IIT-JEE / MEDICAL

PHYSICS

KEY TERMS

OPTICS

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1. **Reflection.** The phenomenon of bouncing back of the light in the same medium when light is incident on a surface is known as **reflection.** The surface which bounces back the light is called **reflection surface.**
2. **Laws of reflection**
   (i) Angle of incidence is equal to angle of reflection i.e. $\angle i = \angle r$.
   (ii) The incidence ray, reflected ray and normal to the reflecting surface at the point of incidence are coplanar.
3. **Principle of Reversibility.** Object and image positions are interchangeable. It is known as **principle of reversibility.**

   Or

   According to this principle, if the path of a ray of light is reversed after suffering a number of reflection and/or refractions, it retraces its path.
4. **Spherical Mirrors** are the reflecting part of spherical surfaces.
5. **Concave Mirror** is a part of a hollow sphere whose outer part (i.e. bulging surface) is silvered and the inner part (i.e. depressed surface) becomes reflecting surface.
6. **Convex Mirror** is a part of a hollow sphere whose inner part (i.e. depressed surface) is silvered and the outer part (i.e. bulging surface) becomes reflecting surface.
7. **Centre of Curvature.** The centre of the sphere of which the spherical mirror forms a part is called the centre of curvature. It is denoted by C.
8. **Radius of Curvature.** The radius of the sphere of which the spherical mirror forms a part is called the radius of curvature. It is denoted by R.
9. **Pole (Vertex).** The mid point of the spherical mirror is called its pole (P).
10. **Principle Axis.** The line joining the centre of curvature and the pole of the spherical mirror is called the principle axis.
11. **Principal section.** Any section of the mirror passing through the pole is called Principle section.
12. **Aperture** of a mirror is the effective diameter of light reflecting area of the mirror.
13. **Angular aperture** of a spherical mirror is the angle subtended by diameter of mirror at the centre of curvature of the mirror.

14. **Principle Focus.** The point on the principal axis of the spherical mirror where the rays of light parallel to the principal axis meet or appear to meet after reflection from the mirror is called principal focus . It is denoted as F.
15. **Focal Length.** The distance between the pole (P) and the principal focus (F) of the spherical mirror is called the focal length of the mirror. It is written as *f.*
16. **Mirror Formula.**

    The relation between u, *v* and *f* of the mirror is known as **mirror formula** i.e.

    $$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$$
17. **Linear Magnification**

    Linear magnification produced by a mirror is defined as the ratio of the size (or height) of the image to the size (or height) of the object.
18. **Spherical Aberration of a Mirror**

    The inability of a spherical mirror to bring all the rays of a wide beam of light (travelling parallel to the axis) falling on it to a focus is called **spherical aberration.**
19. **Refraction.** The phenomenon of change in the direction of path of light when it goes from one medium to another is called **refraction of light .**
20. **Absolute refractive index (μ).** of a medium can be defined as the ratio of speed of light in vacuum/air (c) to the speed of light in the medium (*v*).

    Notes :- A medium having higher value of refractive index is called optically denser medium while a medium having lower value of refractive index is called **optically rarer medium.**

    The speed of light in rarer medium is greater than the speed of light in denser medium.
21. **Relative refractive index**. If medium I has refractive index μ_1 and medium 2 has refractive index μ_2, then $\frac{\mu_2}{\mu_1}={}^1\mu_2$

    where ${}^1\mu_2$ is the relative refractive index of medium 2 relative to medium 1
22. **Laws of Refraction**
    1. The incident ray, the refracted ray and the normal to the interface at the point of incidence lie in the same plane i.e. they all are co-planer.
    2. The ratio of the sine of the angle of incidence (i) to the sine of the angle of refraction (r) is constant for any two given media **(Snell's law).**

i.e. $$\frac{\sin i}{\sin r} = constant$$

23. Lateral Shift. The perpendicular distance between the direction of incident ray and the emergent ray is known as the lateral shift.

24. Total Internal Reflection (TIR). The phenomenon of reflection when a ray of light travelling from a denser to rarer medium is sent back to the same denser medium provided it strikes the interface of the denser and the rarer media at an angle greater than the critical angle is called total internal reflection.

25. Mirage. Mirage is an optical illusion of water observed generally in deserts when the inverted image of an object (e.g., a tree) is observed along with the object itself on a hot day.

26. Spherical Refracting Surface is a refracting medium whose curved surface is a part of a sphere.

Pole (P). The mid point of the spherical refracting surface is called its pole.

Centre of Curvature (C). The centre of the sphere of which the curved refracting surface forms a part is called its centre if curvature.

Radius of Curvature (R). It is the radius of the sphere of which the curved refracting surface forms a part.

It is also defined as the distance between the pole and the centre of curvature of the spherical refracting surface.

Principal axis. A line joining the pole and the centre of curvature of the spherical refracting surface is called principal axis.

Aperture. It is the effective diameter of the light refracting spherical surface exposed to the incident light.

27. New Cartesian Sign Conventions. (i) All the distance are measured from the pole of the spherical refracting surface.

(ii) The distance measured in the direction of the propagation of incident light are taken as positive.

(iii) The distances measured in the direction opposite to the direction of the propagation of incident light are taken as negative.

Notes :- The distances measured in transverse direction above the principle axis are taken as positive.

The distances measured in transverse direction below the principle axis are taken as negative.

28. **The Lens** is a piece of transparent material bounded by two refracting surfaces out of which at least one is curved.
29. **Optical centre (C).** It is that point in the lens through which rays of light pass undeviated.
30. **Principal Focus (F_1).** The point on the principal axis where the incident rays of light parallel to the principal axis meet or appear to meet after refracting through a lens is called principal focus.
31. **Focus length (f).** The distance between the optical centre and the principal focus is known as focal length of a lens.
32. **Lens Marker's Formula.** The formula giving relation between the focal length (f) of the lens, refractive index of the material of the lens (μ) and the radii of curvature of its surfaces (R_1 & R_2) is known as **Lens maker's formula.**
33. **Second Principal focus (F_2).** The position of the image on the principal axis of the lens whose object is lying at infinity is called **second principal focus of the lens.**
34. **Second principal focal length of the lens** is the distance between the optical centre of the lens and its second principal focus. It is denoted by f_2.
35. **Linear Magnification.** It is defined as the ratio of the size of the image to the size of object .
36. **Lens Formula.** The relation between the distances of object (u) and image (v) from the lens and the focal length (f) of the lens is known as lens formula i.e.

$$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$$

37. **Power of a lens.** It is defined as the reciprocal of the focal length of the lens i.e.

$$P=\frac{1}{f_{(in\ m)}}$$

38. **Spherical Aberration in Lenses.** It is defined as its inability to focus all the rays of light falling on it at a single point.
39. **Dispersion.** The phenomenon of splitting of white light into its constituent colours is known as dispersion of light.
40. **Prism.** A simple prism is a homogeneous transparent refracting medium bounded by at least two non parallel plane surfaces inclined at some angle.

41. Angle of Prism. The angle between two refracting surfaces is called the angle of prism or refracting angle and is denoted by A.

42. Condition for minimum deviation. In the position of minimum deviation, the prism lies symmetrically with respect to the incident ray and the emergent ray i.e., $\angle i = \angle e$

43. Minimum Deviation Position. If the angles of the base of the prism are equal, then the refracted ray passes parallel to the base of the prism when prism is in the minimum deviation position.

44. Angular Dispersion. It is defined as the difference in the deviations suffered by the two extreme colours (i.e., red and violet colour) in passing through a prism.

45. Dispersive power (ώ). The dispersive power of the mean deviation produced by the prism.

i.e. $$\omega = \frac{\theta}{\delta} = \frac{\delta_v - \delta_r}{\delta}$$

Notes : Here **mean deviation** means the deviation suffered by the yellow light (which is known as mean light)

46. Spectrum. The ordered arrangement of radiations according to wavelengths or frequencies is called **spectrum.**

Line emission spectra. A spectrum consisting of lines of various wavelengths emitted by the atomic gas or vapour which is excited by suitable means is called Line Emission Spectra.

Band spectra. The spectrum consisting of bands (each band is sharp at one end and diffused at the other) is called band spectra.

Continuous Spectrum. A spectrum. which contains radiations of all possible wavelengths emitted by a substance is called continuous spectrum.

47. Fraunhoffer's Lines. Fraunhoffer studied the spectrum of sun and observed few dark lines in the sun's visible spectrum. These dark lines are known as **Fraunhoffer's lines.**

48. Pure Spectrum. A spectrum in which various colours occupy distinct positions without overlapping each other is called pure spectrum.

49. Impure Spectrum. A spectrum in which various colours overlap on each other and are not distinctly seen is called impure spectrum.

50. Spectrometer. It is an optical instrument used to produce and analyse the pure spectrum .

51. **Scattering of Light.** When the light incident on very small molecules of atmosphere is radiated in all directions then the phenomenon is called scattering of light.
52. **Rayleigh's relation.** According to **Rayleigh,** the intensity of the light scattered is directly proportional to the fourth power of the wavelength (λ) of the incident light.

    i.e., $I \propto 1/\lambda^4$
53. The device which works on the principle of refraction, reflection or rectilinear propagation of light etc. is called optical instrument.
54. **Hyperopia (Hypermetropia) i.e. long sightedness.** Near objects are not clearly seen but the objects which are far away (i.e. distant objects) from the eye are seen clearly. This defect is removed by using suitable convergent lens.
55. **Myopia i.e. short sightedness.** Far off objects are not clearly seen but the near objects are clearly seen. This defect can be corrected by using suitable divergent less.
56. **Presbyopia i.e. loss of power of accommodation.** In this defect both far off and nearer objects are not clearly seen. This defect is generally corrected by using bi-focal lenses.
57. **Astigmatism.** In this defect, focal length of eye lens in two orthogonal directions vary which makes it difficult to clearly see the object in two said directions simultaneously. This defect due to improper spherical eye lens is corrected by using cylindrical lens in specific direction.
58. **Principle of simple Microscope.** A simple microscope is based upon the fact if an object is placed between the optical centre and the focus of a convex lens, it produces a virtual, erect and large image of the object on the same side of the lens.
59. **Magnifying power of a simple microscope** is defined as the ratio of the angle subtended by the image at the eye to the angle subtended by the eye when both are placed at the least distance of distinct vision independently.
60. **Normal Adjustment of Simple Microscope .** The microscope is in normal adjustment when the image is formed at infinity, i.e. $u = \infty$ and $u = -u$.
61. **Telescope.** It is an optical instrument to clearly observe the distant objects.

    Astronomical telescope. This telescope is used to observe heavenly objects like

moon, distant stars and planets etc. The image formed by this telescope is virtual and inverted. Since the heavenly bodies are almost round, so the inverted image does not affect the observations.

Terrestrial telescope. This telescope is used to observe the objects on the

Terrestrial telescope. This telescope is used to observe the objects on the

telescope the final image is virtual and erect.

- The reflecting telescopes are **Cassegrain type and Newtonian type**

62. Magnifying Power (Angular Magnification) of Astronomical Telescope

Magnifying power of an astronomical telescope is defined as the ratio of the angle subtended by the final image at the eye to the angle subtended by the object at the eye.

63. Wavefront is defined as the locus of all the particles of a medium vibrating in the same phase at a given instant.

64. Ray of Light. A line drawn perpendicular to the wavefront gives the direction of propagation of a wave and is called ray of light.

Or

An imaginary line drawn in the direction of propagation of light wave is called a ray of light.

65. Huygen's principle

i. Each source of light is a centre of disturbance from which waves spread in all directons. All particles equidistant from the source and vibrating in same phase lie on a surface known as wavefront.

ii. Every point on a wavefront is a source of a new disturbance which produces secondary wavelets. These wavelets are spherical and travel with the speed of light in all directions in that medium.

iii. Only forward envelope the tangents at the secondary wavelets at any instant gives the new position of wavefront.

iv. Rays are perpendicular to the wavefronts.

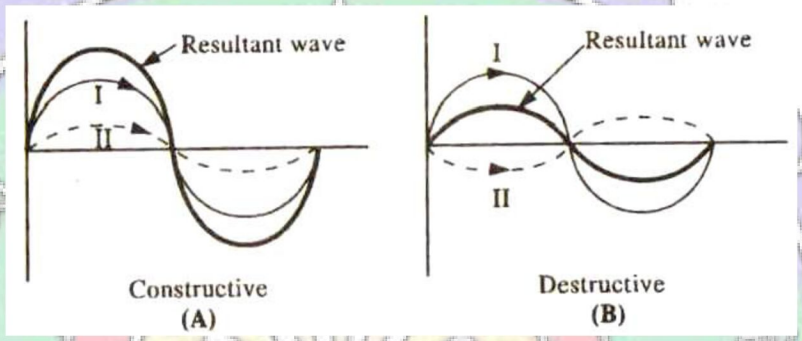
66. Superposition Principle.

According to superposition principle, the resultant displacement of a particle at any instant is the vector sum of the individual displacements caused to the particle by the two or more waves.

Constructive Superposition. When two waves of same wave lengths superimpose on each other in phase (i.e. crest of one wave falls on the crest of other wave or trough of one wave falls on the trough of other wave), then the superposition is constructive [Figure (A)]. In this case, the resultant displacement of the particle is $\vec{y} = \vec{y}_1 + \vec{y}_2$

Destructive Superposition. When two waves of same wave lengths superimpose on each other out of phase, (i.e. crest of one wave falls on the trough of the other wave and vice-versa) then the superposition is destructive (Figure B). In this case, the resultant displacement of the particle is

$$\vec{y} = \vec{y}_1 + (-\vec{y}_2)$$



67. **Coherent Sources.** Two sources of light are said to be coherent if they emit waves of same frequency (or wavelength) and are either in phase or have a constant initial phase difference.
68. **Interference.** The phenomenon of re-distribution of light energy due to the superposition of light waves from two coherent sources is known as interference.
69. **Fringes.** Dark and bright bands in the interference pattern are called interference fringes.
70. **Fringe Width (β).** The distance between any two successive dark fringes is called fringe width.
71. **Sustained Interference.** Interference pattern is said to be sustained if the positions of constructive interference (i.e. bright fringes) and destructive interference (i.e. dark fringes) remain fixed on the screen.
72. **Diffraction of Light** around the corners of an obstacle or an aperture into the region of geometrical shadow of obstacle is called diffraction of light.

Or

The phenomenon of bending of light into the region of geometrical shadow of the obstacle is also called diffraction of light.

 For pronounced diffraction of waves, the size of the obstacle/aperture should be of the order of the wave length of the wave.

73. **Fresnel Diffraction.** In this type of diffraction, the source or the screen or both are at finite distances from the obstacle or the aperture causing the diffraction.

74. **Fraunhoffer diffraction.** In the Fraunhoffer diffraction, the source and the screen are at infinite distance from the obstacle or the aperture causing the diffraction. In this case, the light from the source at infinity after diffraction is focused on the screen using the convex lens.

75. **Fresnel Distance.** Fresnel distance is defined as the distance of the screen from the slit when the spreading of light due to diffraction from the centre of the screen is equal to the size (i.e. width) of the slit. It is represented as Z_F.

76. **Resolving Power**. The ability of an optical instrument to form distinctly separate images of the two closely placed points or objects is called its resolving power. Resolving power is also defined as reciprocal of the limit of resolution.

i.e., $R.P. \alpha \frac{1}{Limit\ of\ resolution}$

Resolving power of a telescope = $\frac{D}{1.22\lambda}$

Resolving power of a microscope = $\frac{2\mu \sin\theta}{1.22\lambda}$ where μ sin θ is the numerical aperture of the objective lens.

77. **Linear Polarisation of Light.** The phenomenon of restricting the vibrations of a light wave in a particular direction in a plane perpendicular to the direction of propagation of light is called polarisation of light.

78. **Nicol Prism.** Nicol prism is an optical device made from a calcite crystal for producing and detecting plane-polarized light.

79. **Dichroism.** Sheets of Iodosulphate of quinine and tourmaline crystals have the property to transmit the light with vibrations parallel to their transmission axis and to absorb the light with vibrations perpendicular to transmission axis. Selective absorption of light is known as dichroism.

80. **Polaroid**. Polaroid is a device used to produce the plane polarized light. It is based on the principle of selective absorption (dichroism) and is more effective

than the tourmaline crystal.

83. **Optical Activity.** The property of a substance by virtue of which it rotates the plane of polarization of the light incident on it is called optical rotation/optical activity of that substance.

84. **Malus Law.** This law states that the intensity of the polarized light transmitted through the analyzer varies as the square of the cosine of the angle between the plane of transmission of the analyzer and the plane of the polarizer.