unit - 1

Mechanics

Two mark questions

1. Define Multiparticle dynamics

The study of dynamics of a system which consists of two or more particle is known as multiparticle dynamics.

2. What is the centre of mass (CM) ?

A point in the system at which whole mass of the body is supposed to be concentrated is called centre of mass of the body.

3. Give the example for motion of centre of mass

i) Motion of planets and its satellite

ii) Projectile trajectory

iii) Decay of a nucleus.

4. Define rigid body

A rigid body is defined as that body which does not undergo any change in shape or volume when external forces are applied on it.

5. Define rigid body rotation

When a body rotates about a fixed axis its motion is known as rotatory motion.

A rigid body is said to have pure rotational motion, if every particle of the body moves in a circle the centre of which lies on a straight line called the axis of rotation.

6. Define moment of inertia of a body

The property of a body by which it resists change uniform rotational motion is called rotational inertia or moment of inertia.

7. What factors the moment of inertia depends?

Moment of inertia depends on mass, distribution of mass and on the position of axis of rotation

8. What is radius of gyration?

The radius of gyration is defined as the distance from the axis of rotation to the point where the entire mass of the body is assumed to be Concentrated.

It is called the Radius of Gyration of the body about the axis of rotation. It is equal to the root mean square distance of all particles from the axis of rotation of the body.

9. What are the theorems on moment of inertia)

i) Parallel axes theorem

ii) Perpendicular axis theorem

10. State parallel axis theorem.

The moment of inertia of a body about any axis is equal to the sum of its moment of inertia about a parallel axis passing through its Centre of gravity of the body and the product of its mass of the body with the square of the distance between the two axes.

11. State perpendicular axis theorem

The moment of inertia of a plane lamina about

an axis perpendicular to its plane is equal to the sum of the moments of inertia of the plane. lamina about any two mutually perpendicular axis in its own plane and intersecting each other at the point where the perpendicular axis passes through it.

12. Define angular momentum (L)

Angular momentum of a particle is defined as its moment of linear momentum it is given by the product of linear momentum and perpendicular distance of its line of action from the axis of rotation.

13. Define torque (τ)

The moment of the applied force is called torque

τ = force × distance

$\vec{\tau} = \vec{F} \times \vec{r}$

14. State Conservation of angular momentum

The law of conservation of ~~energy~~ angular momentum states that in the absence of an external torque the angular momentum of a body or a system of bodies remains conserved.

15. What is gyroscope?

A gyroscope is a device used for measuring or maintaining orientation and angular velocity. It is spinning wheel or disc in which the axis of rotation (spin axis) is free to assume any orientation by itself.

16. What is torsional pendulum?

A circular metallic disc suspended using a thin wire that executes torsional oscillation is called torsional pendulum.

17. What are the uses of torsional pendulum ?

i) Rigidity modulus of the wire

ii) Moment of inertia of the disc

iii) Moment of inertia of an irregular body

18. What is double pendulum ?

A double pendulum is a pendulum with another pendulum attached to its end.

unit - II

Electromagnetic Waves

Two Mark Questions

1. Give the Maxwell's equations in differential form

$$\vec{\nabla}.\vec{D} = \rho$$

$$\vec{\nabla}.\vec{B} = 0$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

$$\nabla \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$$

2. Give the Maxwell's equations in integral form.

$$\oint_S \vec{D}.d\vec{s} = \iiint_V \rho \, dv$$

$$\oint \vec{B}.d\vec{s} = 0$$

$$\oint \vec{E}.d\vec{l} = -\iint_s \frac{\partial \vec{B}}{\partial t}.d\vec{s}$$

$$\oint \vec{H}.d\vec{l} = \iint_S \left(\vec{J} + \frac{\partial \vec{D}}{\partial t}\right) d\vec{s}$$

3. Write the Maxwell's equations for free space

$$\vec{\nabla}.\vec{D} = 0$$

$$\vec{\nabla}.\vec{B} = 0$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

$$\vec{\nabla} \times \vec{H} = \frac{\partial \vec{D}}{\partial t}$$

4. Write the Maxwell's equations for conducting Medium

$$\vec{\nabla}.\vec{D} = \rho$$

$$\vec{\nabla}.\vec{B} = 0$$

$$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$

$$\vec{\nabla} \times \vec{H} = \vec{J} + \frac{\partial \vec{D}}{\partial t}$$

5. Write down general electromagnetic wave equation in terms of electric field vector $\vec{E}$ for free space.

$$\nabla^2 \vec{E} = \mu_0 \varepsilon_0 \frac{\partial^2 \vec{E}}{\partial t^2}$$

μ_0 - Permeability in free space

ε_0 - Permittivity in free space

6. Write down general electromagnetic wave equation in terms of magnetic field vector $\vec{H}$ for free space

$$\nabla^2 \vec{H} = \mu_0 \varepsilon_0 \frac{\partial^2 \vec{H}}{\partial t^2}$$

μ_0 - Permeability in free space

ε_0 - Permittivity in free space

7. Write down the expression for velocity of em waves in free space.

$$C = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$$

$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1} (henry per metre)

$\varepsilon_0 = 8.842 \times 10^{-12}$ F m^{-1} (farad per metre)

8. Write down the general solution of wave equation for plane polarised EM wave.

$$E_y = E_0 \cos(\omega t - kx)$$

$$H_z = H_0 \cos(\omega t - kx)$$

ω - angular frequency

k - wave vector.

9. What is intrinsic or characteristic impedance of free space?

The ratio $\frac{\vec{E}}{\vec{H}}$ is having the unit of impedance (Resistance) ohm, Therefore the quantity $\sqrt{\frac{\mu_0}{\epsilon_0}}$ has the dimensions of impedance.

It is known as intrinsic or characteristic impedance of free space, denoted by Z_0. It is a constant quantity for free space and having value $\approx 377\ \Omega$.

10. What is poynting vector?

The cross product of electric field vector $\vec{E}$ and the magnetic field vector $\vec{H}$ is called poynting vector. It is denoted by $\vec{S} = \vec{E} \times \vec{H}$

11. Write the general wave equation for the electric vector in an em wave in conducting medium

$$\nabla^2 \vec{E} - \mu\epsilon \frac{\partial^2 \vec{E}}{\partial t^2} - \mu\sigma \frac{\partial \vec{E}}{\partial t} = 0$$

$\vec{E}$ - electric field vector

μ - Permeability of medium

ϵ - Permittivity of medium

12. Write the general wave equation for the magnetic vector in an em wave in conducting medium

$$\nabla^2 \vec{H} - \mu\epsilon \frac{\partial^2 \vec{H}}{\partial t^2} - \mu\sigma \frac{\partial \vec{H}}{\partial t} = 0$$

$\vec{H}$ - Magnetic field vector

μ - Permeability of medium

ϵ - Permittivity of medium.

13. What is skin depth?

It is defined as the distance inside the conductor from the surface of the conductor at which the amplitude of the field vector is reduced to $1/e$ times its value at the surface.

14. Define intensity of EM wave

The magnitude of the average value of $\vec{S}$ at a point is called the intensity of radiation at that point. The S.I unit of intensity is W/m^2. It is given by

$$S_{av} = \frac{1}{2} \epsilon_0 c E_y^2$$

ϵ_0 - Permittivity of the medium

c - Velocity of light.

15. Define radiation Pressure

The force per unit area of an object due to EM radiation is the radiation Pressure P_r.

$P_r = \frac{I}{c}$. for total absorption of radiation

$P_r = \frac{2I}{c}$. for total reflection back along the path

16. Give the properties of Electromagnetic waves.

i) Electromagnetic waves are Produced by accelerated charges.

ii) They do not require any material medium for Propagation.

iii) Variation of maxima and minima in both $\vec{E}$ and $\vec{B}$ occur simultaneously (in phase)

iv) They travel in vacuum or free space with a speed $3 \times 10^8 \, m s^{-1}$ given by the relation $c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}}$

v) The energy in an electromagnetic wave is equally divided between electric and magnetic field vectors.

unit - III

oscillations

Two mark questions

1. Define Simple Harmonic motion

when the acceleration of particle is directly Proportional to its displacement from its equilibrium position and it is always directed towards equilibrium position, then the motion of the particle is said to be Simple harmonic motion.

2. What are the characteristics of simple Harmonic motion

- The motion must be periodic
- The motion is oscillatory
- The body executing simple harmonic motion is acted upon by a restoring force whose magnitude is proportional to the displacement and its direction is always towards the mean position
- If there is no air resistance or friction, the motion once started will continue indefinitely.

3. What are examples of simple harmonic motions?

- Vibrations of a tuning fork
- Vibrations of a Sonometer wire
- Vertical oscillations of the liquid column in a U-tube.
- Angular oscillations of a torsion pendulum.

4. what are types of oscillation?

i) Free oscillations

ii) Damped oscillations

iii) Forced oscillations

5. What is resonance ?

The phenomenon of making a body vibrate with its natural frequency under the influence of another vibrating body with the same frequency is called resonance.

6. What is sharpness of resonance ?

The rate of change of amplitude with the change of forcing frequency on each side of resonant frequency is known as sharpness of resonance.

7. Define Progressive wave

Progressive wave originating from a point source and propagating through an isotropic medium travel with equal velocity in all directions.

At any instant, the wavefront will be spherical in nature.

If the sphere of very large radius is considered the spherical wave will approximate to a plane surface and the waves are called plane progressive waves.

8. What are the characteristics of progressive wave ?

- Each particle of the medium executes vibration about its mean position. The disturbance progresses onward from one particle to another.
- The particles of the medium performs a motion similar to that of its predecessor along the propagation of the wave, but later in time.
- The phase of every particle changes from 0 to 2π

9. Define Standing waves

When two progressive waves of same amplitude and wavelength travelling along a straight line in opposite directions superimpose on each other, stationary waves are formed.

10. What are the characteristics of standing waves?

- The waveform remains stationary
- Nodes and antinodes are formed alternately
- The points where the displacement is zero are called nodes and the points where the displacement is maximum are called antinodes.
- Pressure changes are maximum at nodes and minimum at antinodes

11. State Doppler Effect

The phenomenon of the apparent change in the frequency of the sound due to relative motion between the source of sound and the observer is called Doppler effect.

12. What are the differences between Progressive waves and Stationary waves.

Progressive waves	Stationary waves
i) Transfer of energy in direction of propagation of wave	No Transfer of energy
ii) No particle of the wave is permanently at rest.	The particles at nodes are permanently at rest.
iii) The particles of the medium vibrate with same amplitude about their mean.	Amplitude of each particle is not same.
iv) Phase of vibration varies continuously.	Particles in the same segment vibrate in the same phase

Optics

1. State laws of reflection

i) Incident ray, normal and reflected ray lie in the same plane

ii) The angle of incidence is equal to the angle of reflection

iii) $\angle i = \angle r$

2. State laws of refraction

i) The incident ray, the refracted ray and the normal at a point of seperation of two media lie in the same plane.

ii) For any two medium, the ratio of Sine of angle of incidence to Sine of angle of refraction is constant. It is known as Snell's law.

$$\frac{\sin i}{\sin r} = \text{Constant}$$

3. Define refractive index of the medium

The ratio of velocity of light in vacuum to velocity of light in medium is called as refractive index.

Refractive index μ = Velocity of light in vacuum (c) / Velocity of light in medium (v)

$$\boxed{\mu = \frac{c}{v}}$$

4. What is total internal reflection?

When a ray of light within a denser medium approaches the surface at an angle of incidence greater than the critical angle, the ray of light is reflected back into the same medium. This phenomenon is known as total internal reflection.

5. Define Critical angle

The angle of incident at which the refracted ray just graze surface between denser and rarer media is called critical angle.

6. Give conditions of total internal reflection

a) The light should incident from denser medium to rarer medium

b) The angle of incidence i in denser medium should be greater than critical angle θ_c.

7. Write expression for Critical angle

$$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$

n_1 - refractive index of denser medium

n_2 - refractive index of rarer medium

8. Mention a few applications of total internal reflection

i) <u>Mirage</u> : During the day time in the desert, it is seen that sand at some distance from the observer looks like a pond of water. This illusion is called mirage. and it is caused due to total internal reflection of light.

ii) <u>optical fibre</u> : An optical fibre is a transparent fibre used to conduct light through the phenomenon of total internal reflection.

9. what is interference ?

The modification or change of intensity of light resulting from the superimposition of two or more waves of light is called interference.

10. what is air wedge ?

A wedge shaped air film enclosed in between two glass plates is called air wedge

11. what is the expression for the fringe width in air wedge experiment?

Fringe width $\beta = \lambda/2\theta$

λ - wavelength of the light source, θ - Angle of wedge

12. What is the expression for the thickness of the wire in air wedge experiment?

$$d = \frac{\lambda l}{2\beta}$$

λ - wavelength of the light source

l - Distance from the edge of contact

β - Fringe width

13. What is Michelson interferometer?

An interferometer is an instrument for measuring small changes in length. It is based on the principle of interference.

14. What are the applications of Michelson interferometer?

It is used to find

i) the wavelength of a given light source

ii) the refractive index and thickness of a transparent material.

iii) the resolution of wavelengths

iv) the standardisation of metre.

Unit - III

Oscillations, Optics and Lasers

Two Mark questions - Lasers

1. What is stimulated emission ?

The process of induced emissions of photons caused by the incident photons is called stimulated emission. This process is a key factor for the operation of a laser.

2. What are the conditions necessary for stimulated emission of radiation ?

i) The atoms must be in the excited state

ii) The photon of light radiation must strike the atoms in the excited state.

3. Write the differences between Spontaneous emission and stimulated emission.

	Spontaneous emission	Stimulated emission
i.	Emission of light radiation is not triggered by external influence.	Induced emissions of light radiations caused by incident photons.
ii)	Emitted photon travels in random direction.	Emitted photon travels in particular direction.
iii)	Emitted photons cannot be controlled.	Emitted photons can controlled.
iv)	This process is a key factor for ordinary light.	This process is a key factor for laser operation.

4. What is mean by population inversion and how is it achieved ?

The situation in which the number of atoms in higher energy level is more than that in lower energy level is called population inversion. It is an essential requirement for producing a laser beam It is achieved by pumping action.

5. What is pumping action ?

The process of creating a population inversion in the atomic states is known as pumping action. It is essential requirement for producing a laser beam.

6. Explain the need for population inversion in the production of laser ?

Stimulated emission process is a key factor the production of laser. For stimulated emission, more number of atoms must be in the excited state.

The situation in which number of atoms in higher energy state is more than that in lower energy state is called population inversion. Hence population inversion is needed in the production of laser.

7. What are the methods commonly used for pumping action ?

i) optical pumping (excitation by photons)
ii) Electrical discharge method (excitation by electrons)
iii) Direct conversion
iv) Inelastic collision between atoms.

(2)

8. What is optical pumping?

When the atoms are exposed to light radiations (of energy $h\nu$), atoms in the lower energy state absorb these light radiations and go to excited state. This method of pumping is called optical pumping.

9. What is mean by active material in laser?

A material in which population inversion can be achieved is called as active material.

10. What are the characteristics of the laser? (or) what are the properties of the laser beam?

- Laser light is highly coherent
- It is highly powerful and intense
- It is directional and monochromatic
- It is extremely bright.

11. Under which conditions a set of laser beams is said to be coherent?

A set of laser beams is said to be coherent if they have same frequency and constant phase difference among them with respect to space and time.

12. Compare the characteristics of laser with ordinary light

	Ordinary light source	Laser source
1.	Light emitted is not monochromatic	Light emitted is highly monochromatic
2.	Does not have high degree of coherence.	High degree of coherence
3.	Emits light in all directions	Emits light only in one direction
4.	Light is less intense and less bright.	Laser light is much intense and bright.

13. What is optical resonant cavity?

It is a pair of mirrors with active material in between them. one of the mirrors of the resonant cavity is made partially reflecting to serve as an output element passing the light (laser) out of the resonator. The other mirror is a highly reflecting one.

14. What is the principle of laser action?

Stimulated emission process is a key factor for the laser action. This can be multiplied through chain reaction. This multiplication of photons through stimulated emission leads to coherent, powerful, monochromatic, collimated beam of light emission.

15. What are the three important components of any laser device?

i) Active medium

ii) Pumping source

iii) Optical resonator.

16. What are the conditions required for laser action?

- Population inversion should be achieved
- Stimulated emission should be predominant over spontaneous emission.

17. What is the function of resonator cavity in laser?

Resonator cavity is made of a pair of fully reflecting plate and a partially reflecting plate. Both of them are optically plane and accurately parallel. The active medium is placed between these mirrors.

The photons emitted along the axial direction during stimulated emission travel back and forth across the active medium and grow in strength. After enough strength is attained, laser beam emerges out from the partial reflector.

18 How lasers are classified? or Mention the various types of lasers.

i) Solid state lasers
ii) Gas lasers
iii) Liquid lasers
iv) Dye lasers
v) Semiconductor lasers.

19 What is the active medium in CO_2 laser?

A gas mixture consisting of CO_2, nitrogen and helium is the active medium.

20 What is semiconductor laser?

Semiconductor diode laser is a specially fabricated Pn junction device. It emits laser light when it is forward biased.

21 What is homo-junction laser?

Homojunction means that a p-n junction is formed from a single crystalline material.

Example: Gallium Arsenide (GaAs)

22 What are the drawbacks of homojunction laser diodes?

- The output beam has large divergence
- Coherence and stability are poor
- Optical confinement is very poor.

23. What is laser welding?

A focussed laser beam is incident on spot where the two parts are to be welded. The spot-contact points get welded due to heating affect of fine laser beams.

24. What is heat treatment of laser?

A powerful laser beam is incident on a metal surface. That portion at which laser light is incident gets heated. As the beam is moved away to other areas, the heat spot cools down rapidly. This procedure is used for treat of metal surfaces which enhances the strength of the metal.

25. What is laser?

Laser stands for Light Amplification by Stimulated Emission of Radiation.

Laser is a light source. It produces a powerful monochromatic, collimated beam of light in which the light waves are coherent.

26. What is gas laser?

Gas laser is a type of laser, in which gases such as CO_2, Nitrogen and He-Ne are used as active medium for laser operations. CO_2, Nitrogen and He-Ne are the important gas lasers.

Unit - IV

Basic Quantum Mechanics

Two mark questions

1. State Compton effect.

When a beam of x-rays is scattered by a substance of low atomic number, the scattered radiation consists of two components. One has the same wavelength λ as the incident ray and the other has a slightly longer wavelength λ'. This phenomenon of change in wavelength of scattered x-rays is known as Compton effect.

2. What is Compton wavelength?

The change in wavelength corresponding to scattering angle of 90° obtained in Compton effect is called Compton wavelength.

$$\Delta\lambda = \frac{h}{m_0 c}(1 - \cos\theta)$$

m_0 - rest mass of electron $= 9.11 \times 10^{-31}$ kg

$$\theta = 90^\circ, \quad \Delta\lambda = \frac{h}{m_0 c}(1 - \cos 90^\circ)$$

$$= \frac{h}{m_0 c}(1 - 0)$$

$$\frac{h}{m_0 c} = 0.0243 \text{ Å}$$

This is known as Compton wavelength of electron

3. What are matter waves?

The waves associated with moving particles of matter are known as matter waves or de-Broglie waves.

4. Write an expression for the wavelength of matter waves? (or) What is de-Broglie's wave eqn?

$$\boxed{\lambda = \frac{h}{mv} = h/p}$$

h - Planck's Constant
m - mass of the particle
v - Velocity of the particle
p - momentum of the particle

(17)

5. Write an expression for the de-Broglie wavelength associated with electrons.

$$\lambda = \frac{h}{\sqrt{2m_0eV}}$$

h - Planck's constant
e - charge of the electron
m - mass of the electron
V - accelerating voltage.

6. State the properties of the matter waves

i) Lighter is the particle, greater is the wavelength associated with it.

ii) Smaller is the velocity of the particle, greater is wavelength associated with it.

iii) These waves are not electromagnetic waves

iv) The velocity of deBroglie wave is equal to the velocity of the material particle.

7. Mention some of the physical significances of the wave function.

i) The wave function (ψ) relates the particle and wave nature of matter statistically.

ii) It is a complex quantity and hence we cannot measure it.

iii) $P = \iiint_V |\psi|^2 \, dx \, dy \, dz = 1$

8. What are eigen values and eigen function?

Energy of a particle moving in one dimensional box of width 'a' is given by

$$E_n = \frac{n^2h^2}{8ma^2}$$

For each value of n, there is an energy level. Each value of E_n is called an eigen value.

There is a corresponding wave function ψ_n. This corresponding wave function is called eigen function.

Eigen function associated with an electron in a one dimensional box is given by

$$\psi_n = \sqrt{2/a} \sin\left(\frac{n\pi x}{a}\right)$$

9. What is Schrodinger wave eqn ?

The equation that describes the wave nature of a particle in mathematical form is known as Schrodinger wave equation.

10. What is a wave function ?

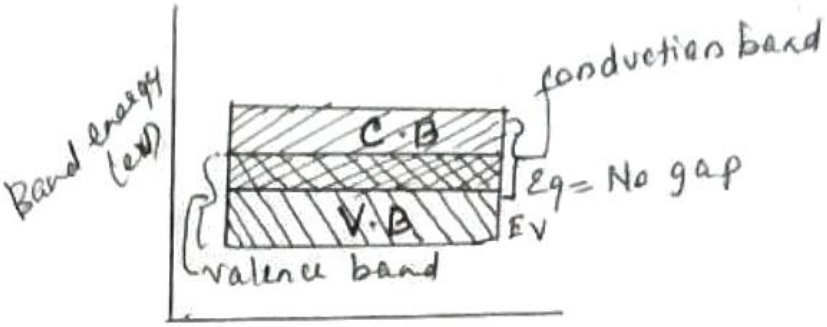
A variable quantity which characterises de-Broglie wave is known as wave function and it is denoted by the symbol ψ.

11. Define correspondance Principle

Any new theory in physics must reduce to well-established corresponding classical theory when the new theory is applied to the special situation in which the less general theory is know to be valid.

Conductor :

- No forbidden gap
- Both valence and conduction bands overlap each other



- As the temperature increases, the electrical conduction decreases
- Mobility decreases due to large number of collisions with ions.

UNIT : V

APPLIED QUANTUM MECHANICS

Two mark questions

1. What is a harmonic oscillator ?

A particle undergoing simple harmonic motion is called a harmonic oscillator.

2. Give examples for harmonic oscillator.
   - Simple pendulum
   - Object floating in a liquid
   - Diatomic molecule

3. What is the significance of zero point energy is a harmonic oscillator ?

For lowest state, $n = 0$

$$E_0 = \frac{1}{2} h\nu$$

Lowest value of energy called zero point energy. Even if the temperature reduces to absolute zero, the oscillator would still have an amount of energy $\frac{1}{2}h\nu$.

In old quantum mechanics, the energy of n^{th} level

$$E_n = nh\nu$$

In wave mechanics

$$E_n = \left(n + \tfrac{1}{2}\right) h\nu$$

4. Define barrier penetration

The transmission of electrons through the barrier is known as barrier penetration.

5. What is quantum tunneling?

The phenomenon of transmission of a particle through a potential barrier of finite width and height even when its energy is less that the barrier height is called quantum tunneling.

6. What is an electron microscope?

. It is a microscope which uses electron beam to illuminate a specimen and it produces an enlarged image of the specimen.

. It has very high magnification power and resolving power when compared to optical microscope.

7. What are the types of electrons microscopes?

Four types of electron microscopes.

i) Transmission Electron Microscope (TEM)
ii) Scanning Electron Microscope (SEM)
iii) Scanning Transmission Electron Microscope (STEM)
iv) Scanning Tunneling Microscope (STM)

8. State Block Theorem

If an electron in a linear lattice of a lattice constant 'a' characterised by potential function $V(x) = V(x+a)$ satisfies the Schroedinger eqn

$$\frac{d^2\psi(x)}{dx^2} + \frac{2m}{\hbar^2}[E - V(x)]\psi(x) = 0$$

then the wave functions $\psi(x)$ of electron (with energy E) obtained as a solution of schrodinger eqn

$$\psi(x) = U_k(x) e^{\pm ikx}$$

$$U_k(x) = U_k(x+a)$$

9. What is an energy band?

A set of closely spaced energy levels is called an energy band

10. what is Valence band?

The electrons in the outermost shell are called Valence electrons. The band formed by a series of energy level containing the valence electrons is known as Valence band.

11. What is conduction band?

The band formed by a series of energy level containing the conduction electrons is known as Conduction band.

12. What is forbidden gap?

Both Conduction and Valence band are seperated by a region or gap is known as forbidden band or gap.