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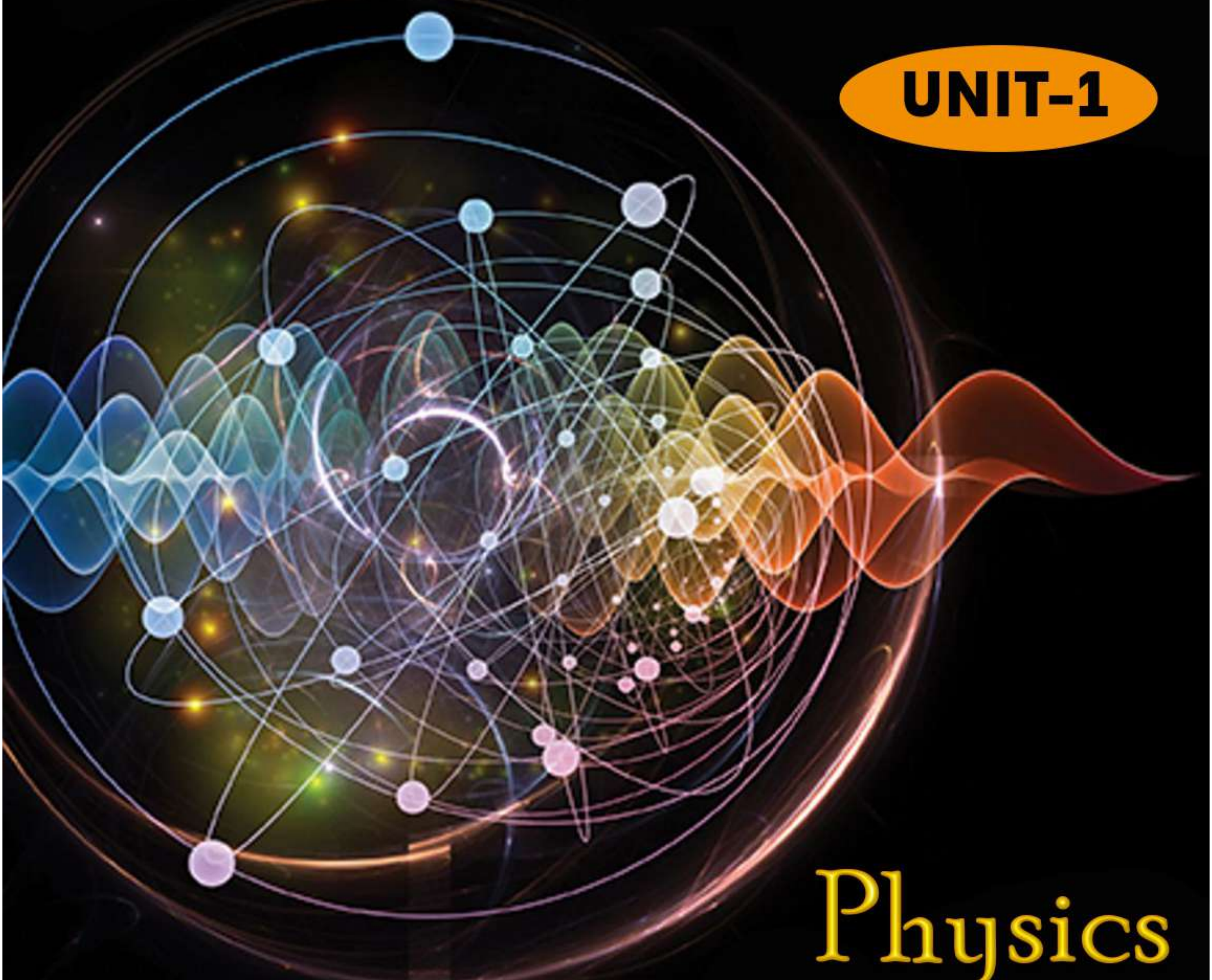


UNIT-1

Physics

SYLLABUS: PHYSICS

UNIT- I

Vector Fields

General expression for gradient, divergence curl and Laplace operators in orthogonal curvilinear Co-ordinates and their explicit form in Cartesion spherical-co-ordinates, Stokes theorem and Gauss theorem.

Matrix theory

Algebraic operation – Rank of a matrix. Eigen values and Eigen vectors - characteristic equation –Cayely Hamilton theorem – Diagonalisation and Diagonalizability of unitary orthogonal. Hermitian and symmetric matrices.

Special functions

Legendre, Hermite and Lagune equation basic properties – Gamma and Beta functions.

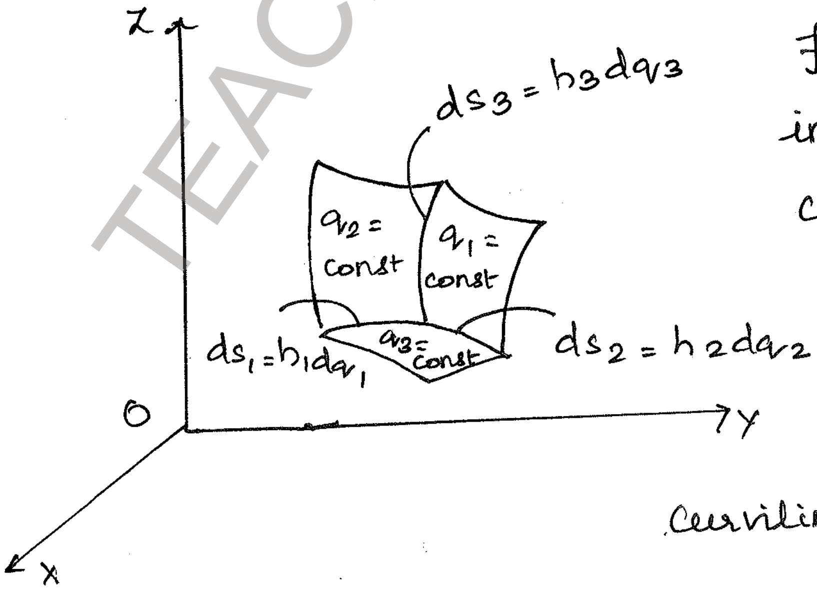
UNIT - I Vector Fields

Orthogonal curvilinear co-ordinates:

The components of vector or vector operators may be formulated in a system of curvilinear coordinates. It is an easy matter to transform them into any one of the several kinds of special coordinate systems which have been found useful in physical problems.

In cartesian coordinates the position of a point $P(x, y, z)$ is determined by the intersection of three mutually perpendicular planes x = constant, y = constant and z = constant.

Let us imagine that we superimpose three other families of surfaces on this system. The surface of any family need not be parallel and they need not be planes. The three new families of surfaces need not be mutually perpendicular. Let the three new families of surfaces described by q_1 = constant, q_2 = constant, q_3 = constant intersect at P.



The values of q_1, q_2, q_3 for the three surfaces intersecting at P are called curvilinear coordinates of P. The three new surfaces are then called coordinate surfaces or curvilinear surfaces.

If the coordinate surfaces are mutually perpendicular at every point $P(x, y, z)$ then the curvilinear coordinates (q_1, q_2, q_3) are said to be orthogonal curvilinear coordinates.

The coordinate surfaces intersect pairwise in three curves, called coordinate lines. The coordinate axes are determined by the tangents to the coordinate lines at the intersection of three surfaces.

The point P identified by curvilinear coordinates (q_1, q_2, q_3) as well as by cartesian coordinates (x, y, z)

$$\left.\begin{aligned} x &= x(q_1, q_2, q_3) \\ y &= y(q_1, q_2, q_3) \\ z &= z(q_1, q_2, q_3) \end{aligned}\right\} \longrightarrow (1)$$

with inverses

$$\left.\begin{aligned} q_1 &= q_1(x, y, z) \\ q_2 &= q_2(x, y, z) \\ q_3 &= q_3(x, y, z) \end{aligned}\right\} \longrightarrow (2)$$

With each family of surface q_i = constant, we can associate a unit vector $\hat{u}_i$ normal to each surface q_i = const and in direction of increasing q_i.

The partial differentiation of eqn (1)

$$dx = \frac{\partial x}{\partial q_1} dq_1 + \frac{\partial x}{\partial q_2} dq_2 + \frac{\partial x}{\partial q_3} dq_3$$

$$dy = \frac{\partial y}{\partial q_1} dq_1 + \frac{\partial y}{\partial q_2} dq_2 + \frac{\partial y}{\partial q_3} dq_3$$

$$dz = \frac{\partial z}{\partial q_1} dq_1 + \frac{\partial z}{\partial q_2} dq_2 + \frac{\partial z}{\partial q_3} dq_3$$

The square of the distance between two neighbouring points is given by,

$$ds^2 = dx^2 + dy^2 + dz^2 = \sum_{ij} h_{ij}^2 \, dq_i \, dq_j \quad (i, j = 1, 2, 3)$$

where the coefficients h_{ij}^2 are given by

$$h_{ij}^2 = \frac{\partial x}{\partial q_i}\frac{\partial x}{\partial q_j} + \frac{\partial y}{\partial q_i}\frac{\partial y}{\partial q_j} + \frac{\partial z}{\partial q_i}\frac{\partial z}{\partial q_j}$$

The most useful coordinate systems are orthogonal ones. i.e. The systems in which surfaces always intersect at right angles.

$$h_{ij} = 0, \quad i \neq j$$

to simplify we write $h_{ij} = h_i$ so that

$$ds^2 = (h_1 dq_1)^2 + (h_2 dq_2)^2 + (h_3 dq_3)^2$$

The specific coordinate systems are described by specifying the scale factors h_1, h_2 and h_3.

The distance between any two points on a coordinate line is called line element

$$ds_i = h_i dq_i$$

The three curvilinear coordinates q_1, q_2, q_3 need not be lengths. The scale factors h_i may depend on q_i's

Question Set - II

Unit - I

Vector fields

1. Which of the following represents Gauss's divergence theorem?

a) $\iint A \cdot ds = \iiint A \cdot dv$

b) $\iint A \cdot ds = \iiint \text{div} A \cdot dv$

c) $\int A \cdot ds = \iint \text{div} A \cdot dv$

d) $\iint A \cdot ds = \iint A \cdot dv$

2. The distance between any two points on a co ordinate line is called

a) element
b) co ordinates
c) line element
d) factor

3. The product $h_1 dq_1$ in orthogonal curvilinear co ordinates have the dimensions of

a) length
b) area
c) volume
d) surface

4. If the coordinate systems are mutually perpendicular at every point then the curvilinear co ordinates are said to be ______

a) orthonormal
b) orthogonal
c) normalized
d) none.

5. For the position vector $r = \hat{i}x + \hat{j}y + \hat{k}z$ then $\text{div}\,\vec{r} =$

a) 1 b) 2 c) 3 d) 4

6. The flux of the curl of a vector function A over surface S of any shape is equal to the line integral of the vector field A over the boundary C is given by

a) Gauss theorem

b) Stokes theorem

c) green's theorem

d) none.

7. What is the RHS of $\oint_c r \times dr$?

a) $\iint ds$ b) $2\,ds$ c) $2\iint ds$ d) 2

8. The operator gradient in orthogonal curvilinear co ordinates is ——

(a) $\frac{\hat{u}_1}{h_1}\frac{\partial}{\partial q_1} + \frac{\hat{u}_2}{h_2}\frac{\partial}{\partial q_2} + \frac{\hat{u}_3}{h_3}\frac{\partial}{\partial q_3}$

b) $\hat{u}_1\frac{\partial}{\partial q_1} + \hat{u}_2\frac{\partial}{\partial q_2} + \hat{u}_3\frac{\partial}{\partial q_3}$

c) $\frac{1}{h_1}\frac{\partial}{\partial q_1} + \frac{1}{h_2}\frac{\partial}{\partial q_2} + \frac{1}{h_3}\frac{\partial}{\partial q_3}$

d) none

9. The value of $\hat{u}_1 \times \hat{u}_3$ is ——

a) $\hat{u}_2$ b) $-\hat{u}_2$ c) 1 d) 0

10. If a matrix has 5 elements, what are the possible orders it can have

a) 1×5, 5×1 b) 2×3 c) 1×5 d) 2×3, 3×2

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Physics

UNIT-2

SYLLABUS: PHYSICS

UNIT- II

Probability and Theory of errors

Basic concept of probability distribution – Exclusive events and addition – Compound events and products – Binomial – Poisson and Guassian distribution – Normal distribution of error – Standard error – Principle of least squares – Application of solution of linear equation – Curve fitting.

Group theory

Definition – Sub-groups – Homomorphism and isomorphism – Group representations – Irreducible representation – Unitary representation.

UNIT - II

Probability and Theory of errors

Basic concepts of Probability distribution

Probability: Mathematical definition

The probability of an event may be defined as the number of cases in which the event occurs to the total number of cases ie

$$\text{The probability of an event} = \frac{\text{number of cases in which the event occurs}}{\text{total number of cases}} \quad \rightarrow (1)$$

Thus if an event happens in 'a' ways and fails to happen in 'b' ways, the probability of happening of the event

$$p = \frac{a}{a+b}$$

and that of failing of the event

$$q = \frac{b}{a+b}$$

∴ Here it has been assumed that $(a+b)$ ways have the same chance of occurence. It should be noted that the sum of two probabilities is always 1, since the event must either happen or fail ie $p+q=1$.

Remarks:

1) The mathematical definition holds if all cases are equally likely. If any case is biased, then it does not hold.

ii) It does not hold when total number of possible outcomes is finite.

iii) It restricts the probability to rational numbers only.

Statistical definition [Emprical or a posteriari probability]

If a large number of trials are performed under same conditions, the ratio of number of happening of event to the total number of trials is unique and finite under the limit when the number of trials tends to infinity and this ratio measures the probability of happening of the event.

Thus if an event occurs m times out of a series of n trials, then probability of happening of the event is

$$P = \lim_{n \to \infty} \frac{m}{n} \longrightarrow (2)$$

The two definitions (1) and (2) must give the same result.

Remarks:

i) The probability of an event must be between 0 and 1

ie $0 \leq P \leq 1$

ii) The probability of an impossible event is always zero.

iii) The probability of a sure or definite event is always 1

iv) sometimes it is said that odds for an event A are a to b. This means that the probability of happening the event is $\frac{a}{a+b}$. Then we say that odds against the event are b to a.

Sample space:

The equally likely cases associated with the definition of probability represent the possible outcomes of an experiment.

For example, in the tossing of a single dice there are 6 equally likely cases; while in the tossing of 2 dice there are 36 equally likely cases in which dice may fall. The set of all possible outcomes is called a **sample space** and the points of sample space are the **events**.

This concept of sample space is meaningful even when the events are not equally likely and even if there are infinitely many possible outcomes. For technical reasons, the events composing the sample space are required to be **mutually exclusive**.

The sample space containing only a finite number of points is called a **finite sample space**. If a sample space contains n points (ie events) with probabilities $P_1, P_2 \dots P_n$ then

$$P_1 + P_2 + \dots + P_n = 1$$

If first m sample points are favourable to another event A, the probability of happening the event A is

$$P(A) = P_1 + P_2 + \dots + P_n \longrightarrow (1)$$

Thus the points of the sample space are weighted according to their probabilities.

UNIT - II

probability and Theory of Errors

Multiple choice Questions. without Explanations :-

1. The probability of getting exactly 2 tails in 6 tosses of a fair coin is ______

a) 3/8 b) 1/4 c) 15/64 d) 49/64

2. Six coins are tossed simultaneously. The probability of getting atleast 4 heads is ______

a) 11/64 b) 11/32 c) 15/44 d) 21/32

3. The probability that in a family of 4 children there will be atleast one boy is ______

a) 1/16 b) 3/16 c) 5/16 d) 15/16

4. A card is taken out of a pack of 52 cards numbered 2 to 53. The probability that the numbers on the card is a prime number less than 20 is ______

a) 1/13 b) 2/13 c) 3/13 d) 4/13

5. If P(A) = 0.4, P(A ∪ B) = 0.7 and A, B are independent then P(B) = ______

a) 0.2 b) 0.3 c) 0.5 d) 0.6

6. When two dice are thrown, the probability of getting the sum 10 or 11 is ______

a) 7/36 b) 5/36 c) 5/18 d) 7/18

7. The probability that top and bottom cards of a randomly shuffled deck are both aces is ______

a) $4/52 \times 4/52$ b) $4/52 \times 3/52$

c) $4/52 \times 3/51$ d) $4/52 \times 4/51$

8. The probability of having atleast one tail is five throws with a coin is ______

a) 31/32 b) 1/32 c) 1/5 d) 1

9. If n coins are tossed, the possible outcomes are

a) 6^n b) 2 c) 2^n d) n

10. Two fair dice are rolled. The probability of throwing an odd sum is ______

a) 1 b) 1/2 c) 1/6 d) 1/36

11. If $P(A/B) = P(A)$ and $P(B/A) = P(B)$, then A and B are

a) Mutually exclusive b) dependent

c) equally likely d) independent

12. If A is an empty set and B is a non-empty set, then

a) $A \cap B = S$ b) $A \cap B = B$

c) $A \cup B = B$ d) $P(A) = P(B)$

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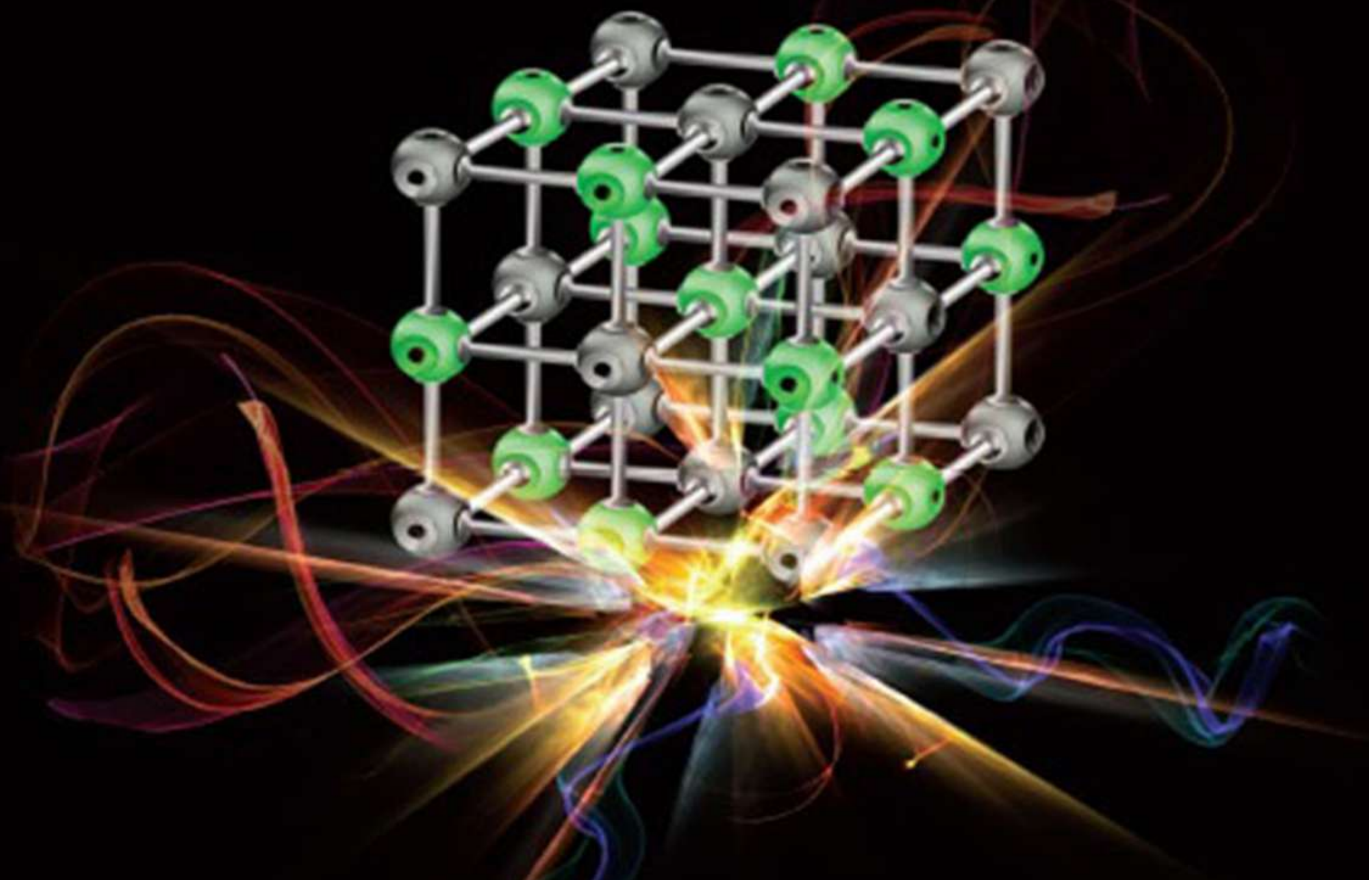

UNIT-3

Physics

SYLLABUS: PHYSICS

UNIT- III

Classical mechanics

Generalised co-ordinates – D’Alembert's principle, Lagrangian equation of motion – Hamiltonian equation – Conservative and non-conservative systems - Hamilton equation, cyclic variables, principle of least action – Theory of small oscillations – Normal co-ordinates and normal modes - Linear Triatomi molecule - Rigid bodies -Moments and products of inertia-Euler’s angle - Euler’s equation of motion- Symmetric top.

Unit - III
Classical Mechanics.

Generalised co-ordinates:-

It is given to a set of independent co-ordinates sufficient in number to describe completely the state of configuration of a dynamical system.

These co-ordinates are denoted as,

$$q_1, q_2, q_3 \ldots, q_k, \ldots q_n.$$

where n is the total number of generalised co-ordinates.

In fact, these are the minimum number of co-ordinates needed to describe the motion of the system.

For eg:- ① a particle constrained to move on the circumference of a circle, only one generalized co-ordinate $q_1 = \theta$ is sufficient and

② Two generalized co-ordinates, $q_1 = \theta$ and $q_2 = \phi$ for a particle moving on the surface of a sphere.

The generalized co-ordinates for a system of N particles, constrained by k equations, are $n = 3N - k$

* It is not necessary that these co-ordinates should be rectangular, spherical or cylindrical.
* In fact, Quantities like length, $(\text{length})^2$, angle, energy or a dimensional Quantity may be used as ~~as~~ generalised co-ordinated but they should completely describe the ~~sy~~ state of the system.

Further these n generalised co-ordinates are not restricted by any constraint.

For a system of N particles, if x_i, y_i, z_i are the cartesian co-ordinates of the i^{th} particles, then these co-ordinates in terms of generalized co-ordinates q_K can be expressed as

$$x_i = x_i(q_1, q_2, \ldots q_K, \ldots q_n, t)$$

$$y_i = y_i(q_1, q_2, \ldots q_K, \ldots q_n, t)$$

$$z_i = z_i(q_1, q_2, \ldots q_K, \ldots q_n, t)$$

Or in general, the position vector $r_i(x_i, y_i, z_i)$ of the i^{th} particle is,

$$r_i = r_i(q_1, q_2, q_3 \ldots q_k \ldots q_n, t)$$

The system is said to be <u>rheonomic</u>, when there is an explicit time dependence in some or all of the functions.

* If there is not the explicit time dependence, the system is called ~~rheono~~ scleronomic and t is not written in the functional dependence ie,

$$r_i = r_i(q_1, q_2, \ldots q_k, \ldots q_n)$$

Principle of virtual Work:-

An infinitesimal virtual displacement of i^{th} particle of the system of N particles is denoted by δr_i. This is the displacement of position co-ordinates only and does not involve variation of time ie.,

$$\delta r_i = \delta r_i(q_1, q_2, \ldots q_n)$$

Suppose the system is in equilibrium, then the total force on any particle is zero, ie,

$$F_i = 0, \quad i = 1, 2, \ldots N$$

The virtual work of the force F_i in the virtual displacement δr_i will be zero ie,

$$\delta W_i = F_i \cdot \delta r_i = 0$$

Similarly, the sum of virtual work for all the particles must vanish ie,

$$\delta W = \sum_{i=1}^{N} F_i \cdot \delta r_i = 0$$

Unit-III

MCQ's Without Explanation

Classical Mechanics

1. The gravitational force between two masses is ____

a) repulsive b) attractive c) zero d) infinity

2. The value of universal gravitational constant G is ____

a) $4 \times 10^{42}\ Nm^2/kg^2$ b) $6.67\times10^{11}\ Nm^2/kg^2$

c) $9.81\ cm/sec^2$ d) $6.67\times10^{-11}\ Nm^2/kg^2$.

3. The value of the permittivity of the vacuum ε_0 is ____

a) $8.1\times10^{12}\ coul/Nm^2$ b) $8.1\times10^{-12}\ coul^2/Nm^2$

c) $8.9\times10^{-12}\ coul^2/Nm^2$ d) $8.9\times10^{12}\ coul^2/Nm^2$

4. The electrostatic forces are very much ____ than the gravitational interaction of atomic and subatomic particles.

a) poor b) stronger c) equal d) lower.

5. The potential due to point charge falls off as ____

a) r b) r^2 c) $1/r^2$ d) $1/r$.

6. The angular momentum is ____ in a central force field.

a) zero b) not-conserved c) infinity d) conserved

7. The electrostatic force between two like charges are ____

a) zero b) attractive c) repulsive d) infinity

8. The degree of freedom for a free particle in space are ____

a) 1 b) 2 c) 3 d) 4

9. The number of independent variable for a free particle in space are ____

a) zero b) one c) two d) three

10. The degree of freedom for N particles in space are ____

a) 2N b) 3N c) N d) zero

11. The number of independent variable for a free particle in space are ____

a) N b) 2N c) 3N d) zero

12. ____ Constraints are independent of time.

a) Holonomic b) Non-Holonomic c) Scleronomous

d) rheonomous

13. ____ constraints are time dependent.

a) Holonomic b) Non-holonomic c) Scleronomous

d) Rheonomous.

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Physics

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UNIT-4

SYLLABUS: PHYSICS

UNIT-IV

Statistical Mechanics

Maxwell Boltzmann statistics Maxwellian distribution of velocities – Mean – root mean square and most probable velocities Bose-Einstein statistics – Distribution function – Phonon gas – Black body radiation – Fermy-Dirac statistics – Distribution function – Electron gas – Pauli paramagnetism – Thermionic emission – Elementary idea of phase transition – Properties of liquid Helium – phase space, Liouville's theorem – statistical equation – micro canonical ensembles – Equation of state thermodynamic functions of an ideal gas equipartition of energy.

Maxwell's Boltzmann statistics:-

Maxwell Boltzmann Energy distribution Law:-

Basic postulates:-

Consider an isolated system of non-interacting identical particles, without spin, in equilibrium at the absolute temperature T, with total energy U, volume V and total number of particles N. Such a System represents the molecules of an ideal mono-atomic gas enclosed in a container.

The particles are distinguishable from one another and there is no restriction to the number of particles which may occupy any given Quantum state.

Suppose the particles are distributed among S energy levels $E_1, E_2, \ldots E_r, \ldots E_s$.

Let $n_1, n_2, \ldots n_r, \ldots n_s$ be the number of particles in the energy levels $E_1, E_2, \ldots$ respectively. Let $g_1, g_2, \ldots g_r, \ldots g_s$ be the number of independent Quantum states associated with the energy level.

It is evident that

$$n_1 + n_2 + \ldots + n_s = N$$

$$\sum_{r=1}^{S} n_r = N \quad \text{——— (1)}$$

and since forces of interaction between particles are negligable, we have

$$E_1 n_1 + E_2 n_2 + \dots + E_s n_s = U$$

$$\sum_{r=1}^{s} E_r n_r = U \quad \text{——— (2)}$$

Taking differentials of eq (1) & (2),

$$\sum_r dn_r = dN = 0 \quad \text{——— (3)}$$

$$\sum_r E_r dn_r = dU = 0 \quad \text{——— (4)}$$

Eq (3) & (4) are the differential forms of eqtns (1) & (2)

The set of occupation numbers $n_1, n_2 \dots$ is a possible mode of distribution of the particles among the energy levels, and it determines a macrostate of the system. According to the fundamental postulate of equal a priori probabilities all quantum states of energy of particles in the system in equilibrium corresponding to the constant values of U, V and N are equally probable. It means that in the equilibrium state, the distribution of the particles among various quantum states has the maximum probability of occurence. This distribution can be obtained in a maximum number of statistically independent ways.

The immediate problem is, therefore, to count (ie, to determine) the total number of independent ways W of distributing the particles among the Quantum states corresponding to the set of numbers $n_1, n_2 \ldots$ and then determine the set of numbers for which W is maximum.

Maxwell - Boltzmann Statistical count :-

For the first energy level E_1 we have to find the number of ways in which n_1 particles are chosen from among N distinguishable particles.

The number of ways of choosing the first particle $= N$

When the first particle has been chosen the number of ways of choosing the second particle $= N-1$

Similarly, the number of ways of choosing the third, fourth ... n_1th particles are respectively $(N-2)$, $(N-3)$, ... $(N-n_1+1)$.

$\therefore$ The Number of ways of choosing n_1 particles from N distinguishable particles is

$$N(N-1)\ldots(N-n_1+1)$$

$$= \frac{N(N-1)\ldots(N-n_1+1)(N-n_1)!}{(N-n_1)!}$$

$$= \frac{N!}{(N-n_1)!}$$

Unit - IV

Statistical Mechanics

MCQ's Without Explanations

Questions.

1. Planck's law of energy distribution of black body radiation agress with the Rayleigh - Jeans law ——

   a) at all wavelengths b) at short wavelengths only
   c) at long wavelengths only
   d) only at the maximum of the energy distribution curve

2. In Debye's model of vibrations of solid the minimum wavelength is equal to ——

   a) a b) a^3 c) $2a$ d) $\sqrt{a}$

3. The Maxwell- Boltzmann distribution law is represented by ——

   a) $n_v = C\exp\left(\frac{-mv^2}{2KT}\right)$ b) $n_0 = c^2\exp\left(\frac{-mv^2}{2KT}\right)$
   c) $n_v = c^2\exp\left(\frac{-mv^2}{KT}\right)$ d) $n_v = c\exp\left(\frac{-mv}{KT}\right)$

4. According to Fermi-Dirac statistics, at the Fermi energy, the occupation index is ——

   a) zero b) almost zero c) half d) unity

5. Einstein's theory of specific heat predicts values lower than the experimental values at ——

   a) all temperatures b) very low temperatures
   c) very high temperatures d) intermediate temperatures

6. Bose-Einstein condensation temperature T_B refers to the temperature below which ___

a) an assembly of Bose gas condense to the liquid state

b) ~~their~~ there is an appreciable occupation of the ground state in an electron system

c) there is a significantly large occupancy of the ground state in a system of bosons.

d) the bosons essentially behave like fermions.

7. A system has N distinguishable particles. Each particle can occupy one of the two non-degenerate states with an energy difference of 0.1eV. If the system is in thermal equilibrium at room temperature, the approximate fraction of particles in the higher energy state is ___

a) exp(−10) b) exp(−4) c) exp(−2) d) zero

8. The average energy for a photon gas at temperature T when the energy levels are given by $E_n = n\hbar\omega$ $(n = 0, 1, 2 \ldots)$ is

a) $\dfrac{\hbar\omega}{(e^{\hbar\omega\beta}-1)}$ b) $\dfrac{\hbar\omega}{(1-e^{-\hbar\omega\beta})}$ c) $\dfrac{1}{(1-e^{-\hbar\omega\beta})}$ d) $\dfrac{\hbar\omega}{(e^{\hbar\omega\beta}-e^{-\hbar\omega\beta})}$

9. A thermally insulated ideal gas $(dQ = 0)$ is compressed quasistatically from an initial macrostate of volume V_0 and pressure P_0 to a final macrostate of volume V_1 and pressure P_1. Then,

a) $\left(\dfrac{C_V}{R}\right)(P_1V_1 - P_0V_0)$ b) $\left(\dfrac{C_P}{R}\right)(P_1V_1 - P_0V_0)$

c) $\left(\dfrac{C_V}{C_P}\right)(P_1V_1 - P_0V_0)$ d) $\dfrac{1}{(P_1V_1 - P_0V_0)}$

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UNIT-5

Physics

SYLLABUS: PHYSICS

UNIT-V

Electromagnetic theory

Coulomb law – Gauss law – Poisson’s equation – Laplace equation and solution to boundry value problem – Electrostatics of dielectric media – Molecular polarisability and its application – Vector – Scalar potential – B and H in a magnetic material – Maxwell’s equations and their significance – Poynting theorem – Radiation of oscillating dipole.

Relativistic Mechanics

Basic ideas - Lorentz transformation. Time dilation and Lorentz contraction -Velocity addition law - Momentum and energy in relativistic Mechanics - Centre of mass system for two relativistic particles.

Unit - V
Electromagnetic theory

Electric charge:

Two charged bodies exert a force upon one another. This force can be used to measure the charge as for example by means of an electrometer. From the results of such measurements, existence of charges of two different kinds called positive and negative charges. These charges can be added algebraically. The charge is a scalar quantity.

Faraday's laws of electrolysis and Millikan's oil drop experiment have shown that the smallest charge that exists in nature is the charge of an electron and charge of any other electrified body is an integral multiple of this electronic charge. Charge is quantised ie it appears in discrete units.

Since charge is a fundamental property of the ultimate particles making up matter, the total charge of a closed system cannot change.

The net charge is conserved in an isolated system. The law of conservation of charge is itself illustrated by nature in pair production or annihilation in which equal quantities of charges of each sign (+ive and -ive) appear or disappear.

Electric charge density

As the electronic charge is extremely small ie 1.6×10^{-19} coulomb, any macroscopic element of charge distribution ~~makes it possible~~ contains a large number of electrons. The large number of electrons in a small element of charge distribution makes it possible to treat the charge as being continuously distributed in space and to define a function called charge density.

Volume density of charge: ρ :

The volume charge density is defined as

$$\rho = \lim_{\Delta\tau \to 0} \frac{\Delta q}{\Delta\tau}.$$

$\Delta q \rightarrow$ net charge enclosed by the volume $\Delta\tau$.

Surface density of charge σ :

The surface density of charge σ is

$$\sigma = \lim_{\Delta s \to 0} \frac{\Delta q}{\Delta s}$$

$\Delta q \rightarrow$ net charge on an element of surface Δs with negligible thickness.

Linear density of charge λ

Linear density of charge

$$\lambda = \lim_{\Delta l \to 0} \frac{\Delta q}{\Delta l}$$

$\Delta q \rightarrow$ net charge in length Δl of a filament of negligible area of cross section

Total charge in a finite region of space will be

$$q = \int dq = \int_{\tau} \rho \, d\tau + \int_{S} \sigma \, ds.$$

Coulomb's law:

Coulomb discovered that interaction force between two static point charges the spatial dimensions of which are small compared to the distance between them acts along the line joining them and is proportional to the inverse square of the distance between them.

Unit - V
Electromagnetic Theory
Multiple Choice questions

1. In a region of constant potential
   a) the electric field is uniform
   b) the electric field is zero.
   c) there can be no charge inside the region.
   d) both (b) & (c)

2. A test charge is moved from lower potential point to a higher potential point. The potential energy of test charge will
   a) remains the same
   b) increase
   c) decrease
   d) become zero

3. Dielectric constant for a metal is
   a) zero
   b) infinite
   c) 1
   d) 0

4. when air is replaced by a dielectric medium of constant K, the maximum force of attraction between two charges separated by a distance
   a) increases K times
   b) remains unchanged
   c) decreases K times
   d) increases K^{-1} times

5. which of the following statement is true?
   a) Electrostatic force is a conservative force.
   b) potential at a point is the work done per unit charge
   c) Electrostatic force is non conservative
   d) Potential is the product of charge and work.

6. 1 volt is equivalent to

a) N/s b) N/C c) J/C d) J/s

7. Which of the following Maxwell equations use curl operation?

a) Maxwell 1st and 2nd equation

b) Maxwell 3rd and 4th equation

c) All the four

d) none

8. The curl of a curl of a vector gives a

a) scalar b) vector c) zero d) non zero

9. Which of the following theorem use the curl operation?

a) Green's theorem b) Gauss divergence theorem

c) Stokes theorem d) Maxwel equation

10. Curl is defined as the angular velocity at every point of the vector field

a) True b) false

11. A field in which a test charge around any closed surface in static path is zero is called

a) Solenoidal b) rotational

c) irrotational d) conservative

12. The potential in a lamellar field is

a) 1 b) 0 c) -1 d) ∞

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Physics

UNIT-6

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2020-2021

SYLLABUS: PHYSICS

UNIT-VI

Spectroscopy

Rotation spectra – Vibration spectra – Rotation vibration spectra of diatomic and linear molecules – Raman Spectra – experimental techniques and classical theory of Raman Scattering – Electronic state of diatomic molecules – Frank–Condon principle – Hund's coupling scheme – Evaluation of molecularconstant from vibrational spectra data. Interaction between nuclear spin and magnetic field – Nuclear resonance-Chemical shift-Dipole-Dipole interaction-Spin lattice interaction.

UNIT- VI

Spectroscopy

Introduction:

The basic units of matter are the atoms and the molecules. Spectoscopy is the measurement and interpretation of absorption and emission of electromagnetic radiation when atoms or molecules or ions move from one energy level to another.

Electromagnetic Spectrum

Electromagnetic theory, developed by clark Maxwell, suggests that an alternating current in a circuit radiates energy in the form of waves having oscillating electric and magnetic fields in planes perpendicular to the direction of propagation.

As these radiations possess electric and magnetic fields, they are called electromagnetic radiations. They travel with the velocity of light (c) and can be treated in terms of frequency (ν) of the oscillating electric and magnetic fields. The frequency, wavelength (λ) and velocity of these radiations are connected by the relation

$$c = \nu\lambda$$

and the energy associated with the wave is given by,

$$E = h\nu = \frac{hc}{\lambda}$$

where h is the Planck's constant and is equal to 6.626×10^{-34} JS.

Regions of the Spectrum

The regions from radio frequency to gamma rays together is called the electromagnetic spectrum. The different regions are primarily based on the experimental techniques used in the generation, dispersion or detection of the radiation.

In increasing frequency the regions are:

1. Radiofrequency region:

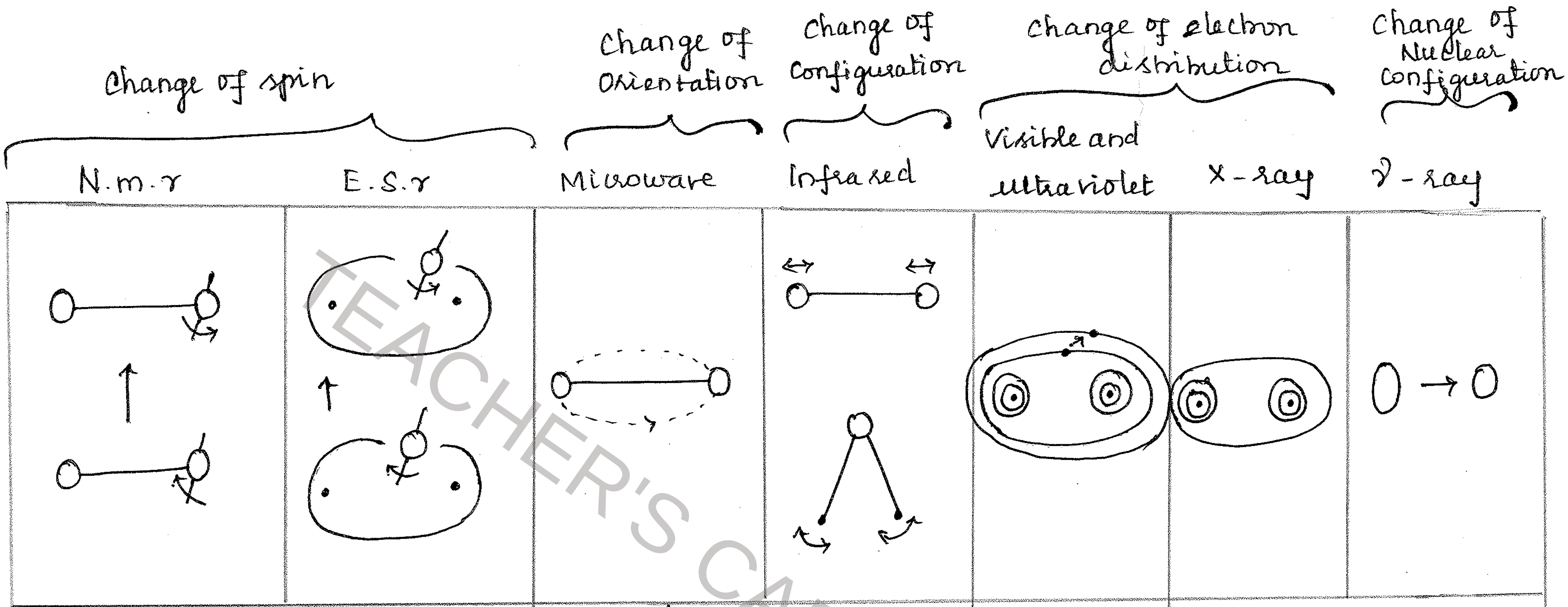
$3 \times 10^6 - 3 \times 10^{10}$ Hz

10 m – 1 cm wavelength

Nuclear magnetic resonance (NMR) and electron spin resonance (e.s.r) spectroscopy. The energy change involved is that arising from the reversal of spin of a nucleus or electron as is of the order 0.001 – 10 joules/mole

2. Microwave region:

$3 \times 10^{10} - 3 \times 10^{12}$ Hz   1 cm – 100 μm wavelength



Wave number		10^{-2}	1	100	10^4	10^6	10^8
Wave length	10m	100cm	1 cm	100μm	1μm	10nm	100pm
Frequency Hz	3×10^6	3×10^8	3×10^{10}	3×10^{12}	3×10^{14}	3×10^{16}	3×10^{18}
Energy Joule/mole	10^{-3}	10^{-1}	10	10^3	10^5	10^7	10^9

Unit VI

Spectroscopy

Question set - II

1. The energy due to the periodic displacement of its atom from their equilibrium position is called ___

   a) Translational energy
   b) Rotational energy
   c) Vibrational energy
   d) Electronic energy

2. The lowest energy state of a system is —

   a) sharply defined
   b) not sharply defined
   c) broader
   d) narrower

3. width of a spectral line is defined by

   a) FWHM
   b) HWFM
   c) HWHM
   d) FWFM

   F → Full W → width H → Half M → Maximum

4. The collision broadening produces a —

   a) line shape
   b) Lorentian line shape
   c) Gaussian line shape
   d) coulombian shape

5. The collision line broadening is

   a) homogenous
   b) inhomogenous
   c) non uniform
   d) uniform

6. The possibility of saturation is more when the population ratio N_n/N_m approaches ___

a) zero b) unity c) infinity d) constant

7. The emission of a photon without the influence of an external agency is called

a) stimulated emission b) Spontaneous emission

c) spontaneous absorption d) none

8. The photons emitted by stimulated emission are ___

a) not in phase b) in coherent

c) in phase d) infinite

9. which of the following is an example of linear molecule?

a) CH_3F b) HCl c) CH_4 d) CH_2Cl

10. For a linear molecule

a) $I_a = 0$ $I_B \neq I_C$ b) $I_A = I_B = I_C$

c) $I_A = 0$ $I_B = I_C$ d) $I_A \neq I_B \neq I_C$

11. For a spherical top molecule,

a) $I_A = I_B = I_C$ b) $I_A = I_B \neq I_C$

c) $I_B = 0$ d) $I_A \neq I_B = I_C$

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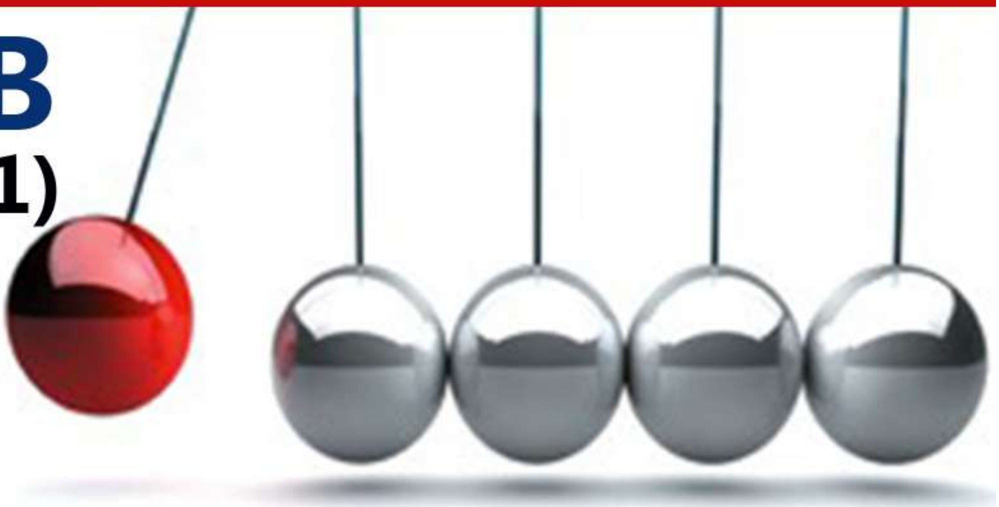


Physics

UNIT-7

SYLLABUS: PHYSICS

UNIT-VII

Solid State Physics

Energy levels and density of states in one, two and three dimensions – Electrical and Thermal conductivities – Wiedmann-Franz law. Energy bands in solids – Transport phenomena in semiconductors operational functions of a junction diode-Schottky diode – Bloch theorem - Krong-Penny mudel – Brillouin zones – Wave equation of an electron in a periodic potential.

Thermal Properties of solids

Laws of Thermodynamics – Maxwell's relations and their applications – Phase transitions – Production and measurement of low temperatures – Einstein and Debye theory of specific heats of solids.

Magnetic properties of materials

Langevin's theory of dia-para-magnetism – Quantum theory of para – magnetism – Ferro – magnetism – Ferri – magnetism – superconductivity – Meissner effect – Thermodynamics of superconducting materials – London equation – B.C.S. theory – Josephson's effect.

Unit - VII
Solid State physics

Energy levels and density of states in one (two, three) dimension :-

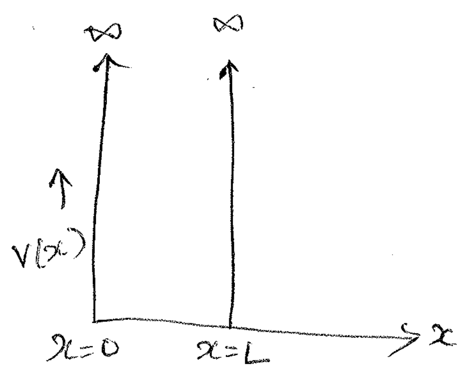
Consider an electron of mass m confined in a box of length L.

Suppose the particle travels along x-axis and is confined between $x=0$ and $x=L$ by two infinitely hard walls, so that the particle has no chance of penetrating them. A plot of potential energy $V(x)$ against distance x is shown in figure. The potential energy V of the particle is infinitely high on both sides of box while the P.E everywhere within the box is uniform and assumed to be zero. So we have,

$$V(x) = 0 \quad \text{for} \quad 0 < x < L$$
$$= \infty \quad x \leq 0 \; ; \; x \leq L.$$

The Schroedinger equation for the region where ~~V=0~~ V=0, is

$$\frac{d^2\psi_n}{dx^2} + \frac{2mE_n}{\hbar^2}\psi_n = 0 \quad \text{—— (1)}$$



$$\frac{d^2\psi_n}{dx^2} + k^2\psi_n = 0$$

$$k^2 = \frac{2mE_n}{\hbar^2} \quad \text{—— (2)}$$

where E_n is the energy of the electron in the state n.

The solution of equation (1) is given by,

$$\psi_n = Ae^{ikx} + Be^{-ikx}$$

A and B are two constants. The value of these constants can be calculated by applying the following boundary conditions

$$\left.\begin{array}{ll}\psi = 0 & \text{when } x = 0 \\ \psi = 0 & \text{when } x = L\end{array}\right\} \quad (3)$$

Applying these conditions to eq(2), we have

$$A + B = 0 \quad (4)$$

$$Ae^{ikL} + Be^{-ikL} = 0 \quad (5)$$

Putting the value of B in eq(5),

$$Ae^{ikL} - Ae^{-ikL} = 0$$

$$A(e^{ikL} - e^{-ikL}) = 0 \quad (6)$$

From eq(6),

$$A = 0 \text{ (or) } (e^{ikL} - e^{-ikL}) = 0$$

Since $A \neq 0$,

$$(e^{ikL} - e^{-ikL}) = 0$$

$$\sin kL = 0.$$

$$kL = n\pi$$

$$k = \frac{n\pi}{L} \quad (7) \quad \text{where } n = 1, 2, 3 \ldots$$

Thus the Solution is,

$$\psi_n = C \sin \frac{n\pi x}{L} \quad \text{——— (8)}$$

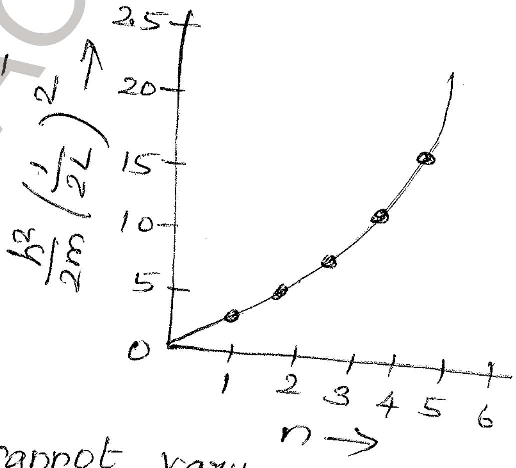
where C is constant. Now

$$k^2 = \frac{n^2\pi^2}{L^2} = \frac{2mE}{\hbar^2}$$

$$E_n = \frac{n^2\hbar^2\pi^2}{2mL^2} = \frac{h^2}{2m}\left(\frac{n}{2L}\right)^2 = \frac{n^2h^2}{8mL^2} \quad \text{——— (9)}$$

The lowest energy of particle is obtained by putting n=1, hence

$$E_1 = \frac{h^2}{(8mL^2)} \quad \text{and} \quad E_n = n^2E_1$$



Eq(9) shows that the energy is Quadratic function of quantum number n as shown in figure. So the energy is Quantized and it cannot vary continuously. This is in contrast to the prediction of classical mechanics that there is a continuous range of possible energies. when the particle becomes heavier and the box larger, the energy levels become more closely spaced.

The value of constant c is chosen So that there is unit probability of finding the electron Some where on the line. Because $\psi_n^*(x)\,\psi_n(x)$ is the

Unit-VII

Solid state physics

MCQ's Without explanations

Questions

1. The classical expression for the electrical conductivity of a metal in terms of mass of the electrons, charge of the electron, concentration of electrons and collision time is given by ——
   a) $mne\tau$ b) $(me\tau/m)$ c) $(ne^2\tau/m)$ d) $(ne^2\tau^2/m)$

2. If the mobility of electrons in a metal increases, the resistivity
   a) decreases b) increases c) remains constant d) none

3. Most widely used conducting materials are —
   a) germanium and silicon b) copper and aluminium
   c) gold and silver d) tungsten and platinum

4. The temperature dependence of the classical expression for electrical resistivity of a metal is ——
   a) $\rho \propto T^2$ b) $\rho \propto 1/T^2$ c) $\rho \propto T^{1/2}$ d) $\rho \propto 1/T$

5. Mobility of the electron is ——
   a) flow of electron per unit electric field
   b) reciprocal of conductivity
   c) average electron drift velocity per unit electric field
   d) none of these.

6. ohm's law relates to the electric field E, conductivity σ and current density J as ——
   a) $J = E/\sigma$ b) $J = \sigma E^2$ c) $J = \sigma/E$ d) $J = \sigma E$

7. order of resistivity of silver is ——
   a) nano ohm m b) milli ohm m
   c) ohm m d) micro ohm m.

8. The average drift velocity v_x of electrons in a metal is related to the electric field E and collision time, τ as

a) $\sqrt{\frac{eE\tau}{m}}$ b) $\sqrt{\frac{m}{eE\tau}}$ c) $\frac{eE\tau}{m}$ d) $\frac{m}{eE\tau}$

9. If e, μ and n respectively represent the charge, mobility and concentration of electrons respectively, then the electrical conductivity of the metal is given by —

a) $n/\mu e$ b) $\mu e/n$ c) ne d) neμ

10. which of the following relation gives wiedmann-franz law?

a) $\sigma_T/\sigma = LT$ b) $\sigma/\sigma_T = LT$ c) $\sigma_T/\sigma = L/T$ d) $\sigma/\sigma_T = T/L$

11. Einstein's theory concludes that at lower temperatures, the specific heat

a) drops linearly with increase of temperature
b) drops linearly with decrease of temperature
c) drops exponentially with decrease of temperature
d) remains constant

12. If the Debye's temperature of a metal is 450K, the Debye's frequency is —

a) 10^{13} Hz b) 10^{2} Hz c) 10^{23} Hz d) 10 Hz

13. At lower temperatures, the lattice specific heat varies as

a) T^3 b) $\frac{1}{T^3}$ c) T d) $1/T$

14. Dulong-petit's law obey at room temperature for many metals while it fails for light elements such as boron, beryllium because ——

a) the Debye temperature of these elements is very high

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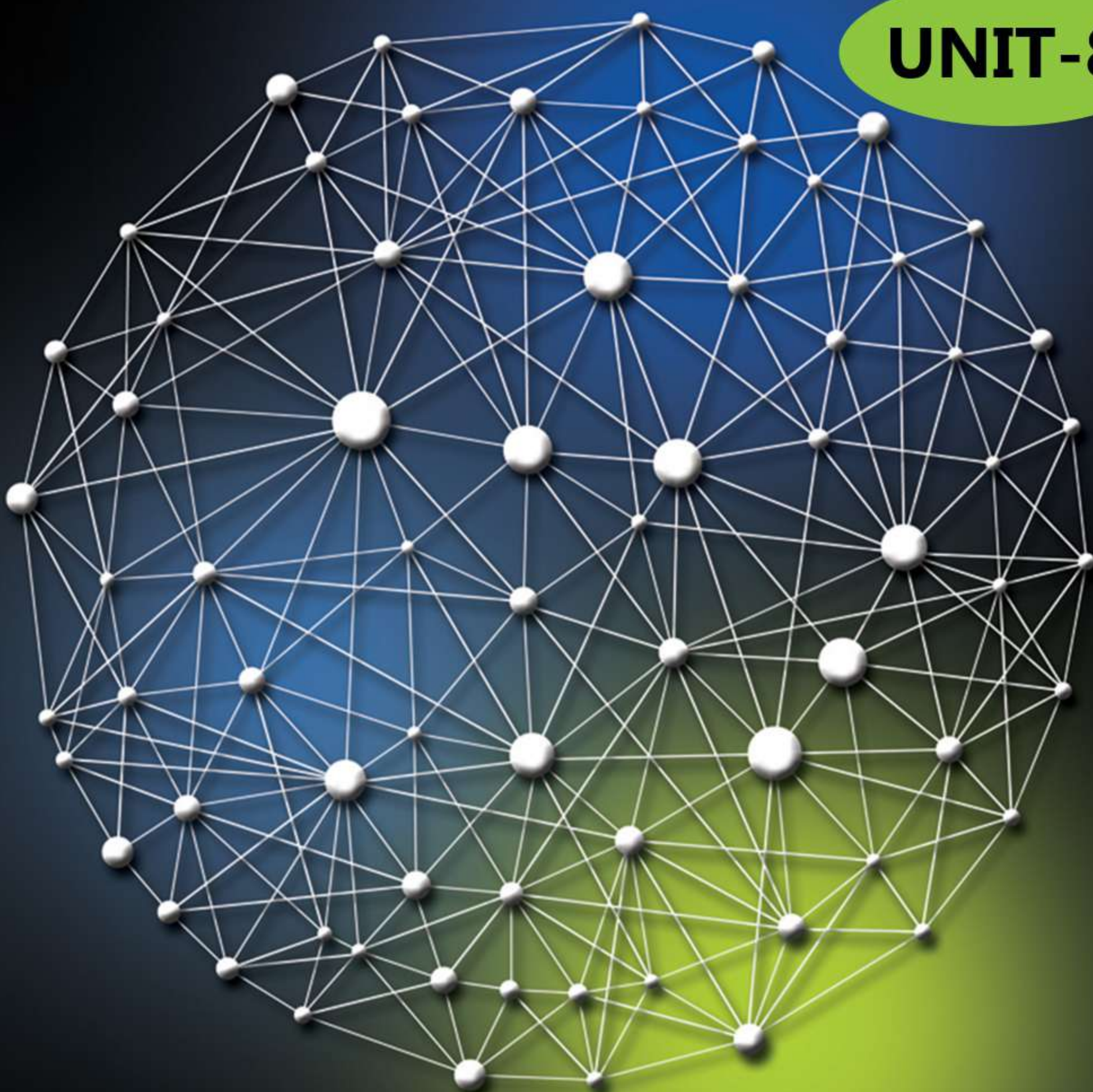
Physics

UNIT-8



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SYLLABUS: PHYSICS

UNIT-VIII

Quantum mechanics

Schrodinger's wave equation – Free particle – Particle in a potential well and barrier penetration - The probability interpretation – Expectation value – Eigen functions and eigen values – Stationery states – Wave packet – Uncertainty principle – Linear Harmonic oscillator – angular momentum and addition of angular momenta.

Perturbation theory – Transition probability – Constant and harmonic perturbation – Scattering theory – Differential and total scattering cross section – Born approximation – Partial wave analysis and phase shift analysis – Relativistic wave equations – Klein – Gordon equations – Dirac equation and its free particle solution.

Quantum Mechanics

Unit - VIII

Schroedinger equation:-

(i) Time independent schroedinger equation:-

The non-dissipation of the wave-packet of the material particle has been explained by assuming the necessity of the guiding wave obeying Schroedinger wave equation.

Consider a system of stationary waves to be associated with the particle. Let $\psi(r,t)$ be the wave displacement for the de broglie waves at any location $r = ix + jy + kz$ at time t. Then the differential equation of the wave motion in three dimensions in accordance with Maxwell's wave-equation can be written as

$$\nabla^2 \psi = \frac{1}{u^2}\frac{\partial^2 \psi}{\partial t^2} \quad \text{(or)}$$

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} = \frac{1}{u^2}\frac{\partial^2 \psi}{\partial t^2} \quad \text{——— (1)}$$

where u is the wave velocity.

The Solution of eq(1) gives ψ as a periodic displacement in terms of time ie,

$$\psi(r,t) = \psi_0(r)\, e^{-i\omega t} \quad \text{---- (2)}$$

where ψ_0 is the amplitude at the point considered. It is function of position r ie, of co-ordinates (x, y, z) and not of time t.

Eq(2) may be expressed as,

$$\psi(r,t) = \psi_0(r)\, e^{-i\omega t} \quad \text{---- (3)}$$

Diff eq(3) twice w.r to t, we get,

$$\frac{\partial^2 \psi}{\partial t^2} = -\omega^2 \psi_0(r)\, e^{-i\omega t}$$

$$= -\omega^2 \psi(r,t)$$

Sub the above in eqn (1), we get,

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} = -\frac{\omega^2}{u^2}\psi \quad \text{---- (4)}$$

$$\omega = 2\pi\nu$$

$$\omega = \frac{2\pi u}{\lambda}$$

$$\frac{\omega}{u} = \frac{2\pi}{\lambda} \quad \text{---- (5)}$$

$$\frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial y^2} + \frac{\partial^2 \psi}{\partial z^2} = \nabla^2 \psi \quad \text{---- (6)}$$

using (5) & (6), the equation (4) becomes,

$$\nabla^2 \psi + \frac{4\pi^2}{\lambda^2}\psi = 0 \quad \text{---- (7)}$$

So, for we have not introduced wave mechanical concept and so the treatment is general.

For introducing the concept of wave ~~equati~~ mechanics we must put from de-Broglie equation,

$$\lambda = \frac{h}{\nu} \quad \text{——(8)}$$

Sub eq(8) this in equation (7), we get

$$\nabla^2\psi + \frac{4\pi^2 m^2 v^2}{h^2}\psi = 0 \quad \text{——(9)}$$

If E and V are the total and potential energies of the particle respectively, ~~then~~ then its K.E $\frac{1}{2}mv^2$ is given by,

$$\frac{1}{2}mv^2 = E - V$$

which gives $m^2v^2 = 2m(E-V)$

Sub this in eqtn (9), we get

$$\nabla^2\psi + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0 \quad \text{——(10)}$$

The above equation is called Schroedinger time independent wave equation. The quantity ψ is usually referred as wave function.

Let us now Substitute in equation (10),

$$\hbar = \frac{h}{2\pi} \quad \text{——(11)}$$

Then the Schroedinger time independent wave equation, in usually used form, may be written as,

$$\nabla^2\psi + \frac{2m}{\hbar^2}(E-V)\psi = 0 \quad \text{——(12)}$$

Unit - VIII
Quantum Mechanics
MCQ's Without Explanations
Questions

1. Which one is not the correct relation in the following.
   a) $h = \frac{E}{V}$ b) $E = mc^2$ c) $\Delta x \times \Delta p = \frac{h}{4\pi}$ d) $\lambda = \frac{h}{mv}$

2. The maximum probability of finding an electron in the d_{xy} orbital is ____
   a) along the x-axis b) along the y-axis
   c) at an angle of 45° from x & y axis
   d) at an angle of 90° from x & y axis

3. Simultaneous determination of exact position and momentum of an electron is ____
   a) possible b) impossible c) sometimes possible sometimes impossible
   d) none

4. If uncertainity in the position of an electron is zero, the uncertainity in its momentum could be ____
   a) zero b) $< \frac{h}{2\lambda}$ c) $> \frac{h}{2\lambda}$ d) infinite

5. The possibility of finding an electron in an orbital was conceived by ____
   a) Rutherford b) Bohr c) Heisenberg d) Schroedinger

6. Uncertainity principle gave the concept of ____
   a) probability b) an orbital c) physical meaning of ψ & ψ^2 d) all the above

7. The uncertainity principle & the concept of wave nature of matter was proposed by ____ and ____ respectively.
   a) Heisenberg, de Broglie b) de Broglie, Heisenberg
   c) Heisenberg, planck d) planck, Heisenberg

8. For an electron, if the uncertainity in velocity is Δv, the uncertainity in its position (Δx) is given by ___

a) $\frac{hm}{4\pi\Delta v}$ b) $\frac{4\pi}{hm\Delta v}$ c) $\frac{h}{4\pi m\Delta v}$ d) $\frac{4\pi m}{h\Delta v}$

9. Orbital is ___

a) circular path around the nucleus in which the electron revolves

b) space around the nucleus where the probability of finding the electron is maximum

c) Amplitude of electron wave d) None of these

10. The schrodinger is a differential ~~wave~~ equation

a) True b) False

11. $\frac{d\psi}{dx}$ must be zero

a) True b) false

12. Schroedinger wave equation can be derived from principles of Quantum mechanics.

a) True b) false

13. The energy levels are proportional to ___

a) n b) n^{-1} c) n^{2} d) n^{-2}

14. The concept of matter wave was suggested by ___

a) Heisenberg b) debroglie c) schrodinger d) Laplace

15. The intensity of diffraction pattern is proportional to ___ of the wave function.

a) fourth power b) Cube c) Sixth power d) square

16. The function representing matter waves must be ___

a) complex b) real c) zero d) infinity

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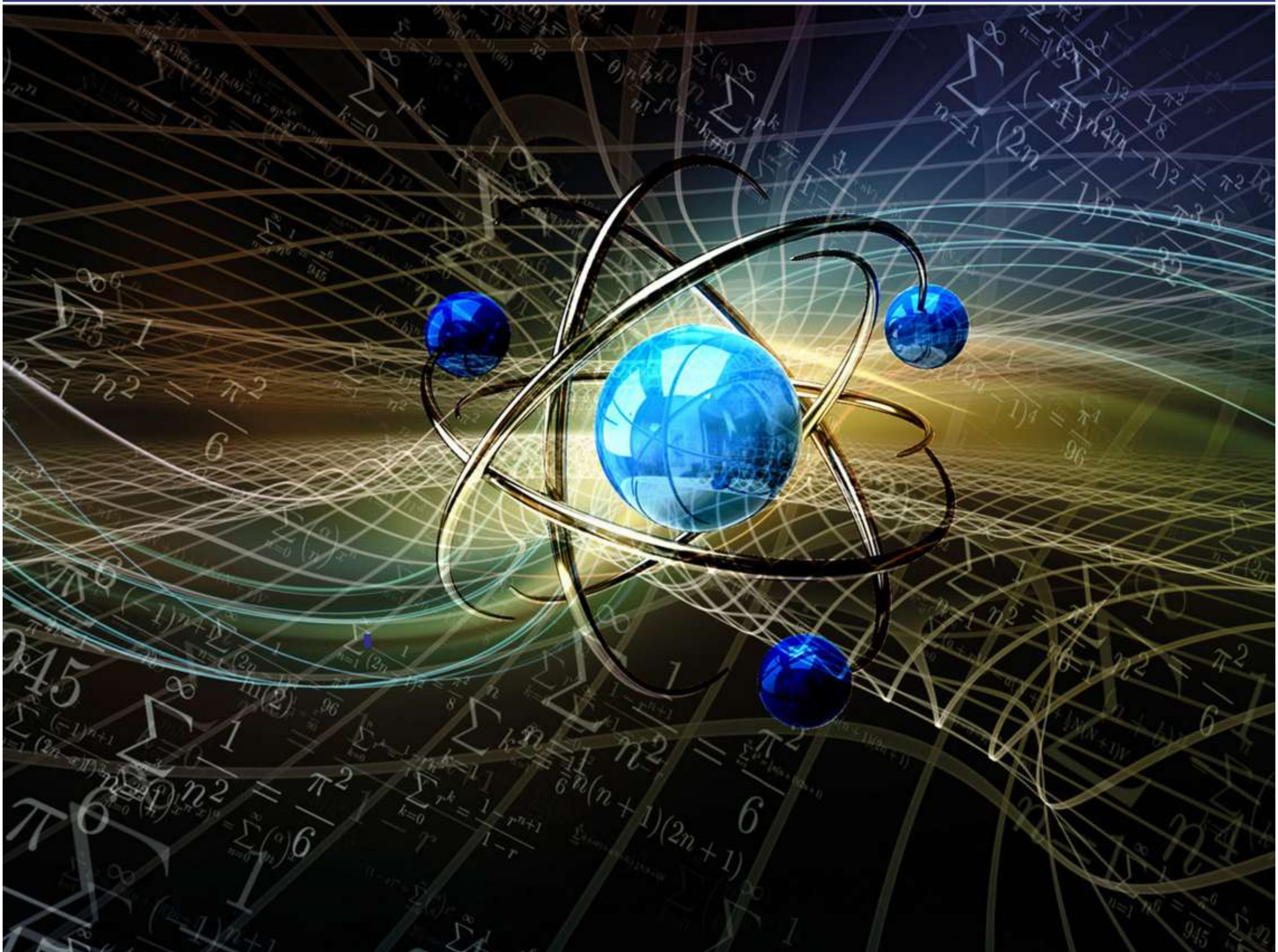
Physics



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UNIT-9

SYLLABUS: PHYSICS

UNIT-IX

Nuclear Physics

Binding energy – Semi empirical mass formula – Stability of nuclei – Nuclear forces – Ground state of deuteron – Alpha decay – B decay – Fermi's theory – Selection rules – Liquid drop model – Nuclear fission – Shell model – Collective models.

Nuclear Instrumentation

Cyclotron - Synchro cyclotron – Proton synchrotron – Detectors – G.M.Counter – Scintillation Counter – Bubble chamber – Nuclear reactors – Neutron cross section – Fission product – Energy release – Chain reaction – Multiplication factor – Moderator – Natural Uranium – Diffusion equation.

Unit - IX

Nuclear physics

Nuclear size

In 1919, Rutherford found that the deviation from pure coulomb's scattering, anomalous scattering, was observable when α - particles were scattered by the lightest elements. In these light elements, the closest distance of approach was of the order of 5×10^{-15} m. The distance of closest approach at which anomalous scattering begins was identified as the first measure of the nuclear radius.

The nucleus is composed of protons and neutrons only, known as nucleons. The shape of the nucleus is taken spherical, because for a given volume this shape possesses the least surface area and thus provides maximum short range binding forces between the nucleons in the nucleus. Small asymmetries of the distribution of negative charge are present in some nuclei as these nuclei exhibit high electric quadrupole moments.

In most nuclei the ellipticity is only of the order of one percent, thus we may suppose that protons are uniformly distributed inside the spherical nucleus.

There is an experimental evidence that nuclear density ρ remains approximately constant over most of the nuclear volume and then decreases rapidly to zero.

This means that the nuclear volume is approximately proportional to the number of nucleons i.e., mass number A.

$$V = \frac{4}{3}\pi R^3 \propto A, \text{ or}$$

nuclear radius $R \propto A^{1/3}$

$$R = R_0 A^{1/3},$$

where R_0 is the nuclear unit radius.

The methods of measuring nuclear radius are divided into two main categories. one group of methods is based on the Study of the range of nuclear forces, the nucleus is probed by a nucleon or light nucleus. other group of methods studies the electric field and charge distribution of the nucleus, the nucleus is probed by electron or muon.

Binding Energy

The mass of an atom should be the sum of the masses of its constituent particles i.e., electrons, protons and neutrons. But the mass of any permanently stable atom is found to be less than the sum of the masses of its constituents.

Aston called the decrease in the mass or loss of mass upon coalescence of the elementary constituents the mass defect, now generally called mass deficiency.

The nucleons that hold the stable nucleus are held together by strong attractive forces, and therefore work must be done in separating from each other until they are very large distance apart. Energy must be supplied to the nucleus to separate it into the individual constituents, and the total energy of the constituents when at a very large distance apart is greater than when they form the nucleus.

For convenience the masses of atoms rather than the masses of nuclei are used in all calculations. This causes no difficulty, except that the binding energy of the atomic electrons should also be considered. For simplicity, we usually omit it. The principle of equivalence of mass and energy confirms the idea that the amount of energy required to break up the atom into its constituents is equivalent to the mass deficiency.

Unit - IX

Nuclear Physics

Question set

1. The size of the nucleus cannot be determined by

a) electron scattering

b) energy levels of muonic atoms

c) excited state energy of the isotopic spin multiplet

d) by selecting the probe using concept of de-broglie wavelength

2. $d + d \longrightarrow \alpha + \pi^0$ is forbidden due to violating the conservation of

a) strangeness

b) Isospin

c) Baryon number

d) Energy

3. The empirical formula for nuclear radius is

a) $R = r_0$

b) $R = r_0 A^{1/3}$

c) $R = r_0 A^{2/3}$

d) $R = r_0 A^2$

4. The parity of system of n particles is given by

a) L

b) S

c) ΣL_n

d) ΣS_n

5. The deviation from spherical body symmetry of the nucleus is expressed as

a) electric dipole

b) electric Quadrupole moment

c) dipole moment

d) polarisation

6. The eccentricity of the ellipsoidal nuclear surface can be expressed as Q =

a) $\int (3z^2 - r^2)\, d\tau$
b) $1/e\, d\tau$
c) $\frac{1}{e}\int (3z^2 - r^2)\, \rho\, d\tau$
d) $\int \rho\, d\tau$

7. For a spherically symmetric charge distribution the value of Q is

a) 1
b) −1
c) ∞
d) 0

8. In nuclear physics, area is measured in

a) barn
b) emu
c) magneton
d) Bohr

9. The energy required to dissociate the constituents of the nucleus is called

a) Binding energy
b) dissociation energy
c) Total energy
d) potential energy

10. The isotopic spin of the nuclear ground state for deuteron is

a) 1
b) 0
c) 1/2
d) −1/2

11. The volume of a nucleus in an atom is proportional to the

a) mass number
b) proton number
c) neutron number
d) electron number

12. A part of neutron proton force acting in deuteron is

a) central
b) non central
c) symmetric
d) central as a whole.

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38/23, Vaigundaperumal Koil Street, Kanchipuram-1
Mobile : 95665 35080, 97862 69980
Help Line Numbers : 9360268118,7639967359

Physics

UNIT-10

PG TRB
2020-2021

SYLLABUS: PHYSICS

Unit X

Electronics (Digital electronics)

Binary - Decimal – Octal and Hexadecimal numbers – 8421 Excess–3 - Gray Codes – Logic gates – Laws Boolean algebra – Half and full adders – Subtractors – RS, RST, JK and M/S Flip-flops – Ripple counter – Decade counter –Up-down counter – Serial and parallel registers.

Operational amplifier

Differential amplifier – Parameters – Applications – Analog integration and differentiation – Analog computation – Comparators – Sample and hold circuits – Oscillator – Hartley-Colpitt-Phase Shift - Wien's bridge oscillators – Astable mono -Bistable multivibrators – Clipping and clamping circuits.

Microwave Physics

Microwave generation – Klystron – Magnetron – Travelling wave tubes – Microwave in rectangular and cylindrical wave guides – Characteristics of Antennas – Short dipole radiation – Antenna gain – Directivity – Radiation resistance – Radiation intensity.

Microprocessor

Evolution of Microprocessors – Organization of micro-computers-Preliminary concepts – Basic concepts of programming – Architecture – Address – Data and control buses – Memory decoding – Memory mapped I/O and I/O mapped I/O. Machine and instruction cycles – Addressing modes – Use of arithmetic logical data – Transfer stack and I/O instructions – Instruction set and assembly programming of 8085 microprocessor – Fetch – Execute – overlap – Instruction cycles – Instruction forward – Memories – RAM-PROMS, EPROMSEEPROMS – Static and Dynamic RAM.

Unit - X

Electronics (Digital Electronics)

Binary Number System:-

A Binary number system uses only two symbols or digits namely 0 and 1. It has a base or radix of 2.

* A binary digit 0 or 1 is called a → Bit.
* All the bits have powers of 2 like $2^0, 2^1, 2^2 \ldots$ for integer portion and $2^{-1}, 2^{-2}, 2^{-3}$ etc., for fractional part.
* Quantities $2^2, 2^1, 2^0, 2^{-1}, 2^{-1}$ etc., are weights in the binary number system.
* A 4 bit binary word is called as a nibble.
* An 8 bit binary word is called as a byte.
* A 16 bit binary word is simply called a word and 32 bit binary word is called double word.

Binary to Decimal Conversion:-

A binary number can be converted into decimal number by adding the products of each bit and its weight. Let us take few examples.

(i) $(101)_2 = 1\times2^2 + 0\times2^1 + 1\times2^0$

$= 4+0+1$

$= 5.$

$(101)_2 = (5)_{10}$

(iii) $(10011)_2 = 1\times2^4 + 0\times2^3 + 0\times2^2 + 1\times2^1 + 1\times2^0$

$= 16+0+0+2+1 = 19$

$(10011)_2 = (19)_{10}$

Decimal to Binary conversion:-

A decimal number like 19 can be converted into binary by repeatedly dividing the number by 2 and collecting the remainders (double dabble method).

```
2 | 19          ↑ (LSB)
  |  9  - 1     |
  |  4  - 1     |
  |  2  - 0     |
  |  1  - 0     |
     0  - 1     | (MSB)
```


collecting the remainders in reverse, we get

$(19)_{10} = (10011)_2$

For eg:- convert decimal fraction 0.625 into binary.

$0.625\times2 = 1.250$; carry is 1 (MSB)

$0.250\times2 = 0.500$; carry is 0

$0.500\times2 = 1.000$; carry is 1 (LSB)

Collecting the carries,

$(0.625)_{10} = (0.101)_2$.

Hexadecimal Number System:-

Hexadecimal number system has a base 16. The basic digits are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. The base of hexadecimal number is 16 & base of binary number system is 2. Since $2^4 = 16$, it follows that any hex digit can be represented by a group of 4 bit binary sequence.

Table (1.1) gives decimal, hexadecimal and the four bit binary equivalence for decimal numbers 0 to 15.

Decimal	Hexadecimal	Binary
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10	A	1010
11	B	1011
12	C	1100
13	D	1101
14	E	1110
15	F	1111

Table (1.1).

Unit - X

Electronics

MCQ's Without Explanations

Questions:-

1. The op-amp filter circuit uses ____
   a) resistors and capacitors but not inductors
   b) inductors and capacitors but not resistors
   c) resistors, capacitors and inductors
   d) only resistors but not inductors or capacitors
2. The main disadvantage in using op-amp is
   a) its low gain b) its drift c) its input impedance
   d) its offset voltage
3. How many truth table can be made from one function table?
   a) one b) Two c) Three d) any number.
4. Number of flip-flops needed to divide the input frequency by 32 is
   a) 2 b) 4 c) 5 d) 8
5. A simple flip-flop is
   a) a 2-bit memory b) a 1 bit memory c) a four-state device
   d) obtained by cross coupling of two NAND gates
6. The circuit used for parallel to serial conversion of data is called
   a) decoder b) demultiplexer c) multivibrator d) multiplexer
7. An SR flip-flop does not accept the input entry when

a) both inputs zero b) zero at R and one at S

c) zero at S and one at R d) both inputs at one

8. A comparison between serial and parallel adder reveals that serial order

a) is slower b) is faster

c) operates at the same speed as parallel adder

d) is more complicated

9. A positive AND gate is also a negative

a) NAND gate b) NOR gate c) AND gate d) OR gate

10. The equipment uses BCD numbers is

a) pocket calculator b) electronic counter

c) digital voltmeter d) all of these

11. The flip-flop free from race-around problem is

a) SR flip flop b) D flip flop c) T flip flop d) Master slave JK flip flop

12. Number of flip flops required in a decade counter is ____

a) 2 b) 3 c) 4 d) 5

13. A n-stage ripple counter will count upto

a) 2^n b) $2^n - 1$ c) n d) 2^{n-1}

14. Most of the memory systems have

a) electro-pneumatic properties b) electrostatic properties

c) magnetic properties d) all of these.

15. The number of flip-flops required to build a modulus 100 counter is

a) 4 b) 6 c) 7 d) 8

PHYSICS