09/07/2025

AP VSAQS:- UNIT-1

1) When two (or) more waves passing through the same medium at the same time, the resultant displacement at any point is equal to vector sum of the displacement.

$$\boxed{y = \vec{y_1} + \vec{y_2} + \ldots}$$

2). When two coherent waves superimpose eachother then the resultant intensity is modified in the region of superposition is called 'Interference'.
Eg: colours observed on soapbubbles & oil films.

3) Condition for C.I $\Delta x = n\lambda$
Condition for D.I $\Delta x = (2n \pm 1)\lambda/2$

4) $\frac{A_1}{A_2} = \frac{2}{1}$

$I \propto A^2$

$\frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} = \frac{4}{1}$

Bright fringe intensity $= (\sqrt{I_1} + \sqrt{I_2})^2 = \cancel{(\sqrt{4}+\sqrt{1})^2} = 9$

dark fringe intensity $= (\sqrt{I_1} - \sqrt{I_2})^2 = \cancel{(\sqrt{4}-\sqrt{1})^2} = 1$

$\frac{I_b}{I_d} = \frac{9}{1}.$

5) To produce sustained interference the conditions are:- coherent source, equal or nearly equal amplitude, same wavelength, same polarization.

6) $I \propto A^2$

$\frac{I_1}{I_2} = \frac{9}{1}$

$\frac{A_1}{A_2} = \frac{3}{1}$

$I_{max} = (A_1+A_2)^2 = 16$

$I_{min} = (A_1-A_2)^2 = 4$

$\frac{I_{max}}{I_{min}} = \frac{\cancel{16}\,4}{\cancel{4}\,1} = \frac{4}{1}$

7) Phase difference: Phase angle difference b/w 2 waves is known as phase difference

Relation b/w phase diff & path diff

$$\text{Phase diff} = \frac{2\pi}{\lambda} \times \text{path diff}$$

$$\boxed{\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x}$$

8) Coherent source which is having same wavelength same frequency, same phase (or) having constant phase difference is called coherent source.

Practically realised by:

· Using a single source split into two by: Young's double slit, Michelson interferometer, Fresnel's biprism.

9) $\Delta\phi = 2n\pi$

$\Delta\phi = \frac{2\pi}{\lambda} \times \Delta x$

$\cancel{2}n\cancel{\pi} = \frac{\cancel{2\pi}}{\lambda} \times \Delta x$ $\boxed{\Delta x = n\lambda}$

10) The resolving power of a grating is defined as its ability to form separate spectral lines of two very closely spaced wavelengths

$$\boxed{RP = \frac{\lambda}{d\lambda} = nN}$$

n = diffraction order

N = total no. of lines on grating

11) The distance b/w the centers of two adjacent slits (lines) in a diffraction grating is called grating element

12) The bending of light waves around the edges of an obstacle is called diffraction.

14)

Interference	Diffraction
1) Superposition of waves from two sources	1) Bending of light around edges
2) Requires two coherent sources	2) Occurs with one slit
3) Young's double slit experiment.	3) Single slit diffraction, diffraction grating.

15)

Fresnel diffn	Fraunhofer diffn
1) In this diffraction, either source or screen kept a finite distance from slit.	1) In this diffraction, source & screen are kept at infinite distance from slit
2) Their is near-field diffraction	2) Their is far-field diffraction
3) lens are not required	3) lens are required

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16) The width of the central fringe depends on the (λ) wavelength (λ) of light and the slit width. (a)

17) $n_{max} = \frac{d}{\lambda}$

$$= \frac{2 \times 10^{-6}}{5890 \times 10^{-10}} \simeq 3.$$

18) It is the plane $\perp^{lar}$ to the direction of vibration of the electric field in polarized light.

~~The plane in which~~

The plane in which the electric field vector oscillates in a polarized light wave

19) When unpolarized light passes through calcite, it splits into two rays - ordinary & extraordinary, showing double refraction due to anisotropic crystal structure

20) At centre we get dark ring because the thickness thickness 't' is zero & it is D.I.

21) Polarization is the phenomenon where light waves are restricted to vibrate in one direction only.

Applications

Sunglasses, 3D movies, photography.

UNIT-2

1) Postulates of planck's Radiation law: Planck proposed that energy is emitted (or) absorbed in discrete packets called quanta, with energy & that these quanta are radiated by atomic oscillators.

2) Expression for spectral distribution of black body radiation $E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \times \frac{1}{\left(\exp\frac{hc}{\lambda kT} - 1\right)} d\lambda$

This relation was found to be valid for all wavelengths black body radiation spectrum.

3) De Broglie proposed that all matter exhibits wave-like properties, and a moving particle has associated with wavelength.

4) $\boxed{\lambda = \frac{h}{p}}$ $\boxed{\lambda = \frac{12.26}{\sqrt{V}}}$ $\boxed{\lambda = \frac{h}{\sqrt{2mE}}}$

5) $\lambda = \frac{12.26}{\sqrt{V}}$ $\lambda = \frac{12.26}{\sqrt{100}} = 1.226\ A^\circ$

$V = 100$

6) $\lambda = \frac{h}{p} = \frac{h}{mv}$ $m = 200g = 0.2kg$

$V = 120km/s = 120000\ m/s$

$\lambda = \frac{6.626\times10^{-34}}{0.2\times12\times10^5} = \frac{6.626\times10^{-34}}{24\times10^4} = 2.761\times10^{-38}$

7) Matter waves do not exihibit both particle & wave nature properties simultenously, wavelength depends upon momentum.

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9) $$\frac{d^2\psi(x)}{dx^2} + \frac{2mE}{\hbar^2}\psi(x) = 0$$

$\psi(x)$ = wave function
m = mass of the particle
E = total energy
$\hbar = \frac{h}{2\pi}$

10) $m = 6\times10^{-34}$
$a = 1.2 A^\circ \quad n=1$

$$E = \frac{h^2n^2}{8ma^2} = \frac{(6.626\times10^{-34})^2(1)}{8\times6\times10^{-34}\times(1.2\times10^{-10})^2} = \frac{4.39\times10^{-67}}{6.912\times10^{-53}}$$

$E = 6.35\times10^{-15} J \longrightarrow$ into eV $= \frac{6.35\times10^{-15}}{1.6\times10^{-19}} = 39.7\,eV$

11) $$\lambda = \frac{h}{\sqrt{2mE}}$$

$E = 2000\,eV = 2000\times1.6\times10^{-19} = 3.2\times10^{-16}$

$$= \frac{6.626\times10^{-34}}{\sqrt{2\times9.1\times10^{-31}\times3.2\times10^{-16}}} = \frac{6.626\times10^{-34}}{7.63\times10^{-23}} = 8.68\times10^{-12}\,m$$

$\boxed{\lambda = 8.68\,Pm}$

12) $a = 4\times10^{-10} \quad m = 9.1\times10^{-31}$

$$E = \frac{h^2n^2}{8ma^2} = \frac{(6.626\times10^{-34})^2(1)}{8(9.1\times10^{-31})(4\times10^{-10})^2} = \frac{4.39\times10^{-67}}{1.1648\times10^{-42}} = 3.77\times10^{-19} J$$

$$E = \frac{3.77\times10^{-19}}{1.6\times10^{-19}} = 2.36\,eV.$$

13) $$f(E) = \frac{1}{1+\exp\left(\frac{E-E_F}{kT}\right)}$$

E_f = fermi energy
k = boltzmann constant
T = absolute temperature
f(E) = probablity in energy state.

$E = E_K$

$f(E) = \frac{1}{1+e^0} = \frac{1}{2}$

Hence at any T > 0, the probability of occupancy at the fermi level is 50%.

13) Electrons in metals move freely like a gas & follow classical mechanics, occasionally scattering with lattice ions.

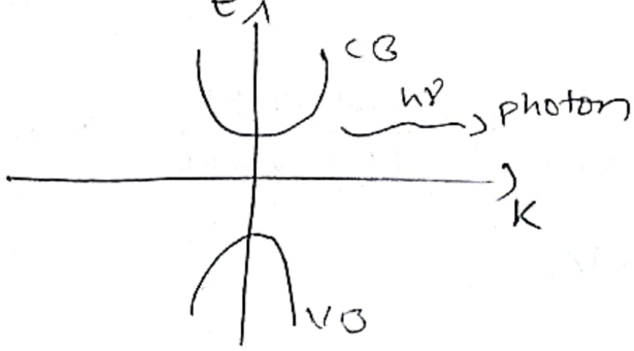
14) Explains ohm's law & electrical conductivity in metals

15) The phenomena such as photoelectric effect, compton effect & spectral distribution of black body radiation could not be explained

16) Electrons move in a periodic potential created by the crystal lattice, leading to formation of energy bands

17) It explains energy band formation, band gaps, & allowed & forbidden energy regions in solids

18)



19) The mass of the electron in the presence of electric field (or) ~~electric~~ magnetic field is known as effective mass of $\bar{e}$.

$$\boxed{m^* = \frac{\hbar^2}{\frac{d^2E}{dK^2}}}$$

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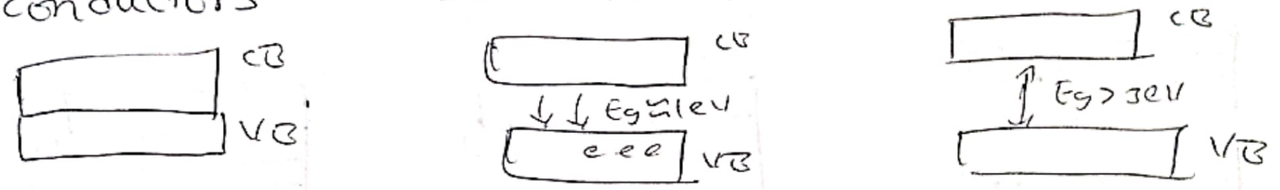
20) Semiconductors (Si: 1.1eV, Ge : 0.7eV)
Insulator (Diamond : 5.5eV)

21) conductors semiconductors Insulator



UNIT-3

1) Doping is the process of adding impurities to intrinsic semiconductors to improve their conductivity by increasing free charge carriers. It is needed to create n-type & p-type semiconductors for electronic applications.

2)

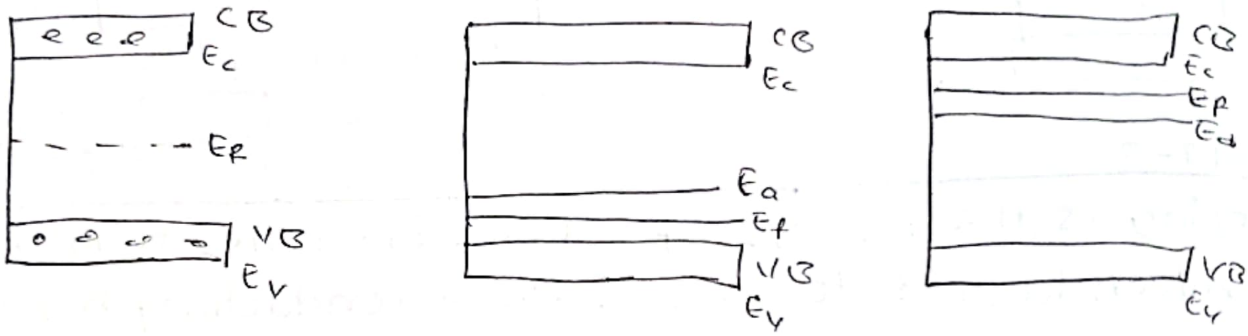
Intrinsic	Extrinsic
1) Intrinsic semiconductors are pure materials	1) Extrinsic semiconductors are doped with impure semiconductors
2) It has equal electron & hole concentration	2) It has P-type & N-type semiconductors.

3)

P-type	N-type
1) P-type SC's have holes as majority carriers	1) N-type SC's have electrons as majority carriers
2) They are doped with donor atoms	2) They are doped with acceptor atoms

4) In conductors, conductivity decreases with temperature due to more collisions in semiconductors, it increases as more electron-hole pairs are generated

5)

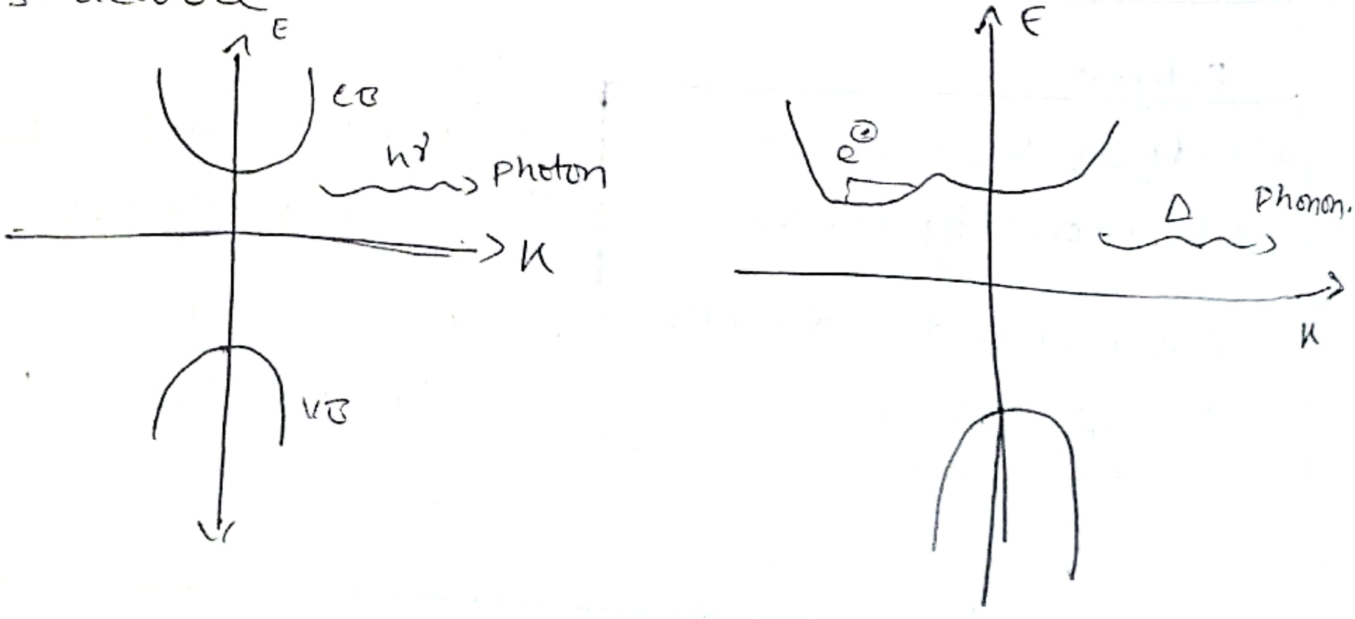


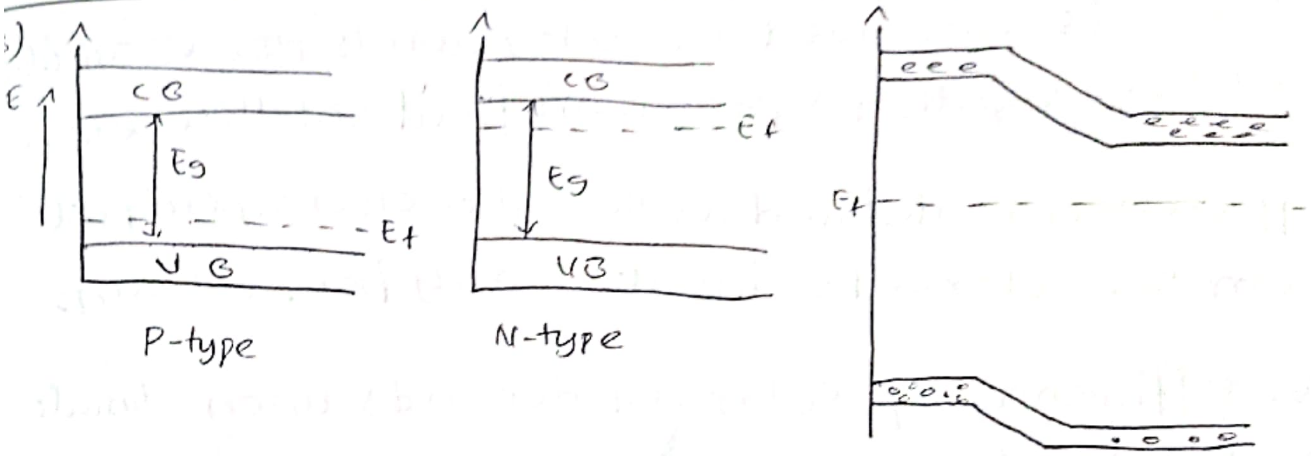
$E_f = \frac{E_v + E_a}{2}$ $\qquad$ $E_f = \frac{E_d + E_c}{2}$

6) In case of direct band gap semiconductors, minimum of conduction band and maximum of valence band are having same K-values in the E-K band structure

In case of indirect band gap semiconductors, ~~electron~~ ~~should~~ minimum of conduction band & maximum of valence band are having different K-values in E-K band structure

7)



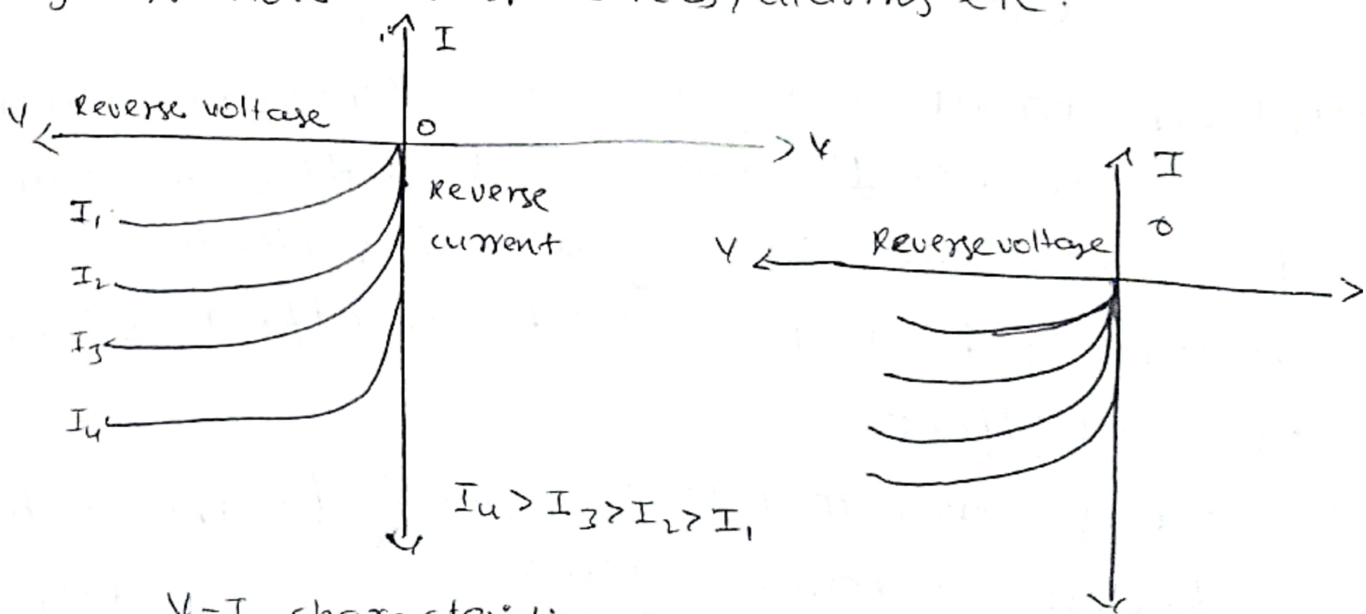


9) Minority carriers are electrons in p-type and holes in n-type, they contribute to reverse current when they diffuse across the junction.

10) A photodiode works on the principle that incident light generates electron-hole pairs, producing photocurrent.

11) Used in light sensors, smoke detectors, ~~smok~~ street lights, remote control devices, alarms etc.

12)



V-I characteristics of photodiode.

13) Solar cells are used in solar panels, power calculators watches, irrigation system, artifical satellite etc.

14) Efficiency is defined as the ratio energy output from the solar cell to input energy from the sun.

15) The efficiency of solar cell depends upon climate and latitude

16) An LED emits light by recombination of electrons and holes in forward bias

17) Low power consumption, long life used in indicators, displays & lighting.

18) $E_g = \frac{hc}{\lambda}$ $\quad E_g = 1.43\,eV$

$$\lambda = \frac{hc}{E_g} = \frac{1240}{1.43} = 867\,nm.$$

19) When current carrying conductor (or) semiconductor is placed in a $\perp^{lar}$ magnetic field then the electric field is generated in a direction $\perp^{lar}$ to the current and magnetic field. This effect is known as Hall effect.

20) Used as sensors to detect magnetic field, magnetically activated electronic switches which are used in non-conducting keyboards & panel switches

21) $V_H = \frac{R_H I \cdot B}{t} = \frac{3.66 \times 10^{-4} \times 10^{-2} \times 0.5}{10^{-3}} = 1.83 \times 10^{-3}\,V.$

1) Nanometer is one billionth of a meter (i.e $1nm = 10^{-9}m$)
Nanoscale refers with dimensions b/w 1-100 nanometers.

2) Quantum confinement occurs when the size of a material is so small that it restricts the motion of electrons, affecting its electrical and optical properties.

3) As the radius of a material decreases, the S/V ratio increases, meaning more atoms are exposed on the surface compared to interior.

4) If the radius of a sphere is doubled, the S/V ratio decreases because volume increases faster than surface area.

5) $r = 6nm$.

$S = 4\pi r^2 = 4\pi(6)^2 = 36(4\pi) = 144\pi$

$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(6)^3 = 36(8\pi) = 288\pi$

$S/V = 144\pi / 288\pi = 0.5 nm^{-1}$

6) If S/V ratio decreases because of increasing radius volumes increases faster than surface area. and reducing height further reduces the ratio.

7) Nanomaterials are prepared using two main approaches 1) top down
2) bottom-up

8) Top-down approach involves breaking bulk molecules into nanomaterials using mechanical methods

Eg:- Ball milling, laser ablation.

9) Bottom-up method builts nanomaterials from moleculeby molecule using chemical methods

Eg:- Sol-gel, CVD, PVP

10) Advantages:- Produces pure high quality thin films

Diadvantages: Requires vacum, costly setup, & limited coating on complex shapes

11) Produces impurities due to contamination from milling tools & has poor control over particle size & shape.

12)

Top-down.	Bottom-up
1) Breaking of bulk molecules into nanomaterials using mechanical method	1) Building nano-materials from molecule by molecu using chemical method.
2) Eg: Ball milling	2) Eg: Sol gel, CVD, PVD

13) characterization means analyzing material's structure & properties, techniques include XRD, SEM, TEM.

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SEM	TEM.
1) SEM provides surface images by scanning a sample with electrons	1) TEM gives detailed internal structure by transmitting electrons through a thin sample

15) Bragg's law helps to determine crystal structure by relating X-ray diffraction angles to interatomic spacing.

16) XRD is non-destructive and provides precise crystal structure and phase information.

17) SEM provides high-resolution surface imaging & detailed morphology analysis

18) TEM requires thin samples, is expensive, & need high vacum & complex sample preparation

19) CVD used to produce thin films in electronics, solar cells, cutting tools, and nanomaterials.

20) Used in drug delivery, sensors, energy storage, electronics, water purification & textiles

UNIT-5

1) Lasers are high directional, monochromatic, coherent and have high intensity.

2) Spontaneous emission is the random emission of a photon by an excited atom

3) stimulated emission occurs when an external photon induces an exicted atom to emit an identical photon

3) Population inversion is a condition where more atoms occupy a higher energy state than a lower one, allowing lasker action.

$$N = N_0 \exp\left(\frac{-E}{KT}\right)$$

4) Optical pumping, electrical discharge, chemical pumping and inelastic collisions

5) Used in communication, computers, industry, military operation, medicines (surgeries)

6) A laser has an active medium, a pumping source, and an optical resonator with mirrors.

7) Lasing requires population inversion, optical feedback and stimulated emission dominance over losses

8) The relations are: $B_{12} = B_{21}$ $A_{21} = B_{21}\rho(\nu)$

9) $E_g = 3eV$

$$E_g = \frac{hc}{\lambda} = \frac{1240}{3} = 413.3nm$$

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10) $\lambda = 1.55\,\mu m = 155 \times 10^{-8} = 1550 \times 10^{-9}$

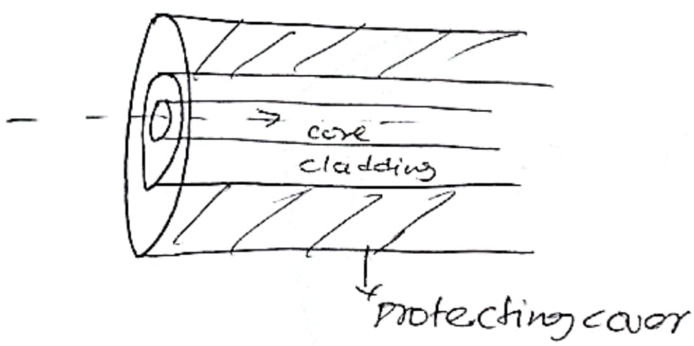
$$E = \frac{1240}{1550} = 0.8\,eV$$

11) It works on TIR principle (Total Internal Reflection)

12) Used in high-speed communciation systems, medical purpose, sensors & military purpose

13) It is the maximum angle at which light can enter the fiber $\boxed{i_{max} = \sin^{-1}(NA)}$

14)



1) Core
2) Cladding
3) Protecting cover.

15) Numerical aperture measures the light-gathering ability of a fiber.

$$NA = \frac{\sqrt{n_1^2 - n_2^2}}{n_0}$$

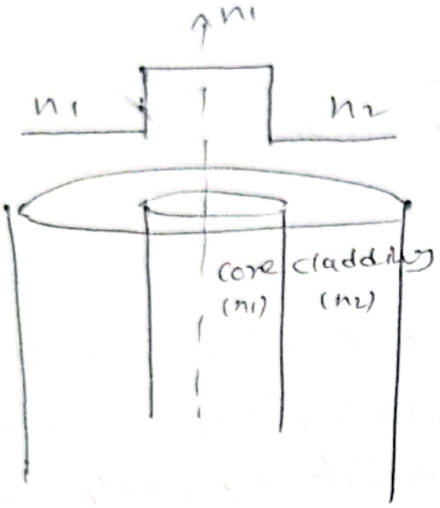
16) $\boxed{NA = \sin i_{max}}$

17) They offer higher bandwidth, less signal loss, immunity to EMI and are lighter, thinner.

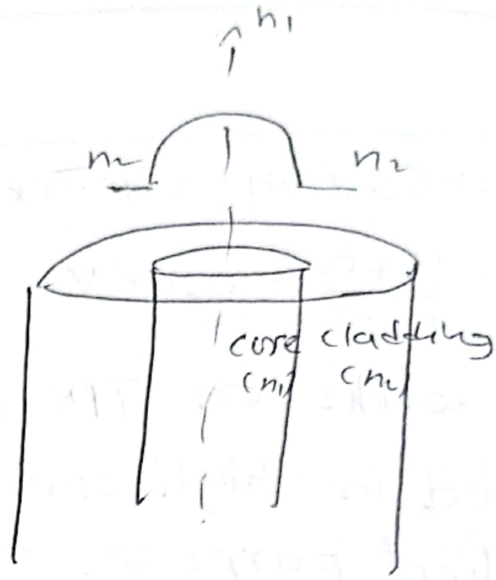
19) $NA = 0.41$

$i_{max} = \sin^{-1}(0.41) \simeq 24.2°$

18)



step-index



Graded index

20) $\Delta = 0.14, n_2 = 1.3$

$$\Delta = \frac{n_1 - n_2}{n_1}$$

$$n_1 = \frac{n_2}{1-\Delta} = \frac{1.3}{1-0.4} \cong 1.5116.$$