in a value, then we know something about it, else our knowledge is limited." So, to understand physics completely, it is necessary to measure quantities like speed, time, mass and force.

Problem Solving Strategy (Unit Conversion)

(i) **Identify the relevant concept** Unit conversion is important to recognise what it's needed. In most cases, you are best off using the fundamental SI units (length in metres, mass in kilograms and time in second) within a problem.

(ii) **Set up the problem** Units are multiplied and divided just like ordinary algebraic symbols. It gives us an easy way to convert a quantity from one set of units to another.

(iii) Execute the problem e.g., We say that 1 min = 60 s. So, the ratio of (1 min) / (60 s) equal to 1/60, as does its reciprocal (60 s) / (1 min). We may multiply a quantity by either of these factors without changing the quantity's by physical meaning. To find the number of seconds in 3 min, we write as

$$3\,\text{min} = (3\,\text{min})\left(\frac{60\,\text{s}}{1\,\text{min}}\right) = 180\,\text{s}$$

(iv) **Evaluate your answer** Check whether your answer is reasonable. Is the result 3 min = 180 s reasonable? Is your answer is consistent with an unit of conversion?

Ex. Calculate the angle of (Conversion of Units)
(i) 1° (degree)
(ii) 1'' (second of arc or arc sec) in radian.

Sol. (i) $1^\circ = \frac{2\pi}{360}\,\text{rad} = \frac{\pi}{180} = \frac{22}{7\times 180} \Rightarrow 1.746\times 10^{-2}\,\text{rad}$

(ii) $1\text{ arc sec} = 1'' = \frac{1'}{60} = \frac{1^\circ}{60\times 60}$

$$= \frac{1}{60\times 60}\times\frac{\pi}{180}\,\text{rad} \Rightarrow 4.85\times 10^{-6}\,\text{rad}$$

ETOOS KEY POINTS

Rules of Writing SI Units

(i) Small letters are used for symbols of units.
(ii) Symbols are not followed by a full stop.
(iii) The initial letter of a symbol is capital only when the unit is named after a scientist.
(iv) The full name of a unit always begins with a small letter even if it has been named after a scientist.
(v) Symbols do not take plural form.

Advantages of SI over other Systems of Units

(i) **SI is a coherent system of units** All derived units can be obtained by simple multiplication or division of fundamental units without introducing any numerical factor.

(ii) **SI is a rational system of units** It uses only one unit for a given physical quantity. e.g., all forms of energy are measured in joule. On the other hand, in MKS system, the mechanical energy is measured in joule, heat energy in calorie and electrical energy in watt hour.

(iii) **SI is a metric system** The multiples and submultiples of SI units can be expressed as powers of 10. i.e. $a \times 10^{\pm b}$.

(iv) **SI is an absolute system of units** It does not use gravitational units. The use of 'g' is not required.

Ex. In ohm's law exp., reading of voltmeter across the resistor is 12.5 V and reading of current i = 0.20 Amp. Estimate the resistance in correct S.F.

Sol. $R = \frac{V}{i} = \frac{12.5 \rightarrow 3\ SF}{0.20 \rightarrow 2\ SF} = 62.5\ \Omega \xrightarrow[\text{to 2 S.F.}]{\text{round off}} 62\ \Omega$

Ex. Using screw gauge radius of wire was found to be 2.50 mm. The length of wire found by mm. scale is 50.0 cm. If mass of wire was measured as 25 gm, the density of the wire in correct S.F. will be (use $\pi = 3.14$ exactly)

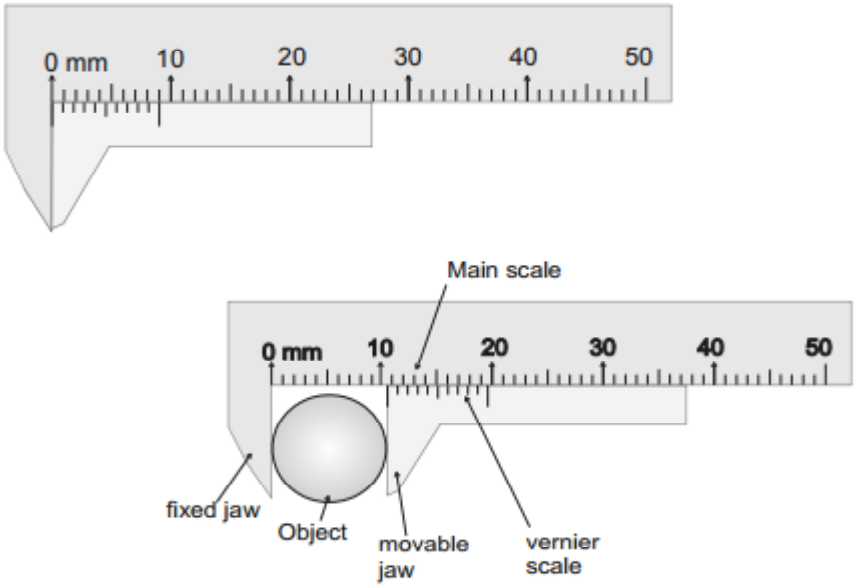
Sol. $$\rho = \frac{m}{\pi r^2 \ell} = \frac{25\ (\text{two S.F.})}{\pi (0.250)^2 (50.0)}$$

(three S.F, three S.F.)

$$= 2.5465 \xrightarrow[\text{S.F.}]{\text{two}} 2.5\ gm/cm^3$$

VERNIER CALLIPERS

It is used to measure accurately upto 0.1 mm.



*On the upper plate, main scale is printed which is simply an mm scale.

*On the lower plate , vernier scale is printed, which is a bit compressed scale. Its one part is of 0.9 mm.

(10 vernier scale divisions = 9 mm $\Rightarrow$ 1 vernier scale division = 0.9 mm)

The object which is to be measured , is fitted between the jaws as shown.

Etoos Tips & Formulas

1. **Fundamental or base quantities :**

The quantities which do not depend upon other quantities for their complete definition are known as fundamental or base quantities. **e.g.** : length, mass, time, etc.

2. **Derived quantities :**

The quantities which can be expressed in terms of the fundamental quantities are known as derived quantities.

e.g. Speed (=distance/time), volume, acceleration, force, pressure, etc.

3. **Units of physical quantities**

The chosen reference standard of measurement in multiples of which, a physical quantity is expressed is called the unit of that quantity.

Physical Quantity = Numerical Value × Unit

4. **Supplementary Units**

(a) Radian (rad) – for measurement of plane angle **(b)** Steradian (sr) – for measurement of solid angle

5. **Dimensional formula**

Physical quantity which express physical quantities in terms of appropriate powers of fundamental units.

6. **Use of dimensional analysis**

(a) To check the dimensional correctness of a given physical relation

(b) To derive relationship between different physical quantities

(c) To convert units of a physical quantity from one system to the other

$$n_1u_1 = n_2u_2 \Rightarrow n_2 = n_1\left(\frac{M_1}{M_2}\right)^a\left(\frac{L_1}{L_2}\right)^b\left(\frac{T_1}{T_2}\right)^c \text{ where } u = M^a L^b T^c$$

7. **Limitations of this method**

(a) In Mechanics the formula for a physical quantity depending on more than three physical quantities cannot be derived. It can only be checked.

(b) This method can be used only if the dependency is of multiplication type. The formulae containing exponential, trigonometrical and logarithmic functions can't be derived using this method. Formulae containing more than one term which are added or subtracted like $s = ut + \frac{1}{2}at^2$ also can't be derived.

(iii) The relation derived from this method gives no information about the dimensionless constants.

(iv) If dimensions are given, physical quantity may not be unique as many physical quantities have the same dimensions.

(v) It gives no information whether a physical quantity is a scalar or a vector.

8. **SI Prefixes**

The magnitudes of physical quantities vary over a wide range. The CGPM recommended standard prefixes for magnitude too large or too small to be expressed more compactly for certain powers of 10.

9. Trigonometric functions $\sin\theta$, $\cos\theta$, $\tan\theta$ etc. and their arrangements θ are dimensionless.

10. Dimensions of differential coefficients $\left[\frac{d^n y}{dx^n}\right] = \left[\frac{y}{x^n}\right]$

11. Dimensions of integrals $\left[\int y dx\right] = [yx]$

12. We can't add or subtract two physical quantities of different dimensions.

13. Independent quantities may be taken as fundamental quantities in a new system of units.

SOLVED EXAMPLE

Ex.1 Which of the following sets connot enter into the list of fundamental quantities in any newly proposed system of units ?

(A) length, mass and velocity

(B) pressure, density and velocity

(C) force, velocity and time

(D) force, momentum and time

Sol. For **(A)** Length [L], Mass [M] and velocity [LT^{-1}] are independent.

For **(B)** Pressure [$M^1L^{-1}T^{-2}$], density [$M^1L^{-3}T^0$] and velocity [M^0LT^{-1}] are dependent as

$$\begin{vmatrix} 1 & -1 & -2 \\ 1 & -3 & 0 \\ 0 & 1 & -1 \end{vmatrix} = 1(3-0)+1(-1-0)-2(1-0)=0$$

Note : Like coplanar vectors, for dependent quantities, determinant of powers of M, L, T's must be zero.

For **(C)** Force [MLT^{-2}], velocity [LT^{-1}] and time [T] are independent as

$$\begin{vmatrix} 1 & 1 & -2 \\ 0 & 1 & -1 \\ 0 & 0 & 1 \end{vmatrix} = 1(1-0)-1(0-0)-2(0-0)=1\neq 0$$

For **(D)** Force $= \dfrac{\text{momentum}}{\text{time}}$

$\Rightarrow$ force, momentum and time are dependent.

Ex.2 Find the dimensional formulae of following quantities

(A) The surface tension S,

(B) The thermal conductivity k and

(C) The coefficient of viscosity η.

Some equation involving these quantities are

$S = \dfrac{\rho grh}{2}$ $Q = k\dfrac{A(\theta_2-\theta_1)t}{d}$ and

$$F = -\eta A\frac{(v_2-v_1)}{x_2-x_1}$$

Sol. **(A)** $S = \dfrac{\rho grh}{2}$

or $[S]=[\rho][g]L^2 = \dfrac{M}{L^2}.\dfrac{L}{T^2}.L^2 = MT^{-2}$

(B) $Q = k\dfrac{A(\theta_2-\theta_1)t}{d}$

or $k = \dfrac{Qd}{A(\theta_2-\theta_1)t}$

Here , Q is the heat energy having dimension ML^2T^{-2}, $\theta_2-\theta_1$ is temperature, A is area, d is thickness and t is time. Thus,

$$[k]=\frac{ML^3T^{-2}}{L^2KT}=MLT^{-3}K^{-1}$$

(C) $F = -hA\dfrac{v_2-v_1}{x_2-x_1}$ or

$MLT^{-2} = [\eta]L^2\dfrac{L/T}{L} = [\eta]\dfrac{L^2}{T}$ or ,

[h] = $ML^{-1}T^{-1}$.

Ex.3 If energy (E), velocity (V) and time (T) are chosen as the fundamental quantities, then the dimensions of surface tension will be. **(Surface tension = force/length)**

(A) $EV^{-2}T^{-1}$ **(B)** $EV^{-1}T^{-2}$

(C) $E^{-2}V^{-1}T^{-3}$ **(D)** $EV^{-2}T^{-2}$

Sol. [surface tension] = [force/length] = $M^1L^0T^{-2}$

suppose [surface tension] = $E^aV^bT^c$

$\therefore$ $M^1L^0T^{-2} = \left[M^1L^2T^{-2}\right]^a\left[L^1T^{-1}\right]^b[T]^c$

Matching dimensions of M $\Rightarrow$ a = 1

Matching dimensions of L $\Rightarrow$ 2a + b = 0

$\Rightarrow$ b = – 2

Matching dimensions of T $\Rightarrow$ –2a – b + c = –2

$\Rightarrow$ c = – 2

$\therefore$ [surface tension] = $EV^{-2}T^{-2}$

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. Which of the following system of units is not based on units of mass, length and time alone
(A) SI (B) MKS
(C) FPS (D) CGS

2. The unit for nuclear dose given to a patient is
(A) Fermi (B) Rutherford
(C) Curie (D) Roentgen

3. Dyne/cm^2 is not a unit of
(A) Pressure (B) Stress
(C) Strain (D) Young's modulus

4. Newton/metre^2 is the unit of
(A) Energy (B) Momentum
(C) Force (D) Pressure

5. The unit of surface tension in SI system is
(A) Dyne/cm^2 (B) Newton / m
(C) Dyne / cm (D) Newton / m^2

6. The unit of reduction factor of tangent galvanometer is
(A) Ampere (B) Gauss
(C) Radian (D) None of these

7. The unit of selt inductance of a coil is
(A) Farad (B) Henry
(C) Weber (D) Tesla

8. 1 a.m.u. is equivalent to
(A) 1.6×10^{-27} kg (B) 934 MeV
(C) 1.6×10^{-34} gm (D) All above

9. The unit of absolute permitivity is
(A) Fm (farad-metre) (B) Fm^{-1} (farad/metre)
(C) Fm^{-2} (farad / metre^2) (D) F (farad)
(E) None of these

10. How many wavelengths of Kr^{86} are there in one metre
(A) 1553164.13 (B) 1650763.73
(C) 652189.63 (D) 2348123.73

11. One million electron volt (1 MeV) is equal to
(A) 10^5 eV (B) 10^6 eV
(C) 10^4 eV (D) 10^7 eV

12. The value of Planck's constant is
(A) 6.63×10^{-34} (B) 6.63×10^{34} J/sec.
(C) 6.63×10^{-34} kg-m^2 (D) 6.63×10^{34} kg/sec.

13. Length cannot be measured by
(A) Fermi (B) Debye
(C) Micron (D) Light year

14. A physical quantity is measured and its value is found to be nu when n = numerical value and u = unit. Then which of the following relations is true
(A) $n \propto u^2$ (B) $n \propto u$
(C) $n \propto \sqrt{u}$ (D) $n \propto \frac{1}{u}$

15. Kilowat-hour is a unit of
(A) Electrical charge (B) Energy
(C) Power (D) Force

16. What is the SI unit of permeability
(A) Henry per metre
(B) Tesla metre per ampere
(C) Weber per ampere metre
(D) All the above units are correct

17. In which of the following system of units, weber is the unit of magnetic flux
(A) CGS (B) MKS
(C) SI (D) None of these

18. Tesla is a unit for measuring
(A) Magnetic moment
(B) Magnetic induction
(C) Magnetic intensity
(D) Magnetic pole strength

19. If the unit of length and force be increased four time, then the unit of energy is
(A) Increased 4 times (B) Increased 8 times
(C) Increased 16 times (D) Decreased 16 times

20. Which is different from other by units
(A) Phase difference
(B) Mechanical equivalent
(C) Loudness of sound
(D) Poisson's ratio

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. In the S.I. system the unit of energy is -
(A) erg (B) calorie
(C) joule (D) electron volt

2. In the S.I. system, the unit of temperature is -
(A) degree centigrade (B) Kelvin
(C) degree celsius (D) degree Fahrenheit

3. In a new system of units, unit of mass is 10 kg, unit of length is 100m, unit of time is 1 minutes. Then magnitude of 1 N force in new system of units will be
(A) 36 (B) 60
(C) 3.6 (D) 0.06

4. Light year is a unit of
(A) Time (B) Mass
(C) Distance (D) Energy

5. Which unit is not for length
(A) Parsec (B) Light year
(C) Angstrom (D) Nano

6. The unit of permeability of vacuum (μ_0) is
(A) $\frac{N}{A}$ (B) $\frac{N}{A^2}$
(C) NA (D) $\frac{J}{A^2}$

7. The correct value of 0°C on the Kelvin scale is
(A) 273.15 K (B) 272.85 K
(C) 273 K (D) 273.2 K

8. Unit of impulse is
(A) Newton (B) kg-m
(C) kg-m/s (D) Joule

9. Match the following
(A) Capacitance (i) Volt (ampere)$^{-1}$
(B) Magnetic induction (ii) Volt-sec (ampere)$^{-1}$
(C) Inductance (iii) Newton (ampere)$^{-1}$ (metre)$^{-1}$
(D) Resistance (iv) Coulomb^2 (joule)$^{-1}$
(A) A-ii, B-iii, C-iv, D-i (B) A-iv, B-iii, C-ii, D-i
(C) A-iii, B-iv, C-i, D-ii (D) A-iv, B-i, C-ii, D-iii
(E) A-ii, B-iv, C-i, D-iii

10. Which of the following pairs of physical quantities may be repesented in the same unit
(A) Heat and temperature
(B) Temperature and mole
(C) Heat and work
(D) Specific heat and heat

11. 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) Power : Newton metre second^{-1}
(E) Surface tension : Newton metre^{-2}

12. The difference in the lengths of a mean solar day and a sidereal day is about
(A) 1 min (B) 4 min
(C) 15 min (D) 56 min

13. A new unit of length is so chosen that the speed of light in vacuum is unity. Calculate the distance (in this new unit) between sun and the earth if light takes 8 min and 20 seconds to reach earth from sun
(A) 300 (B) 400
(C) 500 (D) 600

14. Torr' is the unit of
(A) Pressure (B) Volume
(C) Density (D) Flux

15. $\frac{\text{watt}}{\text{kelvin}}$ is the unit of
(A) Stefan's constant
(B) Wien's constant
(C) Cooling's constant
(D) Thermal conductance

16. The unit of Stefan's constant σ is
(A) $Wm^{-2}K^{-1}$ (B) $W m^2 K^{-4}$
(C) $W m^{-2} K^{-4}$ (D) $W m^{-2} K^4$

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. Match the following :

Physical quantity	Dimension	Unit
(1) Gravitational constant 'G'	(P) $M^1L^1T^{-1}$	(A) N.m
(2) Torque	(Q) $M^{-1}L^3T^{-2}$	(B) N.s
(3) Momentum	(R) $M^1L^{-1}T^{-2}$	(C) Nm^2/kg^2
(4) Pressure	(S) $M^1L^2T^{-2}$	(D) pascal

2. Match the following :

Column- I	Column- II
(A) Base unit	(P) N
(B) Derived unit	(Q) hp
(C) Improper unit	(R) kgwt
(D) Practical unit	(S) rad
(E) Supplementary unit	(T) kg

3. Match the following :

Column- I	Column- II
(A) 1 fermi	(P) 10^{-13}m
(B) 1 X-ray unit	(Q) 10^{-15}m
(C) 1 angstrom	(R) 10^{-10}m
(D) 1 Astronomical unit	(S) 9.46×10^{15}m
(E) 1 Light year	(T) 3.26 Light year
(F) 1 Parsec	(U) 3.08×10^{16}m
	(V) 1.49×10^{11} m

4. Match the following :

Column- I	Column- II
(A) Moment of inertia	(P) newton/metre^2
(B) Surface tension	(Q) kg/(metre-sec)
(C) Angular acceleration	(R) kg-metre^2
(D) Coefficient of viscosity	(S) newton/metre
(E) Modulus of elasticity	(T) radian/sec^2

5. Match the following :

Column- I	Column- II
(A) Dimensional variable	(P) π
(B) Dimensionless variable	(Q) Force
(C) Dimensional constant	(R) Angle
(D) Dimensionless constant	(S) Gravitational constant

Exercise # 4 PART - 1 PREVIOUS YEAR (NEET/AIPMT)

1. Which pair do not have equal dimensions ?
(A) Energy and torque [2000]
(B) Force and impulse
(C) Angular momentum and Planck constant
(D) Elastic modulus and pressure.

2. The dimensions of Planck constant equals to that of [2001]
(A) energy (B) momentum
(C) angular momentum (D) power

3. The unit of permittivity of free space, ε_0, is
(A) coulomb/newton-metre [2004]
(B) newton-metre^2/coulomb^2
(C) coulomb^2/newton-metre^2
(D) coulomb^2/(newton-metre)^2

4. The dimensions of universal gravitational constant are [2004]
(A) $[M^{-1}L^3T^{-2}]$ (B) $[ML^2T^{-1}]$
(C) $[M^{-2}L^3T^{-2}]$ (D) $[M^{-2}L^2T^{-1}]$

5. The ratio of the dimensions of Planck constant and that of moment of inertia is the dimensions of
(A) time (B) frequency [2005]
(C) angular momentum (D) velocity

6. The velocity v of a particle at time t is given by $v = at + \frac{b}{t+c}$, where a, b and c are constants. The dimensions of a, b and c are [2006]
(A) [L], [LT] and $[LT^{-2}]$
(B) $[LT^{-2}]$, [L] and [T]
(C) $[L^2]$, [T] and $[LT^{-2}]$
(D) $[LT^{-2}]$, [LT] and [L]

7. Dimensions of resistance in an electrical circuit, in terms of dimension of mass M, of length L, of time T and of current I, would be [2007]
(A) $[ML^2T^{-2}]$ (B) $[ML^2T^{-1}I^{-1}]$
(C) $[ML^2T^{-3}I^{-2}]$ (D) $[ML^2T^{-3}I^{-1}]$

8. Which two of the following five physical parameters have the same dimensions ? [2008]
1. energy density 2. refractive index
3. dielectric constant 4. Young's modulus
5. magnetic field
(A) 1 and 4 (B) 1 and 5
(C) 2 and 4 (D) 3 and 5

9. If the error in the measurement of radius of a sphere is 2%, then the error in the determination of volume of the sphere will be [AIPMT 2008]
(A) 8 % (B) 2 %
(C) 4 % (D) 6 %

10. If the dimensions of a physical quantity are given by $M^aL^bT^c$, then the physical quantity will be
(A) velocity if a = 1, b = 0, c = – 1 [AIPMT 2009]
(B) acceleration if a = 1, b = 1, c = – 2
(C) force if a = 0, b = – 1, c = – 2
(D) Pressure if a = 1, b = – 1, c = – 2

11. A student measures the distance traversed in free fall of a body, initially at rest, in a given time. He uses this data to estimate g, the acceleration due to gravity. If the maximum percentage errors in measurement of the distance and the time are e^1 and e^2 respectively, the percentage error in the estimation of g is [Mains 2010]
(A) $e_2 - e_1$ (B) $e_1 + 2e_2$
(C) $e_1 + e_2$ (D) $e_1 - 2e_2$

12. The dimension of $\frac{1}{2}\varepsilon_0 E^2$, where ε0 is permittivity of free space and E is electric field, is [Perlims 2010]
(A) ML^2T^{-2} (B) $ML^{-1}T^{-2}$
(C) ML^2T^{-1} (D) MLT–1

13. The density of a material in CGS system of units is 4 g cm^{-3}. In a system of units in which unit of length is 10 cm and unit of mass is 100 g, the value of density of material will be [Mains 2011]
(A) 0.04 (B) 0.4
(C) 40 (D) 400

MOCK TEST

STRAIGHT OBJECTIVE TYPE

1. The ratio of the dimensions of Plank's constant and that of the moment of inertia is the dimension of :
(A) frequency (B) velocity (C) angular momentum (D) time

2. In a system of units if force (F), acceleration (A) and time (T) are taken as fundamental units, then the dimensional formula of energy is :
(A) FA^2T (B) FAT^2 (C) FA^2T^3 (D) FAT

3. The dimensions of quantity L/C is identical to :
(A) $(\text{resistance})^{-1}$ (B) $(\text{time})^{-2}$ (C) $(\text{resistance})^2$ (D) none of these

4. $\frac{E^2}{\mu_0}$ has the dimensions (E = electric flux, μ_0 = permeability of free space)
(A) $[M^2L^3T^{-2}A^2]$ (B) $[MLT^{-4}]$ (C) $[ML^3T^{-2}]$ (D) $[M^{-1}L^2TA^{-2}]$

5. The dimensions of σb^4 (σ = Stefan's constant and b = Wein's constant) are :
(A) $[M^0L^0T^0]$ (B) $[ML^4T^{-3}]$ (C) $[ML^{-2}T]$ (D) $[ML^6T^{-3}]$

6. The dimensions of $\frac{a}{b}$ in the equation $P = \frac{a - t^2}{bx}$ where P is pressure, x is distance and t is time are :
(A) $[M^2LT^{-3}]$ (B) $[MT^{-2}]$ (C) $[ML^3T^{-1}]$ (D) $[ML^{-3}]$

7. In the equation $\int \frac{dt}{\sqrt{2at - t^2}} = a^x \sin^{-1}\left[\frac{t}{a} - 1\right]$ The value of x is :
(A) 1 (B) – 1 (C) 0 (D) 2

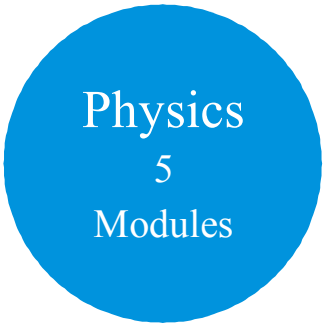
8. The dimensions of the quantity $\hbar c \left(\text{where } \hbar = \frac{h}{2\pi}\right)$ is :
(A) $[ML^2T^{-1}]$ (B) $[MLT^{-1}]$ (C) $[ML^3T^{-2}]$ (D) $[ML^3T^{-1}]$

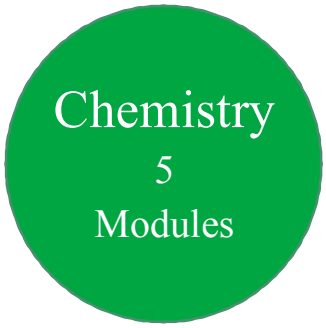
9. A particle of mass m is executing oscillations about the origin on the x-axis. Its potential energy is $U(x) = K|x|^3$, where K is a positive constant. If the amplitude of oscillation is a, then its time period T is :
(A) proportional to $\frac{1}{\sqrt{a}}$ (B) independent of a (C) proportional to $\sqrt{a}$ (D) proportional to $a^{3/2}$

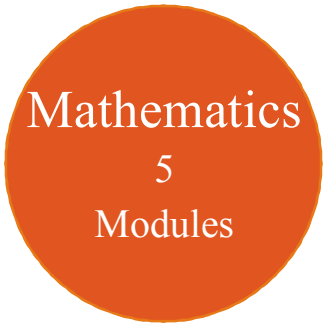
10. In the formula $X = 3YZ^2$, X and Z have dimensions of capacitance and magnetic induction respectively. What are the dimensions of Y in MKSQ system ?
(A) $[M^{-3}L^{-1}T^3Q^4]$ (B) $[M^{-3}L^{-2}T^4Q^4]$ (C) $[M^{-2}L^{-2}T^4Q^4]$ (D) $[M^{-3}L^{-2}T^3Q^1]$

11. The dimensions of $\frac{1}{2}\varepsilon_0 E^2$ (ε_0 : permittivity of free space ; E : electric field) is :
(A) $[MLT^{-1}]$ (B) $[ML^{-1}T^{-2}]$ (C) $[MLT^{-2}]$ (D) $[ML^2T^{-1}]$

11th Class Modules Chapter Details

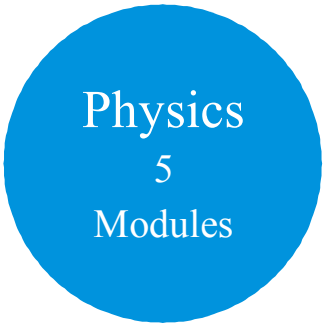


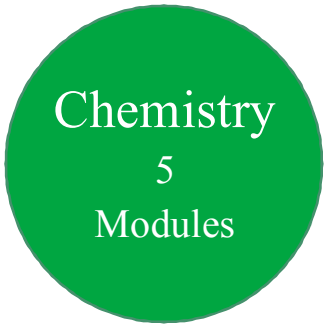


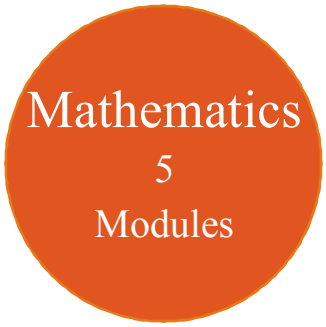


PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal Properties of Matter **Module-5** 1. Oscillations 2. Waves	**Module-1(PC)** 1. Some Basic Conceps of Chemistry 2. Atomic Structure 3. Chemical Equilibrium 4. Ionic Equilibrium **Module-2(PC)** 1. Thermodynamics & Thermochemistry 2. Redox Reaction 3. States Of Matter (Gaseous & Liquid) **Module-3(IC)** 1. Periodic Table 2. Chemical Bonding 3. Hydrogen & Its Compounds 4. S-Block **Module-4(OC)** 1. Nomenclature of Organic Compounds 2. Isomerism 3. General Organic Chemistry **Module-5(OC)** 1. Reaction Mechanism 2. Hydrocarbon 3. Aromatic Hydrocarbon 4. Environmental Chemistry & Analysis Of Organic Compounds	**Module-1** 1. Diversity in the Living World 2. Plant Kingdom 3. Animal Kingdom **Module-2** 1. Morphology in Flowering Plants 2. Anatomy of Flowering Plants 3. Structural Organization in Animals **Module-3** 1. Cell: The Unit of Life 2. Biomolecules 3. Cell Cycle & Cell Division 4. Transport in Plants 5. Mineral Nutrition **Module-4** 1. Photosynthesis in Higher Plants 2. Respiration in Plants 3. Plant Growth and Development 4. Digestion & Absorption 5. Breathing & Exchange of Gases **Module-5** 1. Body Fluids & Its Circulation 2. Excretory Products & Their Elimination 3. Locomotion & Its Movement 4. Neural Control & Coordination 5. Chemical Coordination and Integration

12th Class Modules Chapter Details







PHYSICS

Module-1

1. Electrostatics
2. Capacitance

Module-2

1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3

1. Electromagnetic Induction
2. Alternating Current

Module-4

1. Geometrical Optics
2. Wave Optics

Module-5

1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)

1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)

1. Electrochemistry
2. Surface Chemistry

Module-3(IC)

1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)

1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)

1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1

1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2

1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3

1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4

1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5

1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues