Chapter = 10

Optical Instruments

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Optical instruments: The instruments which are based on the principles of reflections and refractions are called optical instruments. For example microscope, telescope etc.
Visual angle: The angle made by an object at the eye is called visual angle.
Least distance of distinct vision/ near point: The minimum distance from the eye at which an object to be distinct is called least distance of distinct vision or near point. It is denoted by d
Least distance of distinct vision increase with increase of age. Its value is 25 cm or 10 inches.
Linear magnification: The ratio of size of image to size of object is called linear magnification.

$$\text{Magnification} = \frac{\text{Size of object}}{\text{Size of image}} = \frac{I}{O}$$. It has no unit.

Angular magnification: The ratio of angle subtended by the image as seen through optical device to that angle subtended by the object at the unaided eye.

$$\text{Magnification} = \frac{\text{angle subtended by image}}{\text{angle subtended by object}} = \frac{\beta}{\alpha}$$. It has no unit.

Resolving power of an instrument: The resolving power of an instrument is its ability to show the minor details of object under examination.
Formulas of resolving power: The resolving power is the reciprocal of minimum angle of resolution Releigh showed this formula

(1) $R = \frac{1}{\alpha_{min}} = \frac{D}{1.22\lambda}$, D is diameter of lens and λ is wavelength of light

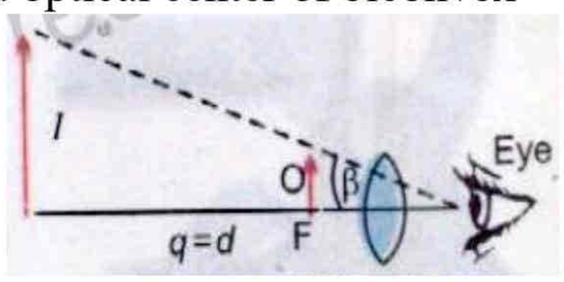
(2) $R = \frac{\lambda}{\Delta\lambda}$ $\lambda \approx \lambda_1 \approx \lambda_2$ and $\Delta\lambda = \lambda_2 - \lambda_1$

(3) R= N*m were N is number of rules lines on grating and m is order of diffraction

What is Simple microscope? Give Working principle and magnification?

Definition: A device which is used to see the magnified image of very small and near object is called simple microscope. A convex lens can be used for magnification.
Working principle of simple microscope: "When the object is placed b/w focal point and optical center of biconvex lens then an erect, virtual and enlarged image is obtained".
Magnification of simple microscope: Magnification for simple microscope

$M = 1 + \frac{d}{f}$ Where d is least distance distinct vision and f is focal length of lens.

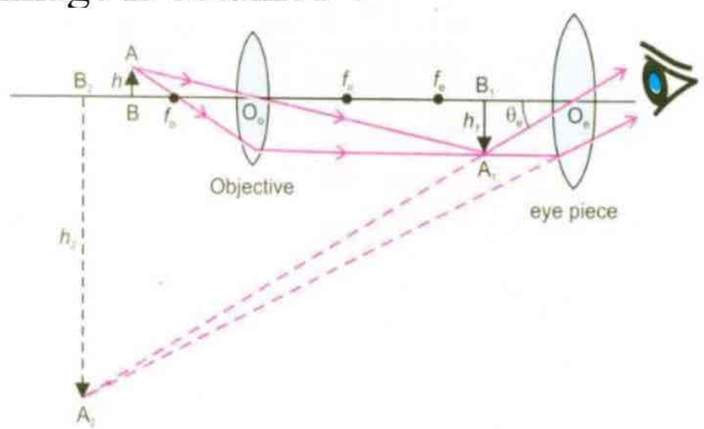


It shows that focal length should be small for higher magnification.

What is Compound microscope? Give Working principle and magnification?

Definition: A compound microscope is used when high magnification is required.
It consists of two convex lenses objective of short focal length, eye piece of large focal length.
Principle of compound microscope: "When the image formed by the objective of small focal length is within focal length of eye piece of large focal length then a virtual, inverted and magnified image is obtained".
Magnification of compound microscope:

Formula for magnification of compound microscope is $M = \frac{q}{p}\left(1 + \frac{d}{f_e}\right)$.



For higher magnification we use eye piece of short focal length..
High resolving power: High resolving power can be achieved by

i. Using wider objective
ii. Using blue light of shorter wavelength to produce less diffraction.

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Astronomical telescope? Give Working principle and magnification?

Definition: The telescope used to see the distinct image of distant heavenly objects like planets or moon is called astronomical telescope. It consists of two lens objective of large focal length and eye piece of short focal length.

Principle of astronomical telescope: "A real, inverted and diminished image formed by the objective serves as an object for eye piece which is at the focal point of both the lenses then a virtual and magnified image is formed at infinity".

Magnification of astronomical telescope: The magnification of astronomical telescope is $M = \frac{f_o}{f_e}$ by using objective of large focal length and large aperture for higher magnification of telescope.

What is Spectrometer? Give its three parts.

Definition: An optical device which is used to study the spectrum of various sources of light is called a spectrometer.

Name of its parts: There are three main parts of spectrometer (i) Collimator (ii) turn table (iii) telescope.

Function of collimator: To make the light beam parallel coming from a nearby source of light. Collimator consists convex lens at one end and adjustable slit at other end, when slit is just at the focus of convex lens then light rays entering from slit become parallel after passing through lens.

Uses of spectrometer: Spectrometer is used to

i. Study the deviation of light by glass prism
ii. Study the spectra of different sources of light
iii. Calculate the wavelength of light and refractive index of material.

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Give Michelson formula for Speed of light.

Michelson formula for speed of light C=16fd, the value of speed of light in vacuum $C=3*10^8$ m/s. speed of light in other materials is less than C and it depends upon the nature of medium.

What is Optical fiber? Give advantages and principle.

Definition: Number of glass fibers combine together to transmit light from one part to other is called optical fiber.

Advantages of fiber optics: There are following advantages of fiber optics

i. It is used to transmit light around the corners and into inaccessible places
ii. It has wider band of capability and free from electromagnetic interference
iii. It increased the efficiency of word processing, image transmission and reception
iv. Fiber optic consist of much smaller and light weight cables

A fiber optic its protective case is about 6 mm, in diameter, which can replace by 7.62cm diameter bundle of copper wires carrying same amount of signals

What is Principle of propagation through fiber optics?

The propagation of light within optical fiber through

i. Total internal reflection
ii. Continuous refraction

Total internal reflection: When a light ray travelling from a denser medium towards a rare medium, makes angle of incidence greater then critical angle of medium, then ray is totally reflected back into the same denser medium, this phenomenon is called total internal reflection.

What is Critical angle? The angle of incidence in denser medium for which its corresponding angle of refraction is 90° is called critical angle.

What is Refractive index? The ratio of speed of light in vacuum to the speed of light in transparent medium is called refractive index. n= C/V.

State Snell's law? The ratio of sines of angle of incidence to angle of refraction is constant. $n = \frac{\sin\theta_i}{\sin\theta_r}$. Also written as $n_1 \sin\theta_1 = n_2 \sin\theta_2$.

Calculate the value of critical angle for glass air boundary

When $\theta_1 = \theta c$, and $\theta_2 = 90^\circ$, $n_1 = 1.5$ for glass, $n_2 = 1$ for air

Snell' s law becomes $\Rightarrow n_1 \sin\theta c = n_2 \sin 90^\circ \Rightarrow \sin\theta c = \frac{n_2}{n_1}$

$\theta c = \sin^{-1}(\frac{1}{1.5}) = 41.8^o$

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State Conditions for total internal reflection? There are two conditions for total internal reflection

i. Light should travel from denser to rare medium
ii. The angle of incidence should be greater than critical angle

What is Continuous refraction? such a process in which propagation of light through fiber is continuously refracted within the fiber is called continuous refraction.

Give the Name of types of optical fiber?

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There are three types of optical fiber

i. Single mode step index fiber
ii. Multimode step index fiber
iii. Multimode graded index fiber

What is Single mode step index fiber?

Single mode step index fiber has very thin core about 5µm diameter. It has relative large cladding and use monochromatic light source i.e laser. It can carry more than 14 tv channels and 14000 phone calls.

What is Multimode step index fiber?

Multimode step index fiber is central core has diameter 50µm and high refractive index. The central core has a constant refractive index of core 1.52 and cladding 1.48. It is used for carrying white light but due to dispersion effects it is used for short distance only.

What is Multimode graded index fiber?

Multimode graded index fiber central core has high refractive index. The diameter of core ranges from 50µm to 1000µm. there is no particular boundary b/w core and cladding. The light is continuously refracted within the fiber optics. It is useful for long distance.

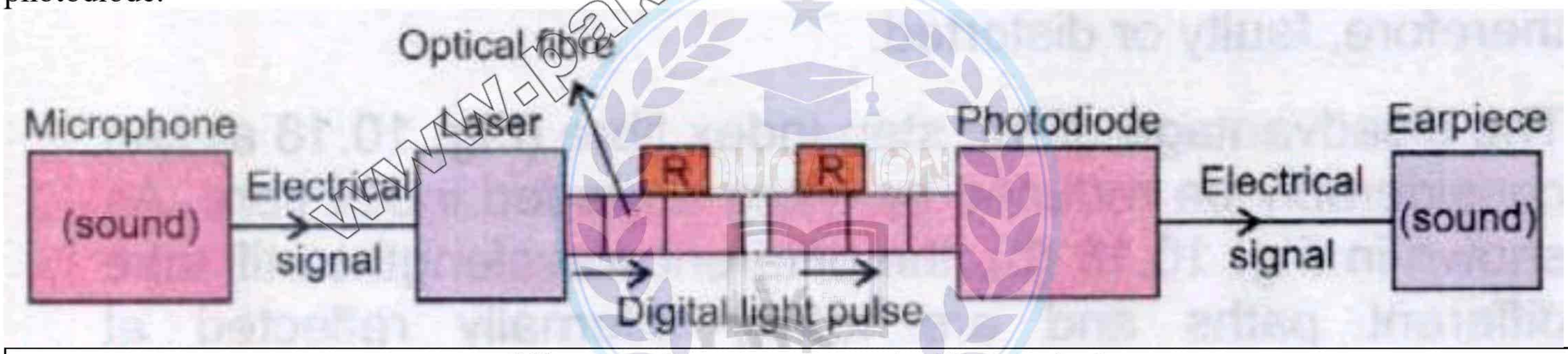
Explain Components of fiber optic communication system.

There are three major components of fiber optic communication system, transmitter, optical fiber, and receiver.

Transmitter: The transmitter converts electrical signal into light signal which is obtained from microphone. The light signal is invisible infrared of typical wavelength 1.3µm which moves faster than visible or UV light.

Optical fiber: The modulated pulse travel through the optical fiber by total internal reflection and continuous refraction with very fast speed. The light signals while through optical fiber become dim and must be degenerated by a device called repeater. Repeaters are typically placed 30km apart, but in newer system this separation is 100 km.

Receiver: Receiver captures the light signals at the other end, and convert the light signal into electrical signal by photodiode.



What are the power losses in fiber optics?

Power is lost in optical fiber by following factors

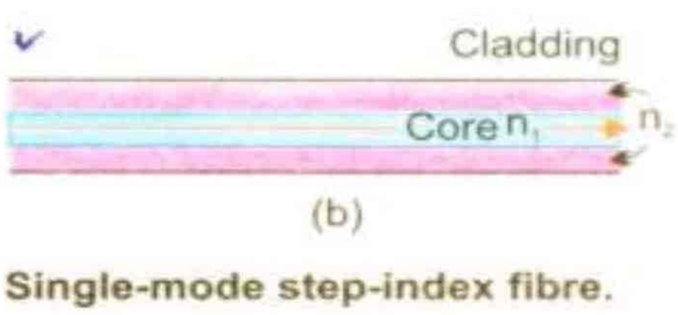
i. Scattering
ii. Absorption
iii. Dispersion

How Power lost by scattering and absorption in fiber optics?

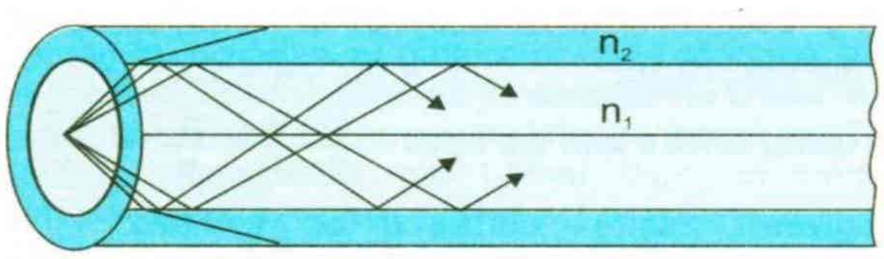
When the light travel along fibers by multiple reflections, some of light energy is absorbed by the glass medium. It is due to the impurity of glass medium. Some part of energy of light signal is scattered by group of atoms such as joints It can be reduced by careful manufacturing.

Give Time difference in step index fiber.

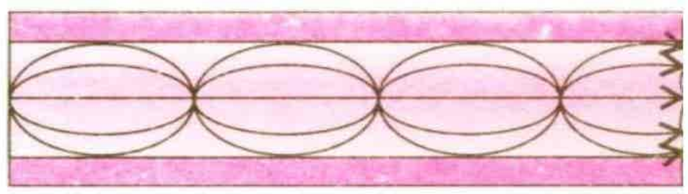
In step index fiber, the overall time difference b/w different wavelengths may about 33 ns per km. but using a graded index fiber, the time difference is reduced to about 1ns per km.



Single-mode step-index fibre.



Light propogation through Multi-mode step-index fibre.



Light propogation through Multi-mode graded-index fibre

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Exercise Short Questions

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1. What* do *you understand by linear magnification and angular magnification? Explain how a convex lens is used as a magnifier?

Linear magnification: The ratio of size of image to size of object is called linear magnification.

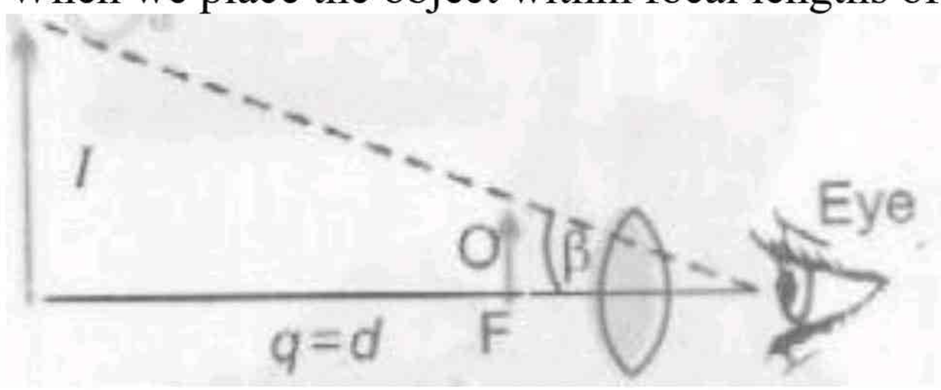
$$\text{Magnification} = \frac{\text{Size of object}}{\text{Size of image}} = \frac{I}{O}$$

Angular magnification: The ratio of angle subtended by the image as seen through optical device to that angle subtended by the object at the unaided eye.

$$\text{Magnification} = \frac{\text{angle subtended by image}}{\text{angle subtended by object}} = \frac{\beta}{\alpha}$$

Both have no units.

When we place the object within focal lengths of convex lens then the image formed is erect, virtual and magnified.



2.*Explain the difference between angular magnification and resolving power of an optical instrument. What limits the magnification of an optical instrument?*

Angular magnification:"The ratio of the angles subtended by the image as seen through the optical device to that subtended by the object at the unaided eye"; M = β / α $R = \frac{1}{\alpha_{\min}} = \frac{D}{1.22\lambda}$. **Resolving power** (αmin): "The ability of an instrument to reveal the minor details of the object under examination..

Limits: Due to chromatic and spherical aberrations, the magnification of the optical instruments is limited.

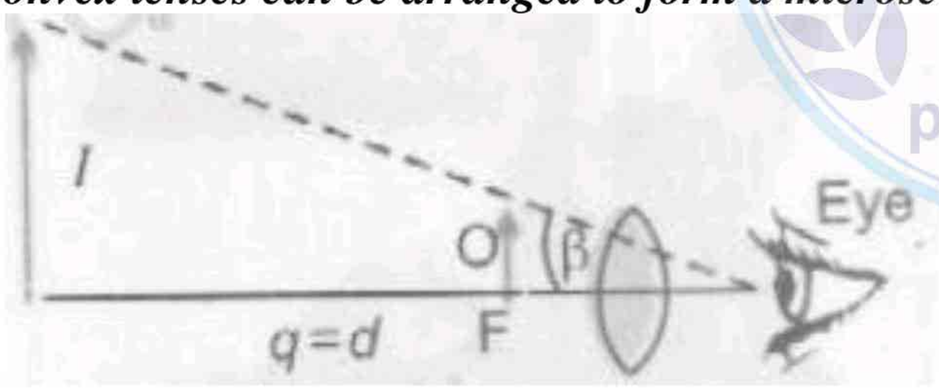
3.*Why would it be advantageous to use blue light with a compound microscope?*

By using wider objective and Blue light increases the resolving power and more details of an object can be seen. As blue light produce less diffraction due to short λ. $R = \frac{1}{\alpha_{\min}} = \frac{D}{1.22\lambda}$.

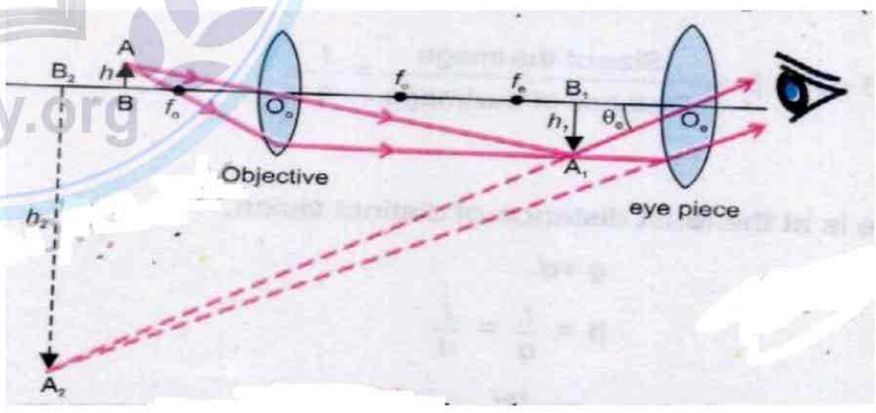
4. One can buy a cheap microscope for use by the children. The image seen in such a microscope have colored edges. Why is this so?

Due to chromatic aberration, we see colored edges in cheap microscope. It is due to non-focusing of light of different colors. These colors arise due to dispersion.

5. *Describe with the help of diagrams, how (a) a single biconvex lens can be used as a magnifying glass. (b) Biconvex lenses can be arranged to form a microscope.*



(a)



(b)

6 .*If a person were looking through a telescope at the full moon, how would the appearance of the moon be changed by covering half of the objective lens?*

The intensity of the image become half and there will be no change of shape. Less transmitted light due to half-covered objective, still he will see full image of the moon.

7. *A magnifying glass gives a five times enlarged image at a distance of 25 cm from the lens. Find, by ray diagram, the focal length of the lens.*

M = 5, d = 25cm, f = ?

$$M = 1 + \frac{d}{f} \Rightarrow 5 = 1 + \frac{25}{f} \Rightarrow \frac{25}{f} = 5 - 1 \Rightarrow f = \frac{25}{4} = 6.25cm$$

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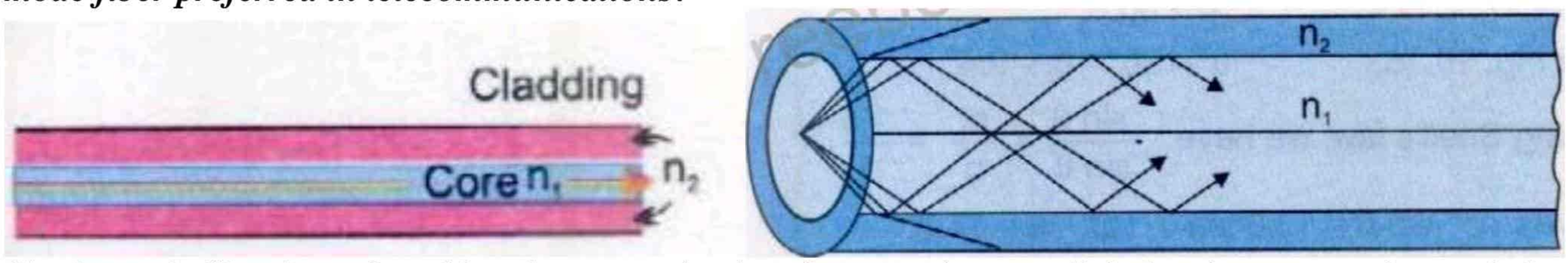
8. Both have same options. The diameter of the objective lens.

9. Draw sketches showing the different light paths through a single-mode and multimode fiber. Why is the single-mode fiber preferred in telecommunications?



Single-mode fiber is preferred in telecommunications because they are digital and use monochromatic laser light. Here the transmission is free from dispersion.

10 ***How the light signal is transmitted through the optical fiber?***

By total internal reflection on continuous refraction light signals is transmitted through the optical fiber. A transmitter converts electrical signal into light signal and at the receiving end these are converted back to electrical signals. The most common method of transmission is digital modulation, in which the laser is flashed on and off at extremely fast rate. The communication is represented by code of 1s and 0s. The receiver is programmed to decode 1s and 0s.

11. ***How the power is lost in optical fiber through dispersion? Explain.*** Power is lost due to scattering and absorption of light signals during travel through the optical fiber. The information received can be faulty and distorted due to dispersion, i.e. spreading of light signals into component wavelengths. Due to impurities in the glass and multiple reflections along the fiber is occurred

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Previous all Punjab Board Exams Solved MCQs

	Questions	Option A	Option B	Option C	Option D
1)	For normal adjustment length of astronomical telescope is	**fo+fe**	fo-fe	fo/fe	fe/fo
2)	The image formed by simple microscope is	Real and inverted	**Erect and virtual**	Erect and real	Inverted and virtual
3)	Which of the following lights travels the fastest in optical fibers?	Visible light	Ultra-violet	**Invisible infra-red**	Ordinary light.
4)	If a single convex lens is placed close to eye then it is being used as	Telescope	**Magnifying glass**	Microscope	None of these
5)	A watch maker uses ____to repair the watches.	Telescope	**Convex lens**	Convex mirror	Concave lens.
6)	The ratio of the _ is called magnification	**Image size to object size**	Eyepiece size to object size	Object size to image size	None of these
7)	Using a graded index fiber, the time difference is reduced to about	33ns per 100Km	33 ns per km	**1ns per km**	1ns per 100km
8	The information received at the other end of a fibre can be inaccurate due to _____ of the light signal.	Longer wavelengths	Intensity	Frequency	**Dispersion or Spreading**
9)	If focal length of objective and eye piece is 0.5m and 10cm respectively then magnifying power of telescope will be?	**5**	0.5	10	20
	Solution: M=? fo=0.5m=0.5*100cm=50cm, fe=10cm, M=fo/fe= 50/10=5				
10)	Final image of compound microscope is	Virtual and erect	**Virtual and inverted**	Real and inverted	Real and erect
11)	Which of the following device works on the principle of interference?	Compound microscope	**Newton rings apparatus**	Telescope	Diffraction grating
12)	Least distance of distinct vision	**Increase with increase in age**	Decrease with increase in age	Remains same	First decrease then increase
13)	The power of lens of one meter focal length is	**1 D**	2D	0.5 D	4 D

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13)	The normal human eye can focus a sharp image of an object on the eye if the object is located at certain distance called	Least Point	Far Point	**Near Point**	Distinct Point
14)	Magnifying power of astronomical telescope increase by	**Increase of fo**	Decrease of fo	Increase of fe	Decrease of fe
15)	An astronomical telescope having magnifying power 5 consists consist of two thin lenses 24cm apart. Focal length of lenses is	**4cm, 20cm**	20cm,30cm	16 cm, 20cm	None of these
As M=5, L=24, as M=fo/fe, 5=fo/fe…fo=5fe & L=fo+fe, 24=5fe+fe, 6fe=24, fe=4cm, put again then fo=20 cm					
16)	Light emitted from LED has wavelength	**1.3µm**	1.3 nm	1.3 mm	1.3cm
17)	At some angle of incidence when angle of refraction become 90°C this angle is called	Phase angle	**Critical angle**	Refractive angle	Incident angle
18)	In case of X-ray diffraction by crystal, the wavelength can be found by using the equation	$d \sin\theta = n\lambda$	$2d \sin\theta = n\lambda$	$2d \cos\theta = n\lambda$	None
19)	To find interplaner spacing we used equation	$d \sin\theta = n\lambda$	$2d \sin\theta = n\lambda$	$2d \cos\theta = n\lambda$	None
20)	A convex lens acts as diverging lens if object is placed at	f	2f	b/w f and 2f	**Within f**
21)	In a multimode step index fiber, density of optical material decrease from	Edge to core	**Core to edge**	Even	Multiple
22)	Glass air boundary acts as a/an	**Mirror**	Glass	Water	Air
23)	Wavelength of X-rays is of the order of	**10^{-10} m**	10^{10} m	10^{-12} m	10^{-14} m
24)	The minimum distance from the eye at which an object appear to be distinct	15cm	10cm	20cm	**25cm**
25)	A convex lens of focal length f is cut into two identical halves along the lens diameter, the focal length of each half	3/2 f	½ half	4 f	**2f**
26)	The technique used to study the structure of hemoglobin is	**X-Rays diffraction**	Newton rings	Polarization	Interference
27)	Near point of normal human eye is	25 m	**250 mm/25cm**	2.5 cm	None of these
28)	The speed of light in vacuum is	**$3*10^8$ m/s**	$3*10^9$ m/s	$3*10^7$ m/s	0 m/s
	A lens whose power is 2 diopter its focal length is	75cm	**50cm**	25cm	5cm
As power=1/f= focal length =1/f= ½=0.5 m to convert into cm 1m=100cm, 0.5*100=50 cm					
29)	Light reaches from the sun to the Earth in the from of	Spherical wave front	**Plane wave front**	Cylindrical wave front	Circular wave front
30)	A double convex lens acts as diverging lens when the object is	**Inside the focus**	Between f and 2f	At the focus	At a large distance
31)	The diameter of single mode step index fiber is	10µm	50µ	100µm	**5µm**
32)	If a convex lens is used as magnifying glass, which lens will give higher magnification?	Short size	Long focal length	Large size	**Short focal length**
33)	In a compound microscope, the magnification by objective = 20,	M = -220	M = -0.05	M = -0.19	**M = 220** M=M1*M2

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34)	magnification by eyepiece = 11, then the total magnification is				20*11=220
35)	The information from one place to another can be transmitted very safely and easily by	Copper wire	Photodiode	Aluminum wire	**Optical fiber**
36)	In normal adjustment of compound microscope, the eye piece is positioned so that the final image is formed at	Optical Center	Principle Focus	Infinity	**Near Point**
37)	When light passes through a pinhole type opening , it seems to spread out , this phenomenon is known as	Dispersion	Reflection	**Diffraction**	Polarization
38)	The speed of light in other material is always	**Less than c**	Greater then c	Equal to c	None of these
39)	Magnifying power of convex lens of focal length 10cm is	7	9.6	11	**3.5**
	M=1+d/f= 1+25/10=1+2.5=3.5 d=least distance of distinct vision=d=25cm				
40)	For the phenomenon of total internal reflection the angle of incidence should be	Equal to critical angle	Smaller then critical angle	**Greater then critical angle**	Zero
41	The optical fiber are of types	Two	**Three**	Four	Five
42)	A transparent refracting medium bounded by two curved surface is called	**Lens**	Glass	Mirror	Prism
43)	A real object placed inside the focus of a convex lens gives	Real image but diminished	Real but enlarge image	Virtual but diminished image	**Virtual but enlarged image**
44)	Television signals are converted into light signals by	**Decoder**	Transistor	Photodiode	Optical fiber
45)	If the object is placed within the focal length of convex lens its image will be	Magnified	Erect	Virtual	**All of these**
46)	The power of lens is measured in	Watt	Joule	**Diopter**	Minutes
47)	Multi-mode step index fiber is useful for	**Short distance**	Long distance	No distance	Infinite distance
48)	The optical fiber in which the central core has higher refractive index and its density gradually decrease towards its periphery is called	Single mode index fiber	Multi-mode index fiber	**Multi-mode graded index fiber**	None of these
49)	The value of critical angle for glass air boundary	**41.8°**	41.5°	42.8°	42°
50)	Which is optical instrument	**Telescope**	Galvanometer	Ammeter	Voltmeter
51)	Resolving power of a lens is expressed by relation	$\alpha_{min} = 1.22\frac{D}{\lambda}$	$\alpha_{min} = 1.22\frac{\lambda}{D}$	$\alpha_{min} = 1.22\lambda D$	$\alpha_{min} = 1.52\lambda D$
52)	Propagation of light in an optical fiber takes place by two phenomenon which are	Total internal reflection & dispersion	**Total internal reflection & continuous refraction**	Interference and dispersion	Interference and continuous refraction
53)	The collimator in a spectrometer is used to	Disperse the light beam	Reflect the light beam	**Make the light beam parallel**	Converge the light beam
54)	Magnification of a convex lens of focal length 25 cm is	**2**	5	6	20
	M=1+d/f=1+25/25=1+1=2				
55)	The medium in which speed of light is the same in all direction is called	Homogenous	Heterogeneous	Non homo genous	**Free space**

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56)	Which of the phenomenon of light is used in propagation of light through optical fiber	**Total internal reflection**	Polarization	Interference	Diffraction
57) 58)	Which combination can ensure less diffraction and more details to be seen by compound microscope	A wider objective and red light	**A wider objective and blue light**	A wider eye piece and red light	A wider eye piece and blue light
59)	In Michelson experiment, the equation used to find the speed of light c=?	**16fd**	16f/d	16d/f	1/16fd
60)	A layer over the central core of the jacket is called	Jacket	Plastic	**Cladding**	Rubber
	The refractive index of water is 1.33. the speed of light in water is:	$3*10^8$ m/s	$1.8*10^8$ m/s	**$2.3*10^8$ m/s**	Zero
As n=c/v 1.33=$3*10^8$/v v=$3*10^8$/1.33= $2.33*10^8$ m/s					
61)	In newer system of fiber optics signals regenerated by placing repeater may separated by as much as	30Km	50Km	**100Km**	500Km
62)	Effective path difference between two reflected beam in X-rays diffraction	$d\sin\theta = n\lambda$	$2d\sin\theta = n\lambda$	$2d\cos\theta = n\lambda$	None
63)	Spectrometer is used to	Study diffraction of light	Measure wavelength of light	Measure refractive index of material	**All of these**
64)	Bragg equation is given by	V=ft	$d\sin\theta = n\lambda$	$2d\sin\theta = n\lambda$	$2d\cos\theta = n\lambda$
65)	The image of an object 5mm high is only 1cm high the magnification produced by lens is	0.5	0.2	1	**2**
M= size of image/size of object= 1cm/5mm= 1*10-2/5*10-3= 10/5=2					
66)	If n1 and n2 are refractive index of core and cladding then for optical fiber	**n1>n2**	n1<n2	n1=n2	None of these
67)	Snell law is expressed as	$n1\sin\theta1 = n2\sin\theta2$	$n\sin\theta = 0$	1/sinϴc	None of these
68)	If N is the number of ruling on the grating then resolving power of nth order diffraction is equal	**R=Nm**	R=N/m	R=1/Nm	R=m/N
69)	Compound microscope forms final image at	**Near point**	Focus of eye piece	Focus of objective	Infinity
70)	If d is the least distance of distinct vision, then magnification of convex lens of focal length f will be	**1+d/f**	1-d/f	1+f/d	1-f/d
71)	Optical rotation a property of optically active substance can be used to	Determine density	Determine viscosity	**Determine concentration of sugar**	Determine elasticity
72)	The ratio of size of image to size of object is called	Focal length	Visual angle	Resolving power	**Magnification**
73)	Optical fiber is covered for the protection by a	Glass jacket	**Plastic jacket**	Copper jacket	Aluminum jacket
74)	If magnifying power of magnifying glass is 3 then focal length will be	25cm	**12.5 cm**	5 cm	3 cm
M=1+d/f 3=1+25/f 3-1=25/f 2=25/f f=25/2=12.5 cm					
75)	Convex lens act as magnifying glass when object is placed	At 2F	At F	**Inside F**	At 3F

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76)	Which of the following will travel must faster than other through optical fiber	UV light	Visible light	**Invisible infrared light**	White light
77)	Using the relation for the magnifying power L_o, M = 1 + d/f, if f = 5 cm and d = 25 cm then M will be	5	**6**	7	8
78)	The focal length of convex lens	Negative	**Positive**	Large	Small
79)	The final image seen through eye piece in telescope	Real, englarged, inverted	Virtual, enlarge, and erect	**Virtual, enlarge and inverted**	Real, enlarge ad erect
80)	Magnifying power of telescope	fo+fe	fo-fe	**fo/fe**	fe/fo
81)	Rayleigh formula for resolving power is	$R = \frac{\lambda}{1.22D}$	$R = \frac{D}{1.22\lambda}$	$\alpha_{min} = 1.22\lambda D$	$\alpha_{min} = 1.52\lambda D$
82)	Multimode graded index fiber has core whose diameter range lie from	5 to 50μm	50 to 100μm	**50 to 1000μm**	50 to 10,000μm
83)	If a convex lens of focal length 5cm is used as simple microscope then magnifying power will be	5	**6**	10	25
	M=1+d/f=1+25/5=1+5=6				
84)	Which is not essential component of spectrometer?	Collimator	Telescope	Turntable	**Microscope**
85)	If p=5cm and d=25cm then linear magnification	5cm	25	**5**	25cm
	Linear magnification= size of image/size of object=25/5=5				
86)	The light signal in optical fiber must be regenerated by a device is called	Regenerator	Generator	**Repeater**	Diode
87)	SI unit of magnifying power of telescope	Watt	Diopter	**No unit**	None
88)	Final image obtained by astronomical telescope is	Erect	Magnified	**Virtual**	None
89)	When the object is placed within the focal length of convex lens then its image will be	Real	Inverted	**Virtual**	Of same size
90)	The detector in photo phone is made up of	Cadmium	Germanium	**Selenium**	Silicon
91)	X-rays diffraction has been very useful in determining the structure of	**Hemoglobin**	Stars	Galaxies	Stones
92)	If speed of light in vacuum is C, then its velocity in a medium of refractive index is 1.3	**C/1.3**	1.3C	1.3/C	C
	As n=c/v, 1.3=c/v, v=C/1.3				

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