JAYA COLLEGE OF ENGINEERING AND TECHNOLOGY ,POONAMALLEE, CHENNAI 600056
Department of Science and Humanities Question Bank, Even Semester
PH3256 & PHYSICS FORINFORMATION SCIENCE (R-2021) PART-A 2-MARKS

UNIT-1; Electrical Properties of Materials

1. Give any two postulates of classical free electron theory

- According to this theory, a metal consists of a very large number of free electrons. These free electrons move freely throughout the volume of the metal. They are fully responsible for the electrical conduction in the metal.
- Drude assumed that the free electrons in a metal form an electron gas. These free electrons move randomly in all possible directions just like the gas molecules move in a container.

2. Define mean free path.

The average distance travelled by a free electron between any two successive collisions in the presence of an applied field is known as **mean free path**.

It is the product of drift velocity of electrons (v_d) and collision time (τ_c),

$$\lambda = v_d \times \tau_c$$

3. Define relaxation time of an electron.

The average time taken by a free electron to reach its equilibrium state from its disturbed state due to application of an external electrical field is called **relaxation time**.

4. Define drift velocity of electron. How is it different from the thermal velocity of an electron?

The average velocity acquired by a free electron in a particular direction after a steady state is reached on the application of an electric field is called drift velocity. It is denoted as v_d and its value is very small (50 cm/s).

The thermal velocity is random in nature and its value is very high (10^5 m/s),

5. Define mobility of electrons.

The magnitude of the drift velocity acquired by the electrons per unit electric field is defined as the mobility of electrons (μ)

i.e., $\mu = ud/E$

where ud→ Drift velocity of electrons

E→ Electrical field.

6. Define electrical conductivity. What is its unit.

The amount of electrical charges (q) conducted per unit time (t) across unit area (A) of the conductor for unit applied electrical field (E) is defined as electrical conductivity.

$\sigma = q / tAE$

Its unit is $ohm^{-1}\, m^{-1}$ or mho m^{-1}.

7. What are the merits of classical free electron theory?

- It is used to verify Ohm's law.

- It is used to explain electrical and thermal conductivities of metals.
- It is used to derive Wiedemann - Franz law.
- It is used to explain the optical properties of metal.

8. What are the drawbacks of classical free electron theory?

- Classical theory states that all free electrons will absorb the supplied energy; on the contrary, quantum theory states that only a few electrons will absorb the supplied energy.
- Electrical conductivity of semiconductors and insulators (non-metals) cannot be explained.
- The phenomena such as photo-electric effect, Compton effect and black body radiation cannot be explained on the basis of this theory because these phenomena are based on quantum theory.

9. State Wiedemann - Franz law.

It states that the ratio of thermal conductivity (K) to electrical conductivity (o) of a metal is directly proportional to absolute temperature (T). This ratio is constant for all metals at a given temperature.

$K/\sigma \text{ a } T$

i.e., $K/\sigma = LT$

where L is a constant and it is known as Lorentz number.

The ratio between thermal conductivity (K) of a metal to the product of electrical conductivity (6) of a metal and absolute temperature (T) of the metal is a constant. It is called Lorentz number and it is given by

$L=K/\sigma T$

11. Define Fermi distribution function.

The probability F (E) of an electron occupancy for a given energy level at temperature T is known as Fermi distribution function. It is given by

$F(E)=1/1+e^{(E-EF)/KT}$

$E_F \rightarrow$ Fermi level

$k \rightarrow$ Boltzmann's constant

$T \rightarrow$ Absolute temperature

$E \rightarrow$ Energy of the level whose occupancy is being considered.

12. Write down the expression for the Fermi distribution law and explain for the electrons in a metal.

Fermi distribution function is given by

$F(E)=1/1+e^{(E-EF)/KT}$

where Ep is called Fermi energy

if $E<E_F$ all levels are filled with electrons

i.e., $F(E)=1$

if $E>E_F$ all levels are empty

i.e., $F(E)=0$

if T>0K at E_F, $F(E)=1/2$

13. Define Fermi level and Fermi importance.

Fermi level: It is the energy level at finite temperature above 0 K in which the probability of the electron occupation is 1/2 and it is also the level of maximum energy of the filled states at 0 K.

Fermi energy: It is the energy of the state at which the probability of the electron occupation is 1/2 at any temperature above OK. It is also the maximum energy of filled states at 0 K

Importance: Fermi level and Fermi energy determine the probability of an electron occupation for a given energy level at a given temperature.

14. Define density of states. What is its use?

It is defined as the number of available electron states per unit volume in an energy interval E and E+dE. It is denoted by Z (E).

It is used to determine Fermi energy at any temperature.

15. What is electron theory of solids?

The electrons in the outermost orbit of the atoms which constitute the solids determine its electrical properties. The electron theory of solids explains the structure and properties of solids through their electronic structure.

16. What are special features of classical free electron theory of solids?

In a metal, the free electrons of an atom are free to move about the entire volume of the metal like the molecules of a perfect gas in a container. These free electrons in the metal are responsible for electrical conduction.

17. What is a periodic potential.

When an electron moves through a solid, its potential energy varies periodically with the periodicity equal to period of space lattice 'a' (interatomic distance). This is called periodic potential.

18. What is an energy band?

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

19. What is an effective mass of electron?

The mass acquired by an electron when it is accelerated in a periodic potential is called effective mass of an electron. It is denoted by m^*.

UNIT-2: Semiconductor Physics

1. What elemental semiconductors? Give some are important elemental semiconductors.

Elemental semiconductors are made from single element of the fourth group elements of the periodic table.

Example: Germanium and silicon.

2. What are the properties of semiconductors?

- They are formed by covalent bond. They have empty conduction band.
- They have almost filled valence band.
- These materials have comparatively narrow energy gap

3. What are compound semiconductors? Give some important compound semiconductors.

Semiconductors which are formed by combining third and fifth group elements or second and sixth group elements in periodic table are called compound semiconductors.

S.NO	GROUP	Compound Semiconductor
1.	Group Combination of third and fifth group elements (III and V)	Compound semiconductor Gallium Phosphide (GaP) Gallium Arsenide (GaAs) Indium Phosphide (InP) Indium Arsenide (InAs)
2.	Combination of second and sixth group elements (II and VI)	Magnesium Oxide (MgO) Magnesium Silicon (MgSi) Zinc Oxide (ZnO) Zinc Sulphide (ZnS)

4. Mention any four advantages of semiconducting materials.

- It behaves as insulator at 0 K and as conductor at high temperatures.
- It has some properties of both conductor and insulator.
- On doping, n and p-type semiconductors are produced with charge carriers of electrons and holes respectively.
- It has many applications in electronic field such & manufacturing of diodes, transistors, LED's, IC etc.

5. What are the differences between elemental semiconductors and compound semiconductors?

S.NO	Elemental Semiconductors	Compound Semiconductors
1.	They are made of single element. Examples: Ge, Si compounds.	They are made of compunds. Examples: GaAs, GaP, MgO etc.
2.	Heat is produced during recombination.	The photons are emitted during recombination.
3.	They are used for the manufacture of diodes and transistors	They are used for making LED's, Laser diodes and IC,s

6. Write an expression for the concentration of electrons in the conduction band of an intrinsic semiconductor.

The concentration of electrons in the conduction band of an intrinsic semiconductor is given by

$$N=2(2\pi m_e^* KT/h^2)^{3/2} e^{(E_f-E_c/KT)}$$

where m^*_e→ effective mass of electron

E_F→ Fermi energy level

E_C→ Energy corresponds to the bottom of conduction band

T→ Absolute temperature

7. Write an expression for the concentration of holes in the valence band of an intrinsic semiconductor.

The concentration of holes in the valence band is given by

$$p=2(2\pi m_h^* KT/h^2)^{3/2} e^{(EV-EF)/KT}$$

m^*_h→ effective mass of hole

T→ absolute temperature

E_f→ Fermi energy

E_v→ Energy corresponds to the top of valence band

8. What is Fermi level in a semiconductor?

Fermi level in a semiconductor is the energy level situated in the band gap of the semiconductor. It is exactly located at the middle of the band gap in the case of an intrinsic semiconductor.

9. Write an expression for carrier concentration in n-type semiconductor.

The carrier concentration in n-type semiconductor is given by

$$N=(2N_d)^{1/2} (2\pi m^*_e KT/h^2)^{3/4} e^{-\Delta E/2KT}$$

Where

$\Delta E \to E_c - E_d$ = Ionisation energy of the donor.
$N_d \to$ Number of donor atoms per unit volume of the material.
$m^*_e \to$ Effective mass of an electron.
$T \to$ Absolute temperature

10. Write an expression for carrier concentration of holes in the valence band of p-type semiconductor.

The carrier concentration in p-type is given by

$$N = (2N_a)^{1/2} (2\pi m^*_e KT/h^2)^{3/4} e^{-\Delta E/2KT}$$

Where
$\Delta E = (E_v - E_a) \to$ ionisation energy of acceptor level
$m^*_h \to$ Effective mass of hole
$N_a \to$ Number of acceptor atoms per unit volume of the material.
$T \to$ Absolute temperature.

11. Define Hall-effect and Hall voltage.

When a conductor carrying a current (I) is placed in a transverse magnetic field (B), a potential difference is produced inside the conductor in a direction normal to the directions of the current and magnetic field.
This phenomenon is known as Hall-effect and the generated voltage is called Hall-voltage.

12. Mention the uses of Hall effect.

- It is used to find type of semiconductor.
- It is used to measure carrier concentration.
- It is used to find mobility of charge carrier. semiconductor sample of known Hall coefficient.
- It is used to measure the magnetic flux density using a semiconductor sample of known Hall coefficient.

13. What are the differences between intrinsic and extrinsic semiconductor?

S.NO	Intrinsic Semiconductor	Extrinsic Semiconductor
1.	Semiconductor in a pure form is called intrinsic semiconductor	Semiconnductors which are doped with impurity is called extrinsic semiconductor.
2.	Here, the charge carriers are produced only due to thermal agitation.	Here, the charge carriers are produced due to impurities.
3.	Examples: Si, Ge, etc.	Examples: Si and Ge doped with Al, In, P, As etc.

14. What are the differences between intrinsic and extrinsic semiconductor?

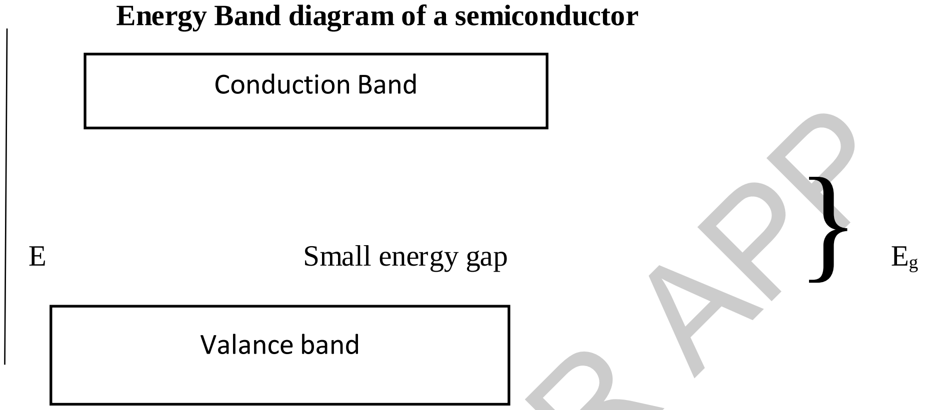
S.NO	n-type semiconductor	p-type semiconductor
1.	When a pentavalent impurity is doped to intrinsic semiconductor, n-type semiconductor is formed.	When trivalent impurity is doped to intrinsic semiconductor, p-type semiconductor is formed.
2.	The impurity is called donor impurity since it donates electron.	The impurity is called acceptor impurity since it accepts electron.

3.	Majority charge carriers are electrons.	Majority charge carrieers are holes
4.	Minority charge carriers are holes.	Minority chare carriers are electrons.

15. What is a semiconductor?
Semiconductor is a special class of material which behaves like an insulator at 0 K and acts conductor at temperature other Semiconductor is a special class of material which behaves than 0 K. Its resistivity lies in between a conductor and an insulator.

16. Draw the energy level diagram of a semiconductor.

Energy Band diagram of a semiconductor



17. What is an intrinsic semiconductor?
Semiconductor in an extremely pure form (without impurities) is known as intrinsic semiconductor.
18. What is an extrinsic semiconductor?
A semiconducting material in which impurity atoms added (doped) to the material to modify its conductivity is known as extrinsic semiconductor or impurity semiconductor.
19. What is an n-type semiconductor?
When a small amount of pentavalent impurity is added to a pure semiconductor, it becomes semiconductor and it is known as n-type semiconductor.
20. What is a p-type semiconductor?
When a small amount of trivalent impurity is added to a pure semiconductor, it becomes extrinsic semiconductor impure semiconductor and it is called p-type semiconductor.
21. What is meant by doping and doping agent?
The technique of adding impurities to a pure semiconductor is known as doping and the added impurity is called doping agent.
22. Explain the concept of hole in semiconductor.
In intrinsic semiconductor, charge carriers are created due to breaking of covalent bonds. When a covalent bond is broken, an electron escapes to the conduction band leaving behind an empty space in the valence band. This missing electron is called a hole.
23. What is meant by donor energy level?
A pentavalent impurity when doped with an intrinsic semiconductor donates one electron which produces an energy called donor energy level.
24. What is meant by acceptor energy level?

A trivalent impurity when doped with an intrinsic semiconductor accepts one electron which produces an energy level called acceptor energy level.

25. Mention the uses of compound semiconductor.

They are used as photovoltaic materials, photoconductive cell, laser materials and for making LED (Light Emitting Diode).

26. Define drift velocity.

When an electrical field is semiconducting material, the free charge carriers and holes attain drift velocity ν_d.

The drift velocity attained by the carries is proportional to the electrical field strienght E.

i.e., $\nu_d \propto E$

$\nu_d = \mu E$

where μ is a proportionality constant and it is known as mobility of the charge carrier.

27. Define drift current.

The electric current produced due to the motion of charge carriers under the influence of an external electric field is known as drift current.

28. Define diffusion current.

The non-uniform distribution of charge carriers creates the regions of uneven concentrations in the semiconductor.

The charge carriers move from the regions of higher concentration to the regions of lower concentration. This process is known as diffusion. The current is known as diffusion current.

29. What is a Hall device?

The device which uses hall effect for its application is the as Hall device.

30. What are different types of Hall devices?

There are three types of Hall devices.

They are

(a) Gauss Meter
(b) Electronic Multiplier
(c) Electronic Wattmeter

31. What is a schottky diode?

It is a junction formed between a metal and n-type semiconductor.

When the metal has a higher work function than that of n-type semiconductor then the junction formed is called schottky diode.

32. What are advantages of schottky diodes?

- In schottky diode, stored charges or depletion region is negligible. So a schottky diode has a very low
- In schottky diode, the depleting region is negligible. So the schottky diode will immediately switch from ON to OFF state (fast recovery time).
- The depletion region is negligible in schottky diode. So applying a small voltage is enough to produce large current.
- It has high efficiency.
- It operates at high frequencies.
- It produces less noise.

33. What are the application of scholtky diode?

- Schottky diode can be used for rectification of signals of frequencies even exceeding 300 MHz.
- It is commonly used in switching device at frequencies of 20 GHz.
- It is used in radio frequency (RF) applications.

- It is widely used in power supplies.

34. What are the differences between schottky diode and p-n diode?

S.NO	Schottky Diode	p-n diode
1.	Forward current due to thermionic emission (majority carrier transport)	Forward current due to diffusion currents (majority carrier transport)
2.	Reverse current only due to majority carriers that overcome the barrier (less temperature dependent)	Reverse current due to minority carriers diffusing to the depletion layer and drifting to the other side (strong temperature dependencies)
3.	Cut-in voltage is small (about 0.3 V)	Cut-in voltage is large (about 0.7V)
4.	High switching speed, because of majority carrier transport. No recombination time needed.	Switching speed limited by the recombination time of the injected minority carriers.

35. What is ohmic contact?

An ohmic contact is a type of metal semiconductor junction. It is formed by a contact of a metal with a heavily doped semiconductor.

When the semiconductor has a higher work function than that of metal, then the junction formed is called Ohmic junction.

36. What are the uses if ohmic contact?

The use of ohmic contacts is to connect one semiconductor device to another, an IC, or to connect an IC to its external terminals.

37. What are the differences between schottky diode ohmic contacts?

S.NO	Schottky Diode	Ohmic contact
1.	It acts as a rectifier	It acts as a resistor
2.	Very low forward resistance but very high reverse biased resistance	Resistance is same in both forward and reverse bias
3.	Work function of metal is greater than that of semiconductor $\phi_m > \phi_{semi}$	Work function of metal is smaller than that of semiconductor $\phi_m < \phi_{semi}$

UNIT-3;MAGNETIC PROPERTIES OF MATERIALS

1. On the basis of spin how the materials are classified as para, ferro, antiferro and ferri magnetic.

- Paramagnetic materials have few unpaired electron spins of equal magnitudes.
- Ferro magnetic materials have many unpaired electron spins with equal magnitudes.
- Anti ferro magnetic materials have equal magnitude of spins but in antiparallel manner.
- Ferrimagnetic materials have spins in antiparallel manner but with unequal magnitudes.

2. What is Curie constant? or What is Curie law?

It is found that susceptibility (x) is inversely proportional to the temperature (T)

$\chi \propto 1/T$

$\chi = C/T$

where C is constant and it is known as Curie constant. This relation is known as Curie law.

3. State Curie Weiss law and its importance.

Curie - Weiss law is given by

$$\chi_x = C/T-\theta$$

where C → Curie constant

T→ Absolute temperature

θ→ Curie temperature

Importance: It determines the susceptibility of the magnetic materials in terms of temperatures i.e., If the temperature is less than curie temperature, a paramagnetic material becomes diamagnetic.

If the temperature is greater than Curie Temperature, a ferromagnetic material becomes paramagnetic material.

4.What is ferromagnetism?

Certain materials like Iron (Fe), Cobalt (Co), Nickel (Ni) certain alloys exhibit spontaneous magnetization i.e., they are a small amount of magnetisation (atomic moments are aligned) even in the absence of an external magnetic field. This phenomenon is known as ferromagnetism.

5. What are ferromagnetic materials?

The materials which exhibit ferromagnetism are called as ferromagnetic materials.

6. What are the properties of ferromagnetic materials?

- All the dipoles are aligned parallel to each other due to the magnetic interaction between any two dipoles.
- They have permanent dipole moment. They attract the magnetic field strongly.
- They exhibit magnetisation even in the absence of magnetic field. This property of ferromagnetic materials is called as spontaneous magnetisation.

7. What is domain theory of ferromagnetism?

According to domain theory, a specimen of ferromagnetic material consists of a number of regions or domains which are spontaneously magnetized due to parallel alignment of all magnetic dipoles. The direction of spontaneous magnetisation varies from domain to domain.

8. Mention the energies involved in origin of domains in ferromagnetic material.

(i) Magnetostatic energy

(ii) Crystalline energy

(iii) Domain wall energy

(iv) Magnetostriction energy.

9. What is antiferromagnetism?

In anti-ferromagnetism, electron spin of neighbouring atoms are aligned antiparallel. Anti-ferromagnetic susceptibility is small and positive and it depends greatly on temperature.

10. State the applications of ferrites.

- They are used in transformer cores for high frequencies upto microwaves.
- They are used in radio receivers to increase the sensitivity and selectivity of the receiver.
- Ferrites are used in digital computers and data processing circuits as magnetic storage elements.
- They are used as an isolator, gyrator and circulator which are used in microwave devices.

11. What are soft magnetic materials?

Materials which are easy to magnetise and demagnetise are called soft magnetic materials.

12.State the properties of soft magnetic material.

- They have high permeability
- They have low coercive force.

- They have low hysteresis loss.

13.Mention few sift magnetic materials and their applications.

Soft magnetic materials:

(i) Pure or ingot iron
(ii) Cast iron (carbon above 2.5%)
(iii) Carbon steel

Applications:

- Cast iron is used in the structure of electrical machinery and frame work of d.c.machine.
- Carbon steel has high mechanical strength used in making motor of turbo alternators.

14. What are hard magnetic materials? (A.U. June 2010)

Materials which retain their magnetism and are difficult to demagnetise are called hard magnetic materials.

15. State the properties of hard magnetic materials.

- They possess high value of B-H product
- They have high retentivity.
- They have high coercivity.
- They have low permeability.

16. Mention few hard magnetic materials and their application.

- Tungsten steel contains 4.5 to 6% tungsten, 0.5 to 0.7% tungsten and remaining is iron.
- Cobalt steel contains 34% cobalt, 5% chromium 3.5 to 6% carbon and the remaining is iron.

Applications:

- Tungsten steel is used in making permanent magnets for dynamos, motor.
- Cobalt steel is used in motor, fans and heavy duty instruments.

17. Differentiate soft and hard magnetic materials. (A.U. April 2008, Jan 2009)

S.NO	Soft magnetic materials	Hard magnetic materials
1.	Magnetic materials can be easily magnetised and Demagnetised.	Magnetic materials cannot be easily magnetised and demagnetised.
2.	They have high permeability	They have low permeability.
3.	Magnetic energy stored is low.	Magnetic energy stored is high.
4.	Low hysteresis loss due to small hysteresis loop area	High hysteresis loss due to large hysteresis loop area.

18. What are ferrimagnetic materials.

Materials which exhibit ferrimagnetism are called ferrimagnetic materials. They are also known as ferrites.

19. Mention the properties of ferrimagnetic materials.

(i) These are the ferromagnetic materials in which equal number of opposite spins with different magnitudes such that the orientation of neighbouring spins is in antiparallel manner.

(ii) Susceptibility is positive and very large for these materials.

20.Why ferrites are advantageous for use as transformer cores?

Ferrites are used as transformer cores for frequencies upto microwaves. This is because the eddy current which prevents the penetration of magnetic flux into the material is very much less in ferrites than in iron.

21What is saturation magnetisation?

The maximum magnetisation in a ferromagnet when all atomic magnetic moments are aligned is called saturation magnetization.

22. What are the required magnetic parameters for recording?

The basic parameters required for recording are

(i) Electromagnetic induction should occur in materials.
(ii) The material should easily acquire magnetism.
(iii) It should possess magneto-resistance i.e., the electrical resistance should vary with respect to the magnetisation.
(iv) Soft magnets should be used for temporary storage and hard magnets should be used for permanent storage.

23. What is Bohr magneton?

The orbital magnetic moment and the spin magnetic moment of an electron in an atom can be expressed in terms of atomic unit of magnetic moment called Bohr magneton.

1 Bohr Magneton = $e\hbar/2m = eh/4\pi m$

1 $\mu B = 9.27 \times 10^{-24}$ Am^2

24. What is Giant magnetoresistance?

It is a quantum mechanical magnetoresistance effect observed in multilayers composed of alternating ferromagnetic and non-magnetic conductive layers.

The effect is observed as a significant change in the electrical resistance depending on whether the magnetization of adjacent ferromagnetic layers are in a parallel or an antiparallel alignment. The overall resistance is relatively low for parallel aligment and relatively high for antiparallel alignment.

The magnetization direction can be controlled, for example, by applying an external magnetic field. The effect is based on the dependence of electron scattering on the spin orientation.

25. Mention application of GMR.

The main application of GMR is magnetic field sensors, which are used to read data in hard disk drives, biosensors, microelectromechanical systems (MEMS) and other devices. GMR multilayer structures are also used in magnetoresistive random-access memory (MRAM) as cell that store one bit of information.

UNIT-4; OPTICAL PROPERTIES OF MATERIALS.

1. What are optical materials?

The materials which are sensitive to light are known as Optical materials.These optical materials exhibit a variety of optical properties.

2. What are the type of optical materials?

Generally, optical materials are classified into three types based on the nature of propagation of light namely,

(i) Transparent

(ii) Translucent

(iii) Opaque

3. Define scattering of light.

It is a process by which the intensity of the wave attenuates as it travels through a medium.

4. Define carrier generation and recombination.

The carrier generation is the process whereby electrons and holes are created. The recombination is the process whereby electrons and holes are annihilated.

5. What are types of carrier generations?

(i) Photogeneration

(ii) Phonon generation

(iii) Impact ionization

6. What are types of recombination process?

(a). Radiative Recombination

(b) Shockley-Read-Hall Recombination

(c) Auger Recombination

7. What is photo diode?

It is a reverse biased P-N junction diode which responds to light absorption.

8. What is the basic principle of photo diode?

When light is incident on the depletion region of the reverse-biased pn junction, the concentration of minority carriers increases. Therefore, reverse saturation current increases.

9. What is solar cell?

It is a P-N junction diode which converts solar energy (light energy) into electrical energy.

10. What is LED?

It is a p-n junction diode which emits light when it is forward biased.

11. What is the basic principle behold LED?

The injection of electrons into the p- region from n- region makes a direct transition from the conduction band to valence band. Then, the electrons recombine with holes and emits photons of energy E_g

The forbidden gap energy is given by

$$\boxed{E_g = h\nu}$$

12. What are the advantages of LEDs?

- LEDs are smaller in size. A number of LEDs can be stacked together in a small space to form numerical display. second (10 second). So, they are known as fast devices.
- LED's can be turned ON and OFF in less than 1 nano second (10^{-9} second). So, they are known as fast devices.
- Variety of LEDs are available which emit light different colours like red, green, yellow etc.
- Light modulation can be achieved with pulse supply.
- It has long life time.
- It has low drive voltage and low noise.
- It is easily interfaced to digital logic circuits.
- It can be operated over a wide range of temperatures.

13. What are the disadvantages of LEDs?

- They require high power.
- Their preparation cost is high when compared to LCD.

14. What are the applications uses of LEDs?

- Because of their miniature size, they are widely used in numeric and alphanumeric display devices.
- They are used as indicator lamps.
- They are used as light sources in fiber-optic communication system.
- Infrared LEDs are used in burglar alarms.
- They are used in image sensing circuits used for picture phone.

15. What is an organic light emitting diodes?

Organic light emitting diodes (OLEDs) are solid state devices made up of thin films of organic molecules that produce light with the application of electricity.

16. What are advantages of OLED?

- OLED's are tough enough to use in portable devices such as cellular phones, digital video cameras, DVD players,car audio equipment etc.,
- Can be viewed up to 160 degrees.
- High information applications including videos and graphics (Active matrix)
- OLEDs are paper-thin.
- Upto 20% to 50% cheaper than LCD processes. .They hold the ability to handle streamlined video, which could revolutionize the display and cellular phone market.
- Takes less power.

17.What are drawbacks of OLED?

- The biggest technical problem for OLEDs is the limited lifetime of the organic materials.
- The intrusion of water into displays can damage or destroy the organic materials.
- Color - The reliability of the OLED is still not upto the mark. After a month of use, the screen becomes non-uniform.

18. What are the applications of OLED?

- OLED technology is used in commercial applications such as small screens for mobile phones and portable digital audio players (MP3 players), car radios, digital cameras and high-resolution micro displays for head-mounted displays.
- They can be used in television screens, computer displays, advertising, information and indication.
- OLEDs can also be used in light sources for general space illumination and large-area light-emitting elements.

19. What is a laser diode?

It is a specially fabricated pn junction diode. This diode emits laser light when it is forward - biased.

20. What are the advantages of Laser diodes?

- This laser is very small in size and compact.
- It has high efficiency.
- The laser output can be easily increased by increasing the junction current.
- It is operated with less power than ruby and CO_2 lasers.
- It requires very little additional equipment.
- It emits a continuous wave output or pulsed output.

21. What are the applications of Laser diodes?

• Used in fibre optic communication.

• Used in various measuring devices such as range finders, bar-code readers.

• Used in printing industry both as light sources for scanning images and for resolution printing plate manufacturing.

• Infrared and red laser diodes are common in CD players, CD-ROM and DVD technology. Violet lasers are used in HD - DVD and Blue-ray technology.

• High power laser diodes are used in industrial applications such as heat treating, cladding, seam welding and for pumping other lasers.

• Used in laser medicine especially, dentistry.

22. What is the principle of CD?

The principle of CD is that the data (Audio/video/text etc.) be stored is first converted into binary form as Os and Is.
It is then stored in the form of reflecting and non-reflecting micro-points in spiral path on a disc. During the read-out process, variation in the reflected intensity of laser is converted back to data.

23. What are advantages of optical dics?

The optical discs have several advantages over semiconductor memories. Some of these include their larger data storage capacity, shorter access time size. Therefore, they are used in terminal equipment of computers as well as in audio visual equipment.

UNIT-5; Nano Devices and Quantum Computing

1. Define nano materials.

Nanophase materials are newly developed materials with grain size at the nanometre range (10^{-9} m), i.e., in the order of 1 - 100 nm. The particle size in a nano material is 1 - 100 nm.

2. What is a quantum confinement?

It is a process of reduction of the size of the solid such that the energy levels inside become discrete.

3. What is quantum structure?

When a bulk material is reduced in its size, atleast one of its dimension, in the order of few nanometres, then the structure is known as quantum structure.

4. What is quantum size-effect?

When the size of a nanocrystal becomes smaller than the deBroglie wavelength, electrons and holes get spatially confined, electrical dipoles get generated, the discrete energy levels are formed.

As the size of the material decreases, the energy separation between adjacent levels increases. The density of states of nanocrystals is positioned in between discrete (as that of atoms and molecules) and continuous (as in crystals).

Quantum size effect is most significant for semiconductor nanoparticles.

5. What is single electron phenomena?

Present day, transistors require 10,000 electrons. Rather than moving many electrons through transistors, it may very well be practical and necessary to move electrons one at a time. The phenomena in known as single electron phenomena.

6.Define Coulomb - Blockade effect.

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- This can be used for the next generation quantum computer.

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- In order to operate SET circuit at room temperature, the size of the quantum dot should be smaller than 10 nm.
- It is very hard to fabricate by traditional optical lithography and semiconductor process. individual structures into logic circuits and these circuits.
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11. What are the applications of single electron Transistor?

• A variety of digital logic functions, including AND or NOR gates, is obtained based on SET operating at room temperature.

• It is used for mass data storage.

• It is used in highly sensitive electrometer.

• SET can be used as a temperature probe, particularly in the range of very low temperatures.

• SET is a suitable measurement set-up for single electron spectroscopy.

• It is used for the fabrication of a homo-dyn receiver operating at frequencies between 10 and 300 MHz.

12. What is Quantum Cellular Automata?

Quantum Cellular Automata CMOS (Complementary Metal Oxide semiconductor) technology has a lot of limitations while scaling into a nano-level.

In order to improve the performance of a system, new nano-technology approach should be taken into account. The QCA technology is a perfect replacement of CMOS technology without any limitations.

13. What are the advantages of QCA?

• It is "edge driven," meaning an input is brought to an edge of a QCA block. (ie it is evaluated and output at another edge). This also means that no power lines need be routed internally.

• The QCA systems should be very low power system because there is no current flowing. Only enough energy needs to add to lift the electrons from their ground states to higher states.

- The QCA cells are very small.

14. Define Hilber space.

Hilbert space is defined as an infinite-dimensional vector space with an inner product and its associated norm.

$|\psi_a\rangle\alpha_0|0\rangle+\alpha_1|1\rangle+\ldots+\alpha_1|i\rangle+\ldots+\alpha_{n-1}|n-1\rangle$

15. Define Clasical Bits.

Classical bit is an abstraction of a physical system, anyone of two states, either '0' or '1'. Hence it can take the value 0 or 1. The bit is a smaller and simpler physical system It requires less energy to speedily process information and to store it. The physical system of bit is at atomic or subatomic level.

16. What is a qubit?

A qubit is a mathematical model of microscopic physical system such as the spin of electron or the polarization of a photon. It also exists in a common intermediate states or superposition states.

17. What are the difference between bits and qubits?

S.No	Bits	Qubits
1.	The device computes by manipulating those bits/manipulating those bits with the help of logical with gates (AND, OR, NOT).	The device computes by manipulating those bits with the help of quantum logic gates.
2.	A classical computer has a memory made up of bits where each bit hold either a one or zero.	A qubits (quantum bitts) can hold a one, a zero or crucially a superposition of there.
3.	Bits are used in classical computers.	Qubits (Quantum bits) are used in quantum computer.
4.	Information is stored in bits which take discrete values 0 and 1	Information is stored in quantum bits, or qubits. A qubit can be in states labelled $|0\rangle$ and $|1\rangle$, but it can also be in a superposition of these states, $a|0\rangle$ and $b|1\rangle$, where a and b are complex numbers. If we think of the state of a qubit as a vector,, then superposition of states is just vector addition.
5.	Processing of Bits are slow.	Processing of Qubits are faster.
6.	Its circuit behaviour is based on classical physics.	Its circuit behaviour is based on quantum mechanics.

18. Define Bloch Sphere.

The Bloch sphere representation is useful in understanding the qubits. It provides a geometric picture of the qubit and of the transformations takes on the state of a qubit.

19. Define one-qubit quantum gates.

A one-qubit gate transforms an input qubit

$|\psi) = \alpha|0) + \alpha\,|\,1))$ into an output qubit

$|\,\varphi) = \alpha\,|0) + \alpha 1'\,|\,1).$

Mathematically, a gate G is represented by a 2 × 2 transfer matrix with complex entries.

20. What are advantages of quantum computing over classical computing?

The quantum computers can solve the complex mathematical problems. Traditional computers find impossible to solve in a practical time frame.

The computing power is sufficient to process excessively large amounts of data (2.5 Exabyte daily i.e. equal to 5 million laptops)

Due to the teleportation phenomenon known as 'quantum tunneling,' it can work in parallel. It uses less amount of electricity, hence, reducing the power consumption upto 100 to 1000 times.

A computer is "thousands of times" faster than any classical computer.

It can work without being overheated. (since for its stability it kept cold upto 0.2 Kelvin inside the quantum system).

It can easily solve optimization problems such as finding the best route and scheduling trains and flights.

The quantum effect is made to reduce the size of electronic devices.

The simulation efficiency is high in quantum computers than in classical computers.

21. What are the disadvantages of quantum computing?

Due to advancements in quantum computers, the security of the existing Internet of Things (IoT) would fall down. Cryptographic techniques, Databases of defense systems can be hacked. Considering these facts, government and private large organizations, banks, and quantum computers can be terrible for our future.

The Quantum Computers will work as a different Since, classical computers are better at some places device and cannot replace classical computers entirely. than quantum computers like email, excel, etc.

It has not been invented completely yet as only parts are being implemented and people are still imaging how it would look.

It is very delicate and error-prone. Any kind of vibrations affects subatomic particles like atoms and electrons. Due to which noise, faults, and even failures are possible. It leads to "*Decoherence*" which is a loss of coherence in quantum.

Quantum processors are very unstable and are very hard to test even. For the stability of the quantum computer, it is kept at 0.2 Kelvin (absolute Kelvin) which is nearly below the inverse temperature.

22. Define nano materials.?

Nanophase materials are newly developed materials with grain size at the nanometre range (10^{-9} m), i.e., in the order of 10^{-9}m . The particle size in a nano material is 1 - 100 nm.

23. Define density of states.?

It is defined as the number of available electron states per unit volume in an energy interval E and E +dE. It is denoted by Z (E).

24. Define Fermi energy.?

It is defined as the highest energy level occupied by theelectron at OK in metal

25. What is a quantum confinement?

It is a process of reduction of the size of the solid suchthat the energy levels inside become discrete.

26. What is quantum structure?

When a bulk material is reduced in its size, atleast one of its dimension, in the order of few nanometres, then the structure is known as quantum structure.

27. What is quantum size-effect?

When the size of a nanocrystal becomes smaller than the deBroglie wavelength, electrons and holes get spatially confined, electrical dipoles get generated, the discrete energy levels are formed.

As the size of the material decreases, the energy separation between adjacent levels increases. The density of states of nanocrystals is positioned in between discrete (as that of atoms and molecules) and continuous (as in crystals).

Quantum size effect is most significant for semiconductor nanoparticles.

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35. What is a carbon nano tube?

The carbon nanotubes are the wires of pure carbon like rolled sheets of graphite or like soda straws.

36. What are the types of carbon nano tube structure?

Three types of nanotube structures are considered by rolling a graphite sheet with different orientations about the axis.

They are

(i) Armchair structure

(ii) Zig-zag structure

(iii) Chiral structure

37. How carbon nanotubes are classified Based on the number of layers, the carbon nanotubes are classified as

(i) Single-walled (SWNTs)

(ii) Multi-walled (MWNTs).

In multi-walled nanotubes, more than one CNTs are coaxially arranged.