***1. Define reflection of light.**

When light travelling in a certain medium falls on the surface of another medium, a part of it turns back in the same medium. This is called reflection of light.

***2. What is difference between incident ray and reflected ray?**

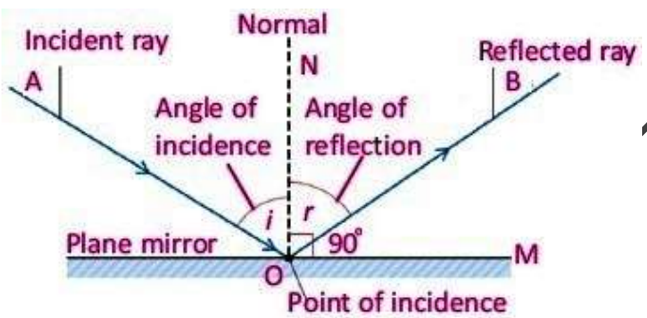
Incident Ray	Reflected Ray
The ray which hits or falls on an object or a material initially is known as incident ray.	The ray which gets reflected after hitting the object is known as reflected ray.

3. Illustrate reflection of light at a plane surface.

When a ray of light from air along the path AO falls on a plane mirror M, it is reflected along the path OB. This phenomenon is called reflection of light.

4. Differentiate between angle of incident and angle of reflection.

The angle NOA made by incident ray OA with the normal N is called angle of incidence. It is denoted by i. The angle NOB made by refracted ray OB with the normal N is called angle of reflection. It is denoted by r.



****4. Describe the following terms used in reflection: (i) normal (ii) angle of incidence (iii) angle of reflection**

Normal: A line drawn perpendicular to the surface of mirror at the point of incidence of light rays is called normal.

Angle of Incidence: Angle between incidence ray and normal is called angle of incidence. It is represented by $\angle i$.

Angle of Reflection: The angle between the reflected ray and normal is called angle of reflection. It is represented by $\angle r$.

****5. State the laws of reflection.**

(i) The incident ray, the normal, and the reflected ray at the point of incidence all lie in the same plane.

(ii) The angle of incidence is equal to the angle of reflection i.e., $i = r$.

****6. What is difference between regular and irregular reflection of light?**

Regular Reflection	Irregular Reflection
A smooth surface of silver reflects rays of light in one direction only. The reflection by the smooth surface is called regular reflection.	The rough surfaces of the objects reflect the rays of light in many directions. Such type of reflection is called irregular reflection.

***7. What is spherical mirror?** *(ALP)*

A mirror whose polished, reflecting surface is a part of a hollow sphere of glass or plastic is called a spherical mirror.

8. How spherical mirror is formed? *(ALP)*

In a spherical mirror, one of the two curved surfaces is coated with a thin layer of silver followed by a coating of red lead oxide paint. Thus, one side of the spherical mirror is opaque and the other side is a highly polished reflecting surface.

****9. What are the types of spherical mirror?** *(ALP)*

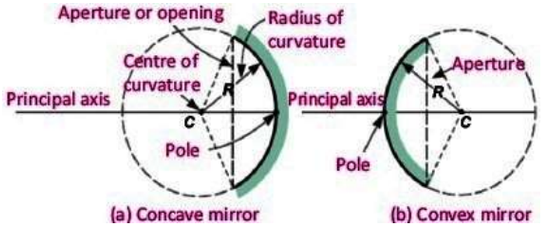
Depending upon the nature of reflecting surface, there are two two types of spherical mirror.

(i) Concave mirror

(ii) Convex mirror

Concave mirror: A spherical mirror whose inner curved surface is reflecting is called concave mirror.

Convex mirror: A spherical mirror whose outer curved surface is reflecting is called convex mirror.



10. Write the characteristics of image formed by concave and convex mirror.

Characteristics of image in concave mirror:

(i) In concave mirror the size of the image depends on the position of the object.

(ii) Both virtual and real images can be formed by a concave mirror.

Characteristics of image in convex mirror:

(i) In convex mirror the size of the image is always smaller than the object.

(ii) Only virtual and erect image is formed by a convex mirror.

***11. Define pole of mirror.** *(ALP)*

It is the midpoint of the curved surface of spherical mirror. It is also called vertex.

****12. Differentiate between center of curvature (C) and radius of curvature (R).** *(ALP)*

Center of curvature: A spherical mirror is a part of a sphere. The center of this sphere is called center of curvature.

Radius of curvature: It is the radius of the sphere of which spherical mirror is a part.

***13. Define principal axis of mirror.** *(ALP)*

It is the line joining center of curvature and pole of the spherical mirror.

****14. Define the principal focus (F).** *(ALP)*

After reflection from a concave mirror, rays of light parallel to the principal axis converge to a point F. This point is called "The Principal Focus" of the mirror.

***15. What is meant by focal length?** *(ALP)*

It is the distance from the pole to the principal focus measured along the principal axis. The focal length is related to the radius of curvature by

$$f = \frac{R}{2}$$

***16. Write any two characteristics of focus of a concave and a convex mirror.** *(ALP)*

Concave Mirror	Convex Mirror
The focus is in front of the mirror	The focus lies behind the mirror
The focus is real as the rays of light after reflection converge at the focus.	The focus is virtual as the rays of light after reflection appear to come from the focus.

17. What are the differences between real and virtual images? *(ALP)*

Real Image	Virtual Image
Real image can be obtained on the screen.	Virtual image cannot be obtained on screen.
This image is smaller than object.	This image is larger than object.
Concave mirror forms real image.	Convex mirror forms virtual image.
Focal length of real image is taken as positive.	Focal length of virtual image is taken as negative.

***18. Define mirror formula.** *(ALP)*

Mirror formula is the relationship between object distance p, image distance q from the mirror and focal length f of the mirror. Thus we can write mirror formula as:

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

***19. Define refraction of light.** *(ALP)*

The process of bending of light as it passes from air into glass and vice versa is called refraction of light.

****20. State the laws of refraction of light.** *(ALP)*

Laws of Refraction:

(i) The incident ray, the refracted ray, and the normal at the point of incidence all lie in the same plane.

(ii) The ratio of the sine of the angle of incidence i to the sine of the angle of refraction r is always equal to a constant i.e.,

$$\frac{\sin i}{\sin r} = constant = n$$

****21. Define the following terms used in refraction: (i) angle of incidence (ii) angle of refraction** *(ALP)*

Angle of Incidence: The angle formed by incident ray with normal is called angle of incidence. It is represented by $\angle i$.

Angle of Refraction: The angle formed by refracted ray with normal is called angle of refraction. It is represented by $\angle r$.

****22. What is Snell's law?** *(ALP)*

When ray of light passes from particular medium to another, the ratio of the sine of the angle of incidence i to the sine of the angle of refraction r is always equal to a constant. This constant is called refractive index of the second medium with respect to the first medium. So, we have

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

It is called Snell's law.

****23. Define Refractive Index. How would you determine the refractive index of a rectangular glass slab?** *(ALP)*

The refractive index n of a medium is the ratio of the speed of light c in air to the speed v of light in the medium:

$$Refractive\ Index = \frac{Speed\ of\ light\ in\ air}{Speed\ of\ light\ in\ medium}$$

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

Refractive Index of Glass Slab:

$$Speed\ of\ light = c = 3 \times 10^8\ ms^{-1}$$

$$Speed\ of\ light\ in\ glass = v = 2 \times 10^8\ ms^{-1}$$

Now by using formula of refractive index

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

$$n = \frac{3 \times 10^8\ ms^{-1}}{2 \times 10^8\ ms^{-1}}$$

$$n = 1.5$$

Note:

Speed of light in air is approximately $3.0 \times 10^8 ms^{-1}$ However, when light travels through a medium, such as water or glass, its speed decreases. The **speed of**

light in water is approximately $2.3 \times 10^8 ms^{-1}$, while **in glass**, it is approximately $2.0 \times 10^8 ms^{-1}$.

****24. What is critical angle? Derive a relationship between the critical angle and the refractive index of a substance.** ***(ALP)***

The angle of incidence that causes the refracted ray in rare medium to bend through 90° is called critical angle.

Relationship Between the Critical Angle and The Refractive Index:

If refractive index of air with respect to glass is n, then refractive index of ray from glass to air is $\frac{1}{n}$.

$$\frac{1}{n} = \frac{\sin \angle i}{\sin \angle r}$$

$$n = \frac{\sin \angle r}{\sin \angle i}$$

For critical angle $\angle r = 90^\circ$ and $\angle i = \angle c$, so

$$n = \frac{\sin 90^\circ}{\sin \angle c}$$

$$n = \frac{1}{\sin \angle c}$$

$$\sin \angle c = \frac{1}{n}$$

****25. What is meant by the term total internal reflection?** ***(ALP)***

When the value of angle of incidence becomes greater than the critical angle, then the ray does not enter into the second medium, but reflects back in the same medium such reflection is called total internal reflection.

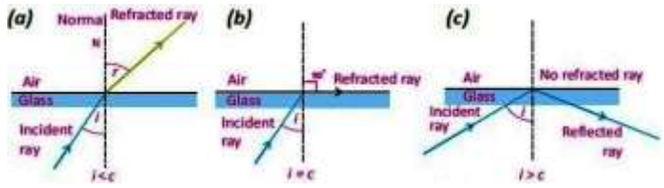
****26. Write the conditions for total internal reflection.** ***(ALP)***

(i) The ray should be travel through denser medium to rare medium.

(ii) The angle of incidence should be greater than the critical angle, i.e $\angle i > \angle c$

Explanation:

- When a ray of light travelling in denser medium enters into a rarer medium, it bends away from the normal (Fig. a). If the angle of incidence i increases, the angle of refraction r also increases.
- For a particular value of the angle of o incidence, the angle of refraction becomes 90°. The angle of incidence, that causes the refracted ray in the rarer medium to bend through 90° is called **critical angle** (Fig. b).
- When the angle of incidence becomes larger than the critical angle, no refraction occurs. The entire light is reflected back into the denser medium (Fig. c). This is known as **total internal reflection of light**.



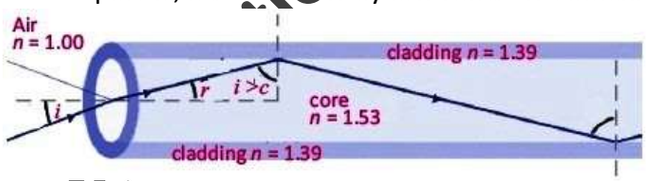
****27. What are optical fibres? Describe how total internal reflection is used in light propagating through optical fibres.**

Optical Fibre: Fibre optics consists of hair size threads of glass or plastic through which light can be travelled. Total internal reflection is used in fibre optics which has number of advantages in telecommunication field.

Parts of optical Fibre:

(i) Core: The inner part of the fibre optics is called core that carries the light is called core. The core is made from glass or plastic of relatively high index of refraction.

(ii) Cladding: An outer concentric shell is called cladding. The cladding is made of glass or plastic, but of relatively low refractive index.



Working: Light entering from one end of the core strikes the core-cladding boundary at an angle of incidence greater than critical angle and is reflected back into the core. In this way light travels many kilometers with small loss of energy.

Uses: In Pakistan, optical fibre is being used in telephone and advanced telecommunication systems. Now we can listen thousands of phone calls without any disturbance.

***28. What is difference between core and cladding?**

Core: The inner part of the fibre optics is called core that carries the light is called core. The core is made from glass or plastic of relatively high index of refraction.

Cladding: An outer concentric shell is called cladding. The cladding is made of glass or plastic, but of relatively low refractive index.

***29. What is light pipe? Also write its uses.**

Light pipe is a bundle of thousands of optical fibres bounded together.

- Light pipe are used to illuminate the inaccessible places by the doctors or engineers. For example, doctors view inside the human body.
- Light pipe can also be used to transmit images from one place to another.

***30. What is meant by endoscope? Also write different types of endoscope.**

An endoscope is a medical instrument used for exploratory diagnostics, and surgical purposes.

Types: Bronchoscope, Gastroscope and Cystoscope.

***31. What are the types of endoscope?**

Bronchoscope: The endoscope which is used to examine the throat is called bronchoscope.

Gastroscope: The endoscope which is used to examine the stomach is called gastroscope.

Cystoscope: The endoscope which is used to examine the bladder is called cystooscope.

32. Define endoscopy.

A medical procedure using any type of endoscope is called endoscopy.

***33. Define prism.** *(ALP)*

Prism is a transparent object (made of optical glass) with at least two polished plane faces inclined towards each other from which light is refracted.

***34. Define lens also give uses.** *(ALP)*

Lesn: A lens is any transparent material having two surfaces, of which at least one is curved.

Uses: Lenses of many different types are used in optical devices such as cameras, eyeglasses, microscopes, telescopes, and projectors.

****35. What are the types of lens?** *(ALP)*

Lenses are classified into two categories

(i) Convex (Converging) Lens

(ii) Concave (Diverging) Lens

Convex (Converging) Lens: The lens which causes incident parallel rays to converge at a point is known as convex or converging lens.

Shape: This lens is thick at the centre but thin at the edges.

Concave (Diverging) Lens: The lens which causes the parallel rays of light to diverge from a point is called concave or diverging lens.

Shape: This lens is thin at the centre and thick at the edges.

****36. Define the following terms applied to a lens: (i) principal axis (ii) optical center (iii) focal length** *(ALP)*

Principal Axis: Each of the two surfaces of a spherical lens is a section of a sphere. The line passing through the two centers of curvatures of the lens is called principal axis.

Optical Center: A point on the principal axis at the center of lens is called optical center.

Focal Length: This is the distance between the optical center and the principal focus.

****37. What is meant by the principal focus of a (a) convex lens (b) concave lens?** *(ALP)*

Principal Focus for Convex Lens: The light rays travelling parallel to the principal axis of a convex lens after refraction meet at a point on the principal axis, called principal focus or focal point F. hence convex lens is also called **converging lens**.

Principal Focus for Concave Lens: For a concave lens, the parallel rays appear to come from a point behind the lens called principal focus F. Hence concave lens is also called **diverging lens**.

38. Define Lens formula. *(ALP)*

The relation between the object and image distance from the lens in terms of the focal length of the lens is called lens formula.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$$

****39. Define power of lens also write its formula and SI unit.**

Power of a lens is defined as the reciprocal of its focal length in meters. Thus

$$Power\ of\ lens = \frac{1}{focal\ lenght\ in\ metres}$$

SI Unit: The SI unit of power of a lens is "Dioptre", denoted by a symbol D. If f is expressed in metres so that

$$1D = 1m^{-1}$$

Thus, 1 Dioptre is the power of a lens whose focal length is 1 metre.

***40. The power of a convex lens is $5\ D$.Find its focal length.**

Given Data

$$Power\ of\ lens = P = 5\ D$$

To Find

$$Focal\ length = f = ?$$

Solution

By using formula of power

$$P = \frac{1}{f\ (in\ meters)}$$

$$5D = \frac{1}{f}$$

$$f = \frac{1}{5D}$$

$$f = \frac{1}{5m^{-1}} \qquad \because 1D = 1m^{-1}$$

$$f = \frac{1}{5}m$$

$$f = 0.2\ m$$

$$f = 0.2 \times 100\ cm$$

$$\boldsymbol{f = 20\ cm}$$

41. What are the parts of simple camera? Explain the working of simple camera.

A simple camera consists of a light-proof box with a converging lens in front and a light sensitive plate or film at the back.

The lens focuses images to be photographed onto the film. In simple lens camera, the distance between lens and film is fixed which is equal to the focal length of the lens. In camera, object is placed beyond 2F. A real, inverted and diminished image is formed in this way.

***42. Define simple microscope.**

A magnifying glass is a convex lens which is used to produce magnified images of small objects. Hence, it is also called simple microscope.

Object Position: The object is placed nearer to the lens than the principal focus such that an upright, virtual and magnified image is seen clearly at $25cm$ from the normal eye.

****43. Define the terms resolving power and magnifying power.**

Resolving Power: The resolving power of an instrument is its ability to distinguish between two closely placed objects or point sources.

Magnifying Power: It is the ratio of angular size of final image produced by magnifying glass to the angular size of object seen without magnifying glass.

$$M = \frac{Angular\ size\ of\ final\ image\ produced\ by\ magnifying\ glass}{Angular\ size\ of\ object\ seen\ without\ \ magnifying\ glass}$$

$$M = \frac{\theta'}{\theta}$$

44. Define compound microscope and give its features.

Compound microscope has two converging lenses, the objective and the eyepiece and is used to investigate structure of small objects. Following are some features of compound microscope:

- **(i)** It gives greater magnification than a single lens.
- **(ii)** The objective lens has a short focal length, $f_o < 1\ cm$.
- **(iii)** The eyepiece has a focal length, f_e of a few cm.

45. Write any two uses of compound microscope.

- A compound microscope is used to study bacteria and other micro objects.
- It is also used for research in several fields of sciences like, Microbiology, Botany, Geology, and Genetics.

46. Define telescope.

Telescope is an optical instrument which is used to observe distant objects using lenses or mirrors. A telescope that uses two converging lenses is called refracting telescope.

47. Define retina, cornea, iris, and pupil.

Retina: Retina is a light sensitive layer at the back of the eye. The eye lens forms an image on the retina.

Cornea: Light enters the eye through a transparent membrane called the cornea.

Iris: The iris is the coloured portion of the eye and controls the amount of light reaching the retina.

Pupil: Iris has an opening at its centre called the pupil.

***48. Define accommodation.**

The variation of focal length of eye lens to form a sharp image on retina is called accommodation.

****49. What is difference between near point and far point?**

Near Point: The near point of the eye is the minimum distance of an object from the eye at which it produces a sharp image on the retina.

Far Point: The far point of the eye is the maximum distance of a distant object from the eye on which the fully relaxed eye can focus.

****50. Define defect of vision. Also define its types.**

Defect of Vision: The inability of the eye to see the image of objects clearly is called defect of vision. There are two types of defect of vision.

- **(i)** Nearsightedness (myopia)
- **(ii)** Farsightedness (hypermetropia)

(i) Nearsightedness (myopia): The disability of the eye to form distinct images of distant objects on its retina is known as nearsightedness.

(ii) Farsightedness (hypermetropia): The disability of the eye to form distinct images of nearby objects on its retina is known as farsightedness.

***51. How nearsightedness happens and can be corrected?**

Nearsightedness may be due to the eyeball being too long. Light rays from a distant object are focused in front of the retina and a blurred image is produced.

Correction: The nearsighted eye can be corrected with glass or contact lenses that use diverging lenses. Light rays from the distant objects will diverge by this lens before entering the eye.

***52. How farsightedness happens and can be corrected?**

Farsightedness may be due to the eyeball becomes thin or the eyeball becomes too short. Due to this effect the image of the near object is formed beyond the retina. That is why the near object appears blurred in farsightedness.

Correction: This defects can be corrected with the aid of a suitable converging lens. The lens refracts the light

rays more towards the principal axis before they enter the eye.

53. Mention the magnifying powers of the following optical instruments: (i) simple microscope (ii) compound microscope (iii) refracting telescope

(i) Simple Microscope: $M = 1 + \frac{d}{f}$

(ii) Compound Microscope: $M = \frac{L}{f_o}\left(1 + \frac{d}{f_e}\right)$

(iii) Refracting Telescope: $M = \frac{f_o}{f_e}$

54. Why or why not concave mirrors are suitable for make up?

Concave mirrors are suitable for make up because when a person stands between the principal focus and the pole of a concave mirror, he/she sees on enlarged, erected and virtual image which reveals the mirror features of his/her face.

55. How does the thickness of lens affect its focal length?

As we know that $f = \frac{R}{2}$ focal length is half of the radius of curvature. Thickness of lens affect the focal length of lens. A thick lens has short focal length and thin has large focal length.

Important Long Questions

(1) State laws of refraction of light describe passage of light through parallel sided transparent material.

(2) What are optical fibres? Describe how total internal reflection is used in light propagation through optical fibers. Also write its uses.

(3) Define total internal reflection. Also write its conditions.

(4) Explain image formation with ray diagrams for objects placed at (i) Beyond $2F$ (ii) at $2F$ (iii) between F and $2F$.

(5) Define simple microscope and drive magnifying power formula.

(6) What is meant by compound microscope? Explain in detail.

(7) What is refracting telescope? Describe working of refracting telescope with ray diagram.

(8) What is telescope? Explain with diagram.

(9) Describe the defects of vision.