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UNIT:06 OPTICS --------2 &3 MARKS

1. State the laws of reflection
   - The incident ray, reflected ray and normal to the reflecting surface all are coplanar (ie. lie in the same plane).
   - The angle of incidence (i) is equal to the angle of reflection(r) ∠i=∠r
2. What is angle of deviation due to reflection?

   The angle between the incident and deviated light ray is called angle of deviation of the light ray.

   d=180-(i+r), i=r; d=180-2i
3. Give the characteristics of image formed by a plane mirror.

   (i)The image formed by a plane mirror is virtual, erect, and laterally inverted.

   (ii) The size of the image is equal to the size of the object.

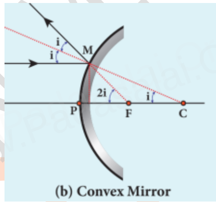
   (iii) The image distance far behind the mirror is equal to the object distance in front of it.

   (iv) If an object is placed between two plane mirrors inclined at an angle θ, then the number of images n formed is as,
   - If $\left(\frac{360}{\theta}\right)$ is EVEN n= $\left(\frac{360}{\theta}-1\right)$for objects placed symmetrically or unsymmetrically,
   - If $\left(\frac{360}{\theta}\right)$ is ODD then, n= $\left(\frac{360}{\theta}-1\right)$for objects placed symmetrically
   - If $\left(\frac{360}{\theta}\right)$ is ODD then, n= $\left(\frac{360}{\theta}\right)$for objects placed unsymmetrically,
4. Derive the relation between f and R for a spherical mirror.
   - Let C be the centre of curvature of the mirror.
   - Consider a light ray parallel to the principal axis is incident on the mirror at M and passes through the principal focus F after reflection.

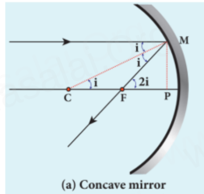
   The geometry of reflection of the incident ray is shown in fig.
   - The line CM is the normal to the mirror at M.

   Let i be the angle of incidence and the same will be the angle of reflection.
   - If MP is the perpendicular from M on the principal axis, then from the geometry,

   The angles ∠MCP = i and ∠MFP = 2i



(b) Convex Mirror



(a) Concave mirror

   - From right angle riangles ΔMCP and ΔMFP,

   tan i=$\frac{PM}{PC}$ And tan 2i=$\frac{PM}{PF}$

   As the angles are small, tan i≈i

   i=$\frac{PM}{PC}$ And 2i=$\frac{PM}{PF}$

   Simplifying further

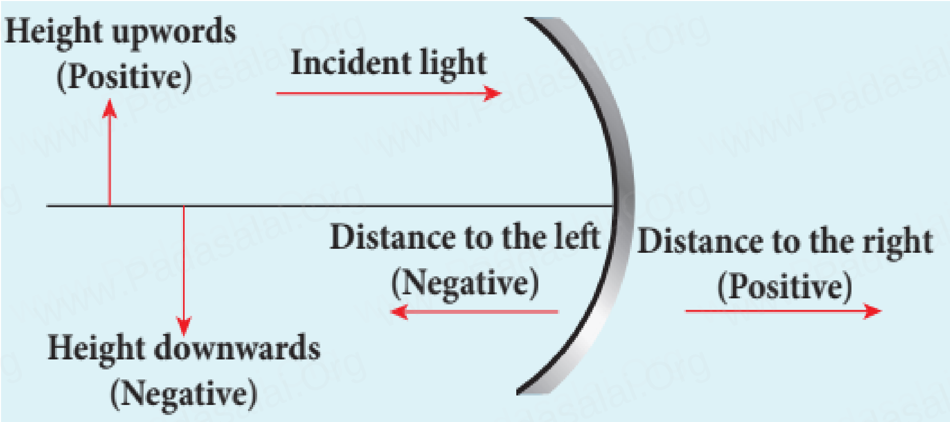
   $2\frac{PM}{PC}=\frac{PM}{PF}$;

   2PF=PC

   PF is focal length f and PC is the radius of curvature R.

   2f=R ; f=$\frac{R}{2}$
5. What is the Cartesian sign convention for a spherical mirror?
   - The Incident light is taken from left to right (i.e. object on the left of lens).

- All the distances are measured from the pole of the mirror (pole is taken as origin).
- The distances measured to the right of pole along the principal axis are taken as positive.
- The distances measured to the left of pole along the principal axis are taken as negative.
- Heights measured in the upward perpendicular direction to the principal axis are taken as positive.
- Heights measured in the downward perpendicular direction to the principal axis, are taken as negative.



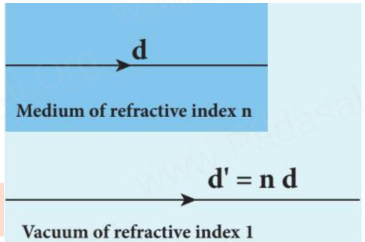
6. What is optical path? Obtain the equation for optical path of a medium of thickness d and refractive index n.

- Optical path of a medium is defined as the distance d' light travels in vacuum in the same time it travels a distance d in the medium.

Light travel in medium	Light travel in air medium
Let us consider a medium of refractive index n and thickness d. Light travels with a speed v through the medium in a time t.	In the same time, light can cover a greater distance d' in vacuum as it travels with greater speed c in vacuum as shown in Fig
$v = \frac{d}{t}$; $t = \frac{d}{v}$	$c = \frac{d'}{t}$; $t = \frac{d'}{c}$

As the time taken in both the cases is the same, we can equate the time t as,

$$\frac{d'}{c} = \frac{d}{v}$$



optical path rewritten for the optical path(d') $d' = \frac{cd}{v}$

$$\frac{c}{v} = n$$

The optical path d'=nd

As n is always greater than 1, the optical path d' of the medium is always greater than d

7. State the laws of refraction.

a)The incident ray, refracted ray and normal to the refracting surface are all coplanar (ie. lie in the same plane).

b) The ratio of angle of incident i in the first medium to the angle of reflection r in the second medium is equal to the ratio of refractive index of the second medium n_2 to that of the refractive index of the first medium n_1

$$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$

8. What is angle of deviation due to refraction?
   - Angle between the incident and deviated light is called angle of deviation.
   - When light travels from rarer to denser medium it deviates towards normal. $d = i - r$
   - if light travels from denser to rarer medium it deviates away from normal $d = r - i$

9. What is principle of reversibility?

The principle of reversibility states that light will follow exactly the same path if its direction of travel is reversed.

10. What is relative refractive index?

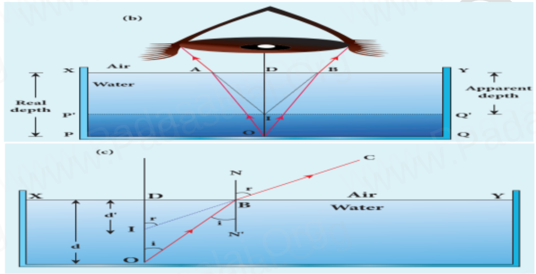
The term $\frac{n_2}{n_1}$ is called relative refractive index of second medium with respect to the first medium. $n_{21}=\frac{n_2}{n_1}$

11. Obtain the equation for apparent depth.
- Light from the object O at the bottom of the tank passes from denser medium (water) to rarer medium (air) to reach our eyes.
- It deviates away from the normal in the rarer medium at the point of incidence B. The refractive index of the denser medium is n_1 and rarer medium is n_2. Here, $n_1 > n_2$.
- The angle of incidence in the denser medium is i and the angle of refraction in the rarer medium is r.
- The lines NN′ and OD are parallel. Thus angle ∠DIB is also r. The angles i and r are very small as the diverging light from O entering the eye is very narrow.
- The Snell's law in product form for this refraction is,

$n_1 \sin i = n_2 \sin r$

As the angles i and r are small, we can approximate, $\sin i \approx \tan i$;

$n_1 \tan i = n_2 \tan r$



In triangle ΔDOB and ΔDIB

$\tan(i)=\frac{DB}{DO}$ and $\tan(r)=\frac{DB}{DI}$

$n_1 \frac{DB}{DO}=n_2 \frac{DB}{DI}$

DB is cancelled on both sides,

DO is the actual depth d and DI is the apparent depth d'.

$n_1 \frac{1}{d}=n_2 \frac{1}{d'}$

$\frac{d'}{d}=\frac{n_2}{n_1}$

$d'=\frac{n_2}{n_1} d$

As the rarer medium is air and its refractive index n_2 can be taken as 1, (n_2=1). And the refractive index n_1 of denser medium could then be taken as n, (n_1=n).

$d'=\frac{d}{n}$

$d-d'=d-\frac{d}{n}$ or

$d-d'=d\left(1-\frac{1}{n}\right)$

12. Why do stars twinkle?

The stars actually do not twinkle. They appear twinkling because of the movement of the atmospheric layers with varying refractive indices which is clearly seen in the night sky.

13. What is critical angle and total internal reflection?

- The angle of incidence in the denser medium for which the refracted ray graces the boundary is called critical angle i_c.

- The entire light is reflected back into the denser medium itself. This phenomenon is called total internal reflection.

14. Obtain the equation for critical angle.

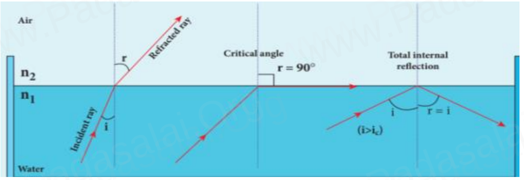
Snell's law in the product form, equation for critical angle incidence becomes,

$n_1 \sin i_c = n_2 \sin 90^0$

$n_1 \sin i_c = n_2$

$\sin i_c = \frac{n_2}{n_1}$

$n_1 > n_2$

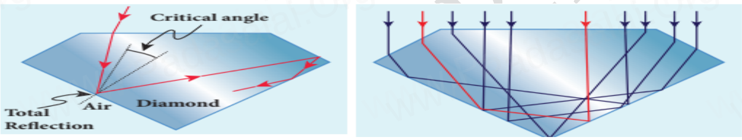


If the rarer medium is air, then its refractive index is 1 and can be taken as n itself. i.e. ($n_2=1$) and ($n_1=n$).

$\sin i_c = \frac{1}{n}$ or $i_c = \sin^{-1}(1/n)$

15. Explain the reason for glittering of diamond.

- Diamond appears dazzling because the total internal reflection of light happens inside the diamond. The refractive index of only diamond is about 2.417. It is much larger than that for ordinary glass which is about only 1.5. The critical angle of diamond is about 24.4°. It is much less than that of glass.
- A skilled diamond cutter makes use of this larger range of angle of incidence (24.4° to 90° inside the diamond), to ensure that light entering the diamond is total internally reflected from the many cut faces before getting out as shown in Fig. This gives a sparkling effect for diamond.

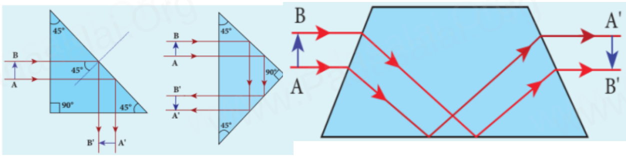


16. What are mirage and looming?

mirage	looming
The refractive index of air increases with its density.	
In hot places, air near the ground is hotter than air at a height. Hot air is less dense. Hence, in still air the refractive index of air increases with height.	In the cold places the refractive index increases towards the ground because the temperature of air close to the ground is lesser than the temperature above the surface of earth.
Because of this, light from tall objects like a tree, passes through a medium whose refractive index decreases towards the ground.	Thus, the density and refractive index of air near the ground is greater than at a height.
Hence, a ray of light successively deviates away from the normal at different layers of air and undergoes total internal reflection when the angle of incidence near the ground exceeds the critical angle. This gives an illusion as if the light comes from somewhere below the ground. This phenomenon is called mirage.	In the cold regions like glaciers and frozen lakes and seas, the reverse effect of mirage will happen. Hence, an inverted image is formed little above the surface as shown in Fig. This phenomenon is called looming.

17. Write a short notes on the prisms making use of total internal reflection.

- Prisms can be designed to reflect light by 90° or by 180° by making use of total internal reflection as shown in Fig(a & b). In the first two cases, the critical angle i_c for the material of the prism must be less than 45°.
- That this is true for both crown glass and flint glass. Prisms are also used to invert images without changing their size as shown fig (c)



18.What is Snell's window?

- When light entering the water from outside is seen from inside the water, the view is restricted to a particular angle equal to the critical angle i_c.
- The restricted illuminated circular area is called Snell's window

19.Write a note on optical fibre.

- Transmitting signals through optical fibres is possible due to the phenomenon of total internal reflection.
- Optical fibres consists of inner part called core and outer part called cladding (or) sleeving.
- The refractive index of the material of the core must be higher than that of the cladding for total internal reflection to happen.
- Signal in the form of light is made to incident inside the core-cladding boundary at an angle greater than the critical angle.
- Hence, it undergoes repeated total internal reflections along the length of the fibre without undergoing any refraction.
- The light travels inside the core with no appreciable loss in the intensity of the light

20.Explain the working of an endoscope.

- An endoscope is an instrument used by doctors which has a bundle of optical fibres that are used to see inside a patient's body.
- Endoscopes work on the phenomenon of total internal reflection.
- The optical fibres are inserted in to the body through mouth, nose or a special hole made in the body.
- Even operations could be carried out with the endoscope cable which has the necessary instruments attached at their ends.

21.What are primary focus and secondary focus of concex lens?

- The primary focus F_1 is defined as a point where an object should be placed to give parallel emergent rays to the principal axis.
- The secondary focus F_2 is defined as a point where all the parallel rays travelling close to the principal axis converge to form an image on the principal axis

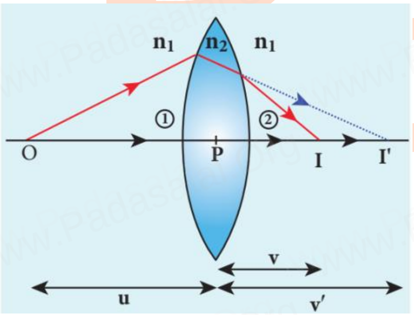
22.What are the sign conventions followed for lenses?

i. The sign of focal length is not decided on the direction of measurement of the focal length from the pole of the lens as they have two focal lengths, one to the left and another to the right (primary and secondary focal lengths on either side of the lens).

ii. The focal length of the thin lens is taken as positive for a converging lens and negative for a diverging lens.

23. Arrive at lens equation from lens maker's formula.

- Let us consider a thin lens made up of a medium of refractive index n_2 is placed in a medium of refractive index n_1.
- Let R_1 and R_2 be the radii of curvature of two spherical surfaces 1 and 2 respectively and P be the pole
- Consider a point object O on the principal axis. The ray which falls very close to P, after refraction at the surface 1 forms image at I'.
- before it does so, it is again refracted by the surface 2 . Therefore the final image is formed at I.
- The general equation for the refraction at a spherical surface is given from Equation



$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

For the refracting surface 1, the light goes from n_1 to n_2

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} \text{------1}$$

For the refracting surface 2, the light goes from medium n_2 to n_1.

$$\frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_1 - n_2}{R_2} \text{-------2}$$

Adding the above two equations 1 and 2

$$\frac{n_2}{v'} - \frac{n_1}{u} + \frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1} + \frac{n_1 - n_2}{R_2}$$

$$\frac{n_1}{v} - \frac{n_1}{u} = n_2 - n_1 \left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

both side divide by n_1

$$\frac{1}{v} - \frac{1}{u} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

If the object is at infinity, the image is formed at the focus of the lens. Thus, for u = ∞, v = f. Then the equation becomes

$$\frac{1}{f} - \frac{1}{\infty} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \text{------3}$$

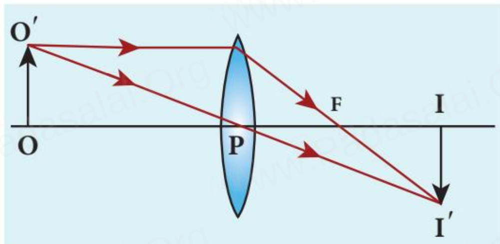
If the refractive index of the lens is n2 and bit is placed in air, then n2 = n and n1 = 1. So the equation (3) becomes,

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

The above equation is called the lens maker's formula,

24. Obtain the equation for lateral magnification for thin lens.

- Let us consider an object OO' of height h_1 placed on the principal axis with its height perpendicular to the principal axis as shown in Figure.



- The ray OP passing through the pole of the lens goes undeviated. The inverted real image II' formed has a height h_2.
- The lateral or transverse magnification is defined as the ratio of the height of the image to the height of the object.

$m=\frac{II'}{OO'}$-----(1)

From the two similar triangles Δ POO'and Δ PII' we can write,

$\frac{II'}{OO'}=\frac{PI}{PO}$-----(2)

Applying sign convention,

$\frac{-h_2}{h_1}=\frac{v}{-u}$------(3)

From above equations

$m=\frac{-h_2}{h_1}=\frac{v}{-u}$

After rearranging,

$m=\frac{h_2}{h_1}=\frac{v}{u}$

The magnification is negative for real image and positive for virtual image

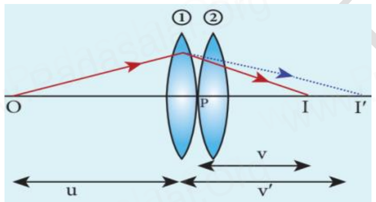
Magnification by combining the lens equation with the formula for magnification as,

$m=\frac{h_2}{h_1}=\frac{f}{f+u}$ or $m=\frac{h_2}{h_1}=\frac{f-v}{f}$

25.What is power of a lens?

- power of a lens is a measure of the degree of convergence or divergence of light falling on it.
- Power of the lens is inversely proportional to focal length. $P=\frac{1}{f}$ unit :dioptre

26.Derive the equation for effective focal length for lenses in contact.



➢ Let us consider two lenses 1 and 2 of focal length f_1 and f_2 are placed coaxially in contact with each other so that they have a common principal axis.

➢ For an object placed at O beyond the focus of the first lens 1 on the principal axis, an image is formed by it at I'.

➢ This image I' acts as an object for the second lens 2 and the final image is formed at I as shown in Figure.

➢ As these two lenses are thin, the measurements are done with respect to the common optical centre P in the middle of the two lenses.

➢ Let, PO be object distance u and PI' be the image distance (v') for the first lens 1and object distance for the second lens 2 and PI=v be the image distance for the second lens 2.

Writing the lens equation for first lens 1,

$\frac{1}{v'}-\frac{1}{u}=\frac{1}{f_1}$------(1) Writing the lens equation for second lens 2

$\frac{1}{v}-\frac{1}{v'}=\frac{1}{f_2}$------(2)

Adding the above two equations

$\frac{1}{v'}-\frac{1}{u}+\frac{1}{v}-\frac{1}{v'}=\frac{1}{f_1}+\frac{1}{f_2}$

$\frac{1}{v}-\frac{1}{u}=\frac{1}{f_1}+\frac{1}{f_2}$ -----(3)

If the combination acts as a single lens of focal length f so that for an object at the position O it forms the image at I then,

$\frac{1}{v}-\frac{1}{u}=\frac{1}{F}$--------(4)

Comparing equations 3 and 4

$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$

The above equation can be extended for any number of lenses in contact as,

$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}+\frac{1}{f_4}+$.........

27.What is angle of minimum deviation?

The minimum value of angle of deviation is called angle of minimum deviation D.

28.What is dispersion?

Dispersion is splitting of white light into its constituent colours. This band of colours of light is called its spectrum.

29.How are rainbows formed?

- When sunlight falls on the water drop suspended in air, it splits (or dispersed) into its constituent seven colours. Thus, water drop suspended in air behaves as a glass prism.
- Primary rain bow is formed when light entering the drop undergoes one total internal reflection inside the drop before coming out from the drop

30.What is Rayleigh's scattering?

If the scattering of light is by atoms and molecules which have size a very less than that of the wave length λ of light a<<λ, the scattering is called Rayleigh's scattering.

31.Why does sky appear blue?

- According to equation $I=\frac{1}{\lambda^4}$, violet colour which has the shortest wavelength gets much scattered during day time.
- The next scattered colour is blue. As our eyes are more sensitive to blue colour than violet colour the sky appears blue during day time

32.What is the reason for reddish appearance of sky during sunset and sunrise?

- During sunrise and sunset, the light from sun travels a greater distance through the atmosphere.
- Hence, the blue light which has shorter wavelength is scattered away and the less-scattered red light of longer wavelength manages to reach our eye.
- This is the reason for the reddish appearance of sky during sunrise and sunset.

33.Why do clouds appear white?

In clouds which contains large amount of dust and water droplets. Thus, in clouds all the colours get equally scattered irrespective of wavelength.

This is the reason for the whitish appearance of cloud.

34.What are the salient features of corpuscular theory of light?

- According this theory, light is emitted as tiny, massless (negligibly small mass) and perfectly elastic particles called corpuscles. As the corpuscles are very small, the source of light does not suffer appreciable loss of mass even if it emits light for a long time.
- On account of high speed, they are unaffected by the force of gravity and their path is a straight line in a medium of uniform refractive index. The energy of light is the kinetic energy of these corpuscles.
- When these corpuscles impinge on the retina of the eye, the vision is produced. The different size of the corpuscles is the reason for different colours of light.
- When the corpuscles approach a surface between two media, they are either attracted or repelled.The reflection of light is due to the repulsion of the corpuscles by the medium and

refraction of light is due to the attraction of the corpuscles by the medium.

35.What is wave theory of light?

Light is a disturbance from a source that travels as longitudinal mechanical waves through the ether medium that was presumed to pervade all space as mechanical wave requires medium for its propagation

36.What is electromagnetic wave theory of light?

- Light is an electromagnetic wave which is transverse in nature carrying electromagnetic energy.
- No medium is Necessary for the propagation of electromagnetic waves.

37.Write a short note on quantum theory of light.

- Plank was able to explain photoelectric effect in which light interacts with matter as photons to eject the electrons.
- A photon is a discrete packet of energy. Each photon has energy E of, E = hv Where, h is Plank's constant and v is frequency of electromagnetic wave.
- As light has both wave as well as particle nature it is said to have dual nature.
- Light propagates as a wave and interacts with matter as a particle.

38.What is a wavefront?

A wave front is the locus of points which are in the same state or phase of vibration.

39.What is Huygens' principle?

According to Huygens principle, each point of the wavefront is the source of secondary wavelets emanating from these points spreading out in all directions with the speed of the wave. These are called as secondary wavelets.

40.What is interference of light?

The phenomenon of addition or superposition of two light waves which produces increase in intensity at some points and decrease in intensity at some other points is called interference of light.

41.What is phase of a wave?

- Phase is the angular position of a vibration.
- Phase is a particular point in time on the cycle of a waveform, measured as an angle in degrees

42.Obtain the relation between phase difference and path difference.

- Phase difference is the difference in phase angle between two waves, measured in degree or radian
- Path difference is the difference in path traversed by the two waves , measured in terms of Wavelength of the associated wave.

A path difference δ corresponds to a phase difference ϕ

$$\delta = \frac{\lambda}{2\pi} \times \phi \; ; \textbf{ or } \; \boldsymbol{\phi} = \frac{2\pi}{\lambda} \times \delta,$$

43.What are coherent sources?

Two light sources are said to be coherent if they produce waves which have same phase or constant phase difference, same frequency or wavelength (monochromatic), same waveform and preferably same amplitude.

44.What is intensity division?

- If we allow light to pass through a partially silvered mirror (beam splitter), both reflection and refraction take place simultaneously.
- As the two light beams are obtained from the same light source, the two divided light beams will be coherent beams. They will be either in-phase or at constant phase difference

45.How does wavefront division provide coherent sources?

- Wavefront division is the most commonly used method for producing two coherent sources. We know a point source produces spherical wavefronts.
- All the points on the wavefront are at the same phase. If two points are chosen on the wavefront by using a double slit, the two points will act as coherent sources.

46.How do source and images behave as coherent sources?

- Source and images: In this method a source and its image will act as a set of coherent source, because the source and its image will have waves in-phase or constant phase difference.
- The Instrument, Fresnel's biprism uses two virtual sources as two coherent sources and the instrument, Lloyd's mirror uses a source and its virtual image as two coherent sources.

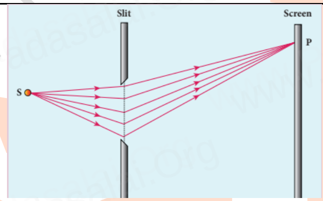
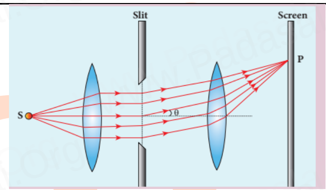
47.What is bandwidth of interference pattern?

The bandwidth (β) is defined as the distance between any two consecutive bright or dark fringes.

48.What is diffraction?

Diffraction is bending of waves around sharp edges into the geometrically shadowed region.

49.Differentiate between Fresnel and Fraunhofer diffraction.

S	Fresnel diffraction	Fraunhofer diffraction
1.	Spherical or cylindrical wavefront undergoes diffraction	Plane wavefront undergoes diffraction
2.	Light wave is from a source at finite distance	Light wave is from a source at infnity
3.	For laboratory conditions, convex lenses need not be used	In laboratory conditions, convex lenses are to be used
4.	difficult to observe and analyses	Easy to observe and analyses
5.		

50.Discuss the special cases on first minimum in Fraunhofer diffraction.

Let us consider the condition for first minimum with ($n = 1$) $a \sin\theta = \lambda$

The first minimum has an angular spread of, $\sin\theta = \frac{\lambda}{a}$

<u>special cases for above condition</u>

- When $a < \lambda$, the diffraction is not possible, because $\sin\theta$ can never be greater than 1.
- When $a \geq \lambda$, the diffraction is possible. For $a = \lambda$, $\sin\theta = 1$ i.e, $\theta = 90^0$. That means the first minimum is at 90^o. Hence, the central maximum spreads fully in to the geometrically

shadowed region leading to bending of the diffracted light to 90°

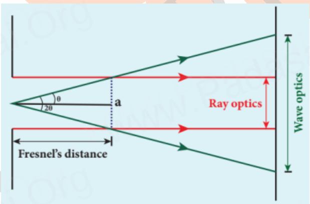
- For $a >> \lambda$, $\sin\theta << 1$ i.e, the first minimum will fall within the width of the slit itself. The diffraction will not be noticed at all.
- When $a > \lambda$ and also comparable, say $a = 2\lambda$,

  $\sin\boldsymbol{\theta} = \frac{\lambda}{a} = \frac{\lambda}{2\lambda} = \frac{1}{2}$

  $\boldsymbol{\theta} = 30^0$ These are practical cases where diffraction could be observed effectively.

51.What is Fresnel's distance? Obtain the equation for Fresnel's distance.

- **Fresnel's distance** is the distance up to which the ray optics is valid in terms of rectilinear propagation of light.
- As there is bending of light in diffraction, the rectilinear propagation of light is violated.
- But, this bending is not significant till the diffracted ray crosses the central maximum at a distance z
- Hence, Fresnel's distance is the distance upto which ray optics is obeyed and beyond which ray optics is not obeyed but, wave optics becomes significant.



From the diffraction equation for first minimum,

$\sin\boldsymbol{\theta} = \frac{\lambda}{a}$; $\boldsymbol{\theta} = \frac{\lambda}{a}$--------(1)

From the definition of Fresnel's distance,

$\sin 2\boldsymbol{\theta} = \frac{a}{z}$; $2\boldsymbol{\theta} = \frac{a}{z}$…., $\boldsymbol{\theta} = \frac{a}{2z}$….,(2)

From equation 1 and 2

After rearranging, we get Fresnel's distance z as

$\frac{\lambda}{a} = \frac{a}{2z}$;

$$\textbf{Fresnel's distance } \mathbf{z} = \frac{\mathbf{a^2}}{\mathbf{2\lambda}}$$

52.Mention the differences between interference and diffraction.

S.	INTERFERENCE	DIFFRACTION
1.	Superposition of two waves	Bending of waves around edges
2.	Superposition of waves from two coherent sources.	Superposition wavefronts emitted from various points of the same wavefront.
3.	Equally spaced fringes	Unequally spaced fringes
4.	Intensity of all the bright fringes is almost same	Intensity falls rapidly for higher orders
5.	Large number of fringes are obtained	Less number of fringes are obtained

53.What is a diffraction grating?

Grating has multiple slits with equal widths of size comparable to the wavelength of diffracting light. Grating is a plane sheet of transparent material on which opaque rulings are made with a fine diamond pointer.

54.What are resolution and resolving power?

- Optical resolution describes the ability of imaging system to resolve detail in the object that is being imaged.
- The inverse of resolution is called resolving power.
- The ability of an optical instrument to separate or distinguish small or closely adjacent objects through the image formation is said to be resolving power of the instrument.

55. What is Rayleigh's criterion?

According to Rayleigh's criterion, for two point objects to be just resolved,the minimum distance between their diffraction images must be in such a way that the central maximum of one coincides with the first minimum of the other and vice versa

56. What is polarisation?

The phenomenon of restricting the vibrations of light to a particular direction perpendicular to the direction of wave propagation motion is called polarization of light.

57. Differentiate between polarised and unpolarised light

S	**Polarized light**	**unpolarised light**
1.	Consists of waves having their electric field vibrations in a single plane normal to the direction of ray	Consists of waves having their electric Field vibrations equally distributed in all directions normal to the direction of ray
2.	Asymmetrical about the ray direction	Symmetrical about the ray direction
3.	It is obtained from unpolarised light with the help of polarisers	Produced by conventional light sources.

58. Discuss polarisation by selective absorption.

- Selective absorption is the property of a material which transmits waves whose electric fields vibrate in a plane parallel to a certain direction of orientation and absorbs all other waves.
- The polaroids or polarisers are thin commercial sheets which make use of the property of selective absorption to produce an intense beam of plane polarised light. Selective absorption is also called as dichroism.

59. What are polariser and analyser?

- the Polaroid which plane polarises the unpolarised light passing through it is called a polarizer
- The polaroid which is used to examine whether a beam of light is polarised or not is called an analyser.

60. What are plane polarised, unpolarised and partially polarised light?

- Plane polarized: if the vibration of a wave are present in only one direction in a plane perpendicular to the direction of propagation of the wave is said to be polarized or plane polarised light
- Unpolarised : a transverse wave which has vibrations in all directions in a plane perpendicular to the direction of propagation is said to be unpolarised light.
- Partially polarised light: vibration is in all directions but the amplitude is more in one direction as compared to the other.

61. State and obtain Malus' law.

When a beam of plane polarised light of intensity I_0 is incident on an analyser, the light transmitted of intensity I from the analyser varies directly as the square of the cosine of the angle θ between the transmission axis of polariser and analyser .This is known as Malus' law.

$$I=I_o\cos^2\theta$$

62.List the uses of polaroids.

Polaroid's are used in

1. Goggles and cameras to avoid glare of light.
2. Three dimensional motion pictures i.e., in holography.
3. Improve contrast in old oil paintings.
4. Optical stress analysis.
5. Window glasses to control the intensity of incoming light
6. Polarised laser beam acts as needle to read/write in compact discs (CDs).
7. Polaroids produce polarised lights to be used in liquid crystal display (LCD).

63.State Brewster's law.

The tangent of the polarising angle for a transparent medium is equal to its refractive index. $n = \tan i_p$

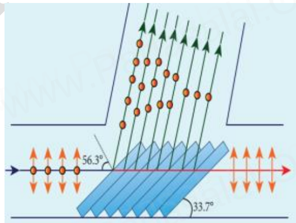
64.What is angle of polarisation and obtain the equation for angle of polarisation.

The angle of incidence at which a beam of unpolarised light falling on a transparent surface is reflected as a beam of plane polarised light is called polarising angle or Brewster's angle.

$r_p + i_p + 90^o = 180^o$

$r_p = 90^o - i_p$

65.Discuss about pile of plates.



- The phenomenon of polarisation by reflection is used in the construction of pile of plates.
- It consists of a number of glass plates placed one over the other in a tube as shown in Fig.
- The plates are inclined at an angle of 33.7^o ($90^o - 56.3^o$) to the axis of the tube.
- A beam of unpolarised light is allowed to fall on the pile of plates along the axis of the tube. So, the angle of incidence of light will be at 56.3^o which is the polarising angle for glass.
- The vibrations perpendicular to the plane of incidence are reflected at each surface and those parallel to it are transmitted.
- The larger the number of surfaces, the greater is the intensity of the reflected plane polarised light.
- The pile of plates is used as a polarizer and also as an analyser.

66.What is double refraction?

When a ray of unpolarised light is incident on a calcite crystal, two refracted rays are produced. Hence, two images of a single object are formed. This phenomenon is called double refraction

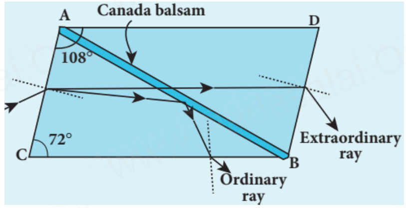
67.Mention the types of optically active crystals with example.

- Crystals like calcite, quartz, tourmaline and ice having only one optic axis are called uniaxial crystals.
- Crystals like mica, topaz, selenite and aragonite having two optic axes are called biaxial crystals.

68.Discuss about Nicol prism.

- Nicol prism is an optical device incorporated in optical instruments both for producing and analysing plane polarized light.
- The construction of a Nicol prism is based on the phenomenon of Double refraction and was designed by William Nicol

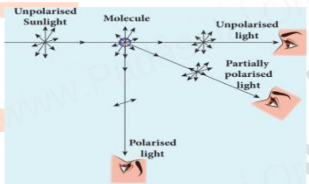
- One of the most common forms of the Nicol prism is made by taking a calcite crystal which is a double refracting crystal with its length three times its breadth.
- ABCD represents the principal section of a calcite crystal. It is cut into two halves along the diagonal so that their face angles are 72^o and 108^o.



- The two halves are joined together by a layer of canada balsam, a transparent cement.

69.How is polarisation of light obtained by scattering of light?

- The light from a clear blue portion of the sky shows a rise and fall of intensity when viewed through a polaroid which is rotated.



- This is because of sunlight, which has changed its direction (having been scattered) on encountering the molecules of the earth's atmosphere.
- As Figure shows, the incident sunlight is unpolarised. The electric field of light interact with the electrons present in the air molecules.
- Under the influence of the electric field of the incident wave the electrons in the molecules acquire components of motion in both these directions.
- We have shown an observer looking at 90° to the direction of the sun. Clearly, charges accelerating parallel do not radiate energy towards this observer since their acceleration has no transverse component.
- The radiation scattered by the molecule is therefore polarized perpendicular to the plane

70.Discuss about simple microscope and obtain the equations for magnification for near point focusing and normal focusing.

- A simple microscope is a single magnifying (converging) lens of small focal length. To get an erect, magnified and virtual image of the object.
- For this the object is placed between F and P on one side of the lens and viewed from other side of the lens.

There are two magnifications to be discussed for two kinds of focusing

- magnification for near point focusing $m=1+\frac{D}{f}$
- magnification for normal focusing $m=\frac{D}{f}$

71.What are near point and normal focusing?

- Near point focusing – The image is formed at near point, i.e. 25 cm for normal eye. This distance is also called as least distance D of distinct vision. In this position, the eye feels comfortable but there is little strain on the eye.
- Normal focusing – The image is formed at infinity. In this position the eye is most relaxed to view the image.

72.Why is oil immersed objective preferred in a microscope?

- Oil immersion objectives are used only at very large magnifications that require high resolving power.
- Objectives with high power magnification have short focal lengths, facilitating the use of oil.

73.What are the advantages and disadvantages of using a reflecting telescope?

Advantages

- The main advantage is reflector telescope can escape from chromatic aberration because wavelength does not affect reflection.
- The primary mirror is very stable because it is located at the back of the telescope and can be support in the back.
- More cost effective than refractor of similar size.
- Easier to make a high quality mirror than lens because mirror need to only concern with one side of the curvature.

Disadvantages

- Optical misalignment can occur quite easily.
- Require frequent cleaning because the inside is expose to the atmosphere.
- Secondary mirror can cause diffraction of original incoming light rays causing the "christmas star effect" where bright objects have spikes.

74.What is the use of an erecting lens in a terrestrial telescope?

A terrestrial telescope has an additional erecting lens to make the final image erect.

75.What is the use of collimator?

The collimator is an arrangement to produce a parallel beam of light.

76.What are the uses of spectrometer?

- A spectrometer is a device for measuring a wavelengths of light over a wide range of the electromagnetic spectrum.
- spectrometer is used for measuring ray deviations and refractive indices.

77.What is myopia? What is its remedy?

- A person suffering from nearsightedness or myopia can see nearby object clearly but cannot see distant objects clearly beyond certain limit
- Myopia can be corrected by using a concave lens of suitable focal length.

78.What is hypermetropia? What is its remedy?

- A person suffering from long sightedness or hypermetropia can see distant object clearly but cannot see nearby objects clearly.
- Hypermetropia can be corrected by using a convex lens of suitable focal length

79.What is presbyopia?

This defect is similar to hypermetropia i.e., a person having this defect cannot see nearby objects distinctly, but can see distant objects without any difficulty. This defect occurs in elderly persons

80.What is astigmatism?

Astigmatism is the defect arising due to different curvatures along different planes in the eye lens. Astigmatic person cannot see all the directions equally well. The defect due to astigmatism is more serious than myopia and hyperopia.

CONCEPTUAL QUESTIONS

1. Why are dish antennas curved?

Dish antenna is curved so as it can receive parallel signal rays coming from same direction. These parallel signal rays reflect from parabolic dish, and gathered at main antenna part. This increases directivity of antenna, and gives sufficient amplitude signal.

2. What type of lens is formed by a bubble inside water?

Biconvex lens is the lens formed when an air bubble is inside water. The air bubble acts as a diverging lens (concave lens) in water. This makes it equivalent to two convex interfaces meeting each other with light entering from a medium with a higher refractive index. Therefore an air bubble in water acts in the same manner as a concave lens made of glass does in air.

3. It is possible for two lenses to produce zero power?

If one lens is converging lens with some focal length so that its power is $P_1=P$ and the other lens diverging lens with the same focal length but with a negative sign so that its power is $P_2=-P$, then the combination of these two lenses will be zero

4. Why does sky look blue and clouds look white? (B.Q)

5. Why is yellow light preferred to during fog?

Yellow light supposedly penetrates further because of its long wavelength, but it's still much smaller than fog particles. The scattering effects of fog are essentially independent of wavelength.

6. Two independent monochromatic sources cannot act as coherent sources,why?

Two independent sources of light cannot be coherent. This is because light is emitted by individual atoms, when they return to ground state. Even the smallest source of light contains billions of atoms which obviously cannot emit light waves in the same phase

7. Does diffraction take place at the Young's double slit?

Both diffraction and interference occur in the double slit experiment. The wavefront is diffracted as it passes through each of the slits. The diffraction causes the wavefronts to spread out as if they were coming from light sources located at the slits.

8. Is there any difference between colored light obtained from prism and colours of soap bubble?

Unlike those seen in a rainbow, which arise from differential refraction, the colours seen in a soap bubble arise from interference of light reflecting off the front and back surfaces of the thin soap film. Depending on the thickness of the film, different colours interfere constructively and destructively

9. A small disc is placed in the path of the light from distance source. Will the center of the shadow be bright or dark?

Waves diffracted from the edge of circular obstacle interfere constructive at the center of the shadow resulting in the formation of a bright spot.

10. When a wave undergoes reflection at a denser medium, what happens to its phase?

When a wave undergoes a reflection at a denser medium then it's crest reflected as trough and vice versa. So, it's phase changes at 180(degree)

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