RAY OPTICS

1) Explain the image formation in plane mirror

- The image formed by a plane mirror is virtual, erect and laterally inverted.
- The image formed by a plane mirror is at the same distance behind the mirror as the object is in front of it.

2) State the laws of reflection

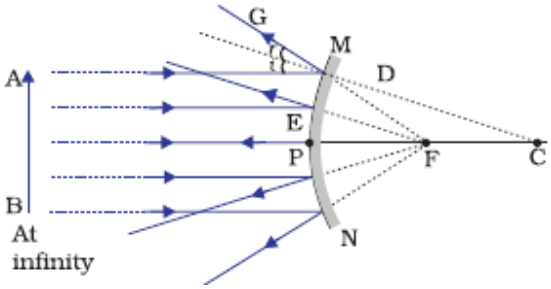
- The angle of incidence is equal to the angle of reflection. *i.e.* $\angle i = \angle r$
- The incident ray, reflected ray and normal to the reflecting surface at the point of incidence are coplanar

3) What are convex and concave mirror?

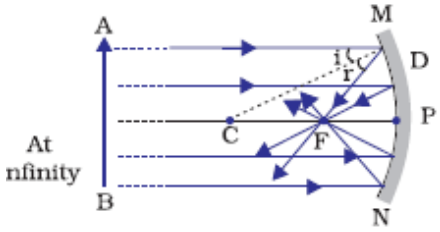
- A spherical mirror, whose reflecting surface is curved inwards, that is, faces towards the centre of the sphere, is called a concave mirror.
- A spherical mirror whose reflecting surface is curved outwards, is called a convex mirror

4) Define focus F of concave mirror and convex mirror

The rays are *paraxial*, i.e., they are incident at points close to the pole P of the mirror and make small angles with the principal axis. The reflected rays converge at a point F on the principal axis of a concave mirror



The rays are *paraxial*, i.e., they are incident at points close to the pole P of the mirror and make small angles with the principal axis. The reflected rays appear to come from a point on the principal axis. This point is called the principal focus of the convex mirror.



5) Define focal length of mirror

The distance between principal focus and pole of the curved mirror is called focal length f

6) **Obtain relation between focal length and radius of curvature of concave and convex mirror**

7) State the rules for the formation of images in curved mirror

(i) A ray parallel to the principal axis, after reflection, will pass through the principal focus in case of a concave mirror or appear to diverge from the principal focus in case of a convex mirror.

ii) A ray passing through the principal focus of a concave mirror or a ray which is directed towards the principal focus of a convex mirror, after reflection, will emerge parallel to the principal axis

iii) A ray passing through the centre of curvature of a concave mirror or directed in the direction of the centre of curvature of a convex mirror, after reflection, is reflected back along the same path. The light rays come back along the same path because the incident rays fall on the mirror along the normal to the reflecting surface.

iv) A ray incident obliquely to the principal axis, towards a point P (pole of the mirror), on the concave mirror or a convex mirror is reflected obliquely. The incident and reflected rays follow

the laws of reflection at the point of incidence (point P), making equal angles with the principal axis.

8) State Cartesian sign convention in curved mirror

- All distances are measured from the pole of the mirror.
- The distances measured in the same direction as the incident light are taken as positive and those measured in the direction opposite to the direction of incident light are taken as negative.
- The heights measured upwards with respect to *x*-axis and normal to the principal axis (*x*-axis) of the mirror/ lens are taken as positive . The heights measured downwards are taken as negative.

9) Obtain an relation between object distance , image distance and focal length of curved mirror with neat diagram

i) Concave mirror real image ii) concave mirror – Virtual image iii) convex mirror – virtual image

10) Obtain magnification of curved mirror in all the above cases

11) What are the uses of concave and convex mirror?

- Concave mirrors are commonly used in torches, search-lights and vehicles headlights to get powerful parallel beams of light.
- They are often used as shaving mirrors to see a larger image of the face. The dentists use concave mirrors to see large images of the teeth of patients.
- Large concave mirrors are used to concentrate sunlight to produce heat in solar furnaces.

- Convex mirrors are commonly used as rear-view (wing) mirrors in vehicles. These mirrors are fitted on the sides of the vehicle, enabling the driver to see traffic behind him/her to facilitate safe driving. Convex mirrors are preferred because they always give an erect, though diminished, image. Also, they have a wider field of view as they are curved outwards. Thus, convex mirrors enable the driver to view much larger area than would be possible with a plane mirror.

REFRACTION OF LIGHT

12) What is refraction of light?

The direction of propagation of an obliquely incident ray of light that enters the other medium, changes at the interface of the two media. This phenomenon is called refraction of light

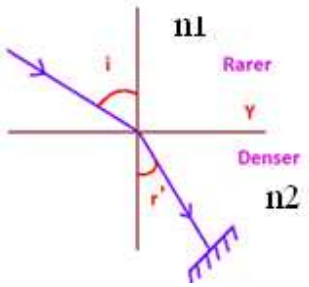
13) State laws of refraction

- The incident ray, the refracted ray and the normal to the interface at the point of incidence, all lie in the same plane.
- (ii) The ratio of the sine of the angle of incidence to the sine of angle of refraction is constant. Remember that the angles of incidence (i) and refraction (r) are the angles that the incident and its refracted ray make with the normal, respectively

$$n_{21} = \frac{\sin i}{\sin r} = \frac{C}{V} = \frac{n_2}{n_1}$$

14) State the law of reversibility

According to this principle, if the path of a ray of light is reversed after suffering reflections and refractions it retraces its path.



When a ray of light go from rarer to denser media

$n_{21} = n_2/n_1 = \sin i / \sin r$ -(1)

But when a mirror is kept normal to the refracted ray retraces its path.

The rays travels from denser to rarer

$n_{12} = n_1/n_2 = \sin r / \sin i$ --2

Eqn 2 becomes $\sin i / \sin r = 1/ n_{12}$ ----(3)

From eqn 1 and 3

we get $n_{21} = 1/n_{12}$

15) How does the ray bend when it moves from i) denser to rarer ii) rarer to denser medium? Justify your answer [HOMEWORK]

16) Is there any relation between mass density and optical density? Explain [Home work]

17) Draw a ray diagram to show the incident and emergent ray are parallel in rectangular glass slab and also derive an expression for lateral displacement?

18) How will the lateral displacement and lateral shift change when i) thickness of the slab increases? [HOMEWORK]

19) On what factors the lateral shift depends on?

Thickness of the slab, angle of incident , refractive index of the material of slab and colour of light used

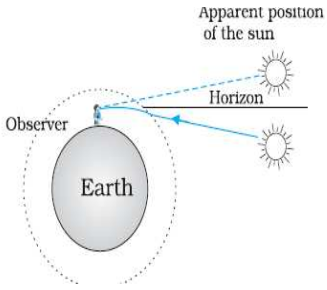
20) i)What is apparent depth? Obtain relation between apparent depth, real depth and refractive index of material of liquid. Derive an expression for the distance through which object appears to be seen

ii) How will the appaerent depth change when i) refractive index of the medium (denser) increases ii) refractive index of the surrounding medium increases iii) wavelength of light used increases? Justify your answer

iii) Which colour of light seen nearer to the surface of the liquid? Blue or red light?

21) What is the reason for early sunrise and delayed sunset?

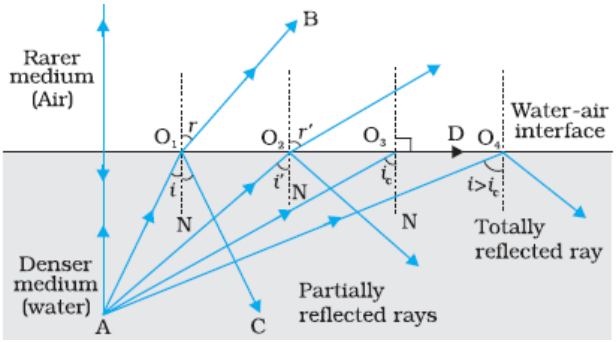
- The refraction of light through the atmosphere.
- For example, the sun is visible a little before the actual sunrise and until a little after the actual sunset due to refraction of light through the atmosphere shown inFig. By actual sunrise we mean the actual crossing of the horizon by the sun. Figure shows the actual and apparent positions of the sun with respect to the horizon.. The refractive index of air with respect to vacuum is 1.00029. Due to this, the apparent shift in the direction of the sun is by about half a degree and the corresponding time difference between actual sunset and apparent sunset is about 2 minutes



22) What is the reason for apparent flattening of sun during sun rise and sunset?
The refraction of light through the atmosphere
23) The earth takes 24 h to rotate once about its axis. How much time does the sun take to shift by ½ ° when viewed from the earth? [HOMEWORK]

TOTAL INTERNAL REFLECTION

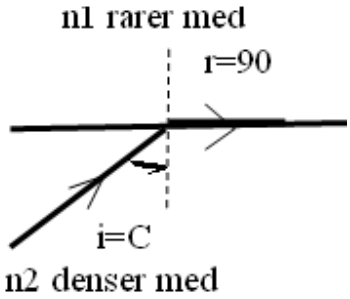
24) Explain the phenomena TIR with diagram



A ray of light travels from denser to rarer medium. When the ray incident normally, it goes undeviated.
When a ray incident at angle i, part of the light gets reflected and parts get refracted away from the normal. As the angle of incident increases, angle of refraction also increases. At a particular angle of incident C(critical angle) the refracted ray just glances the interface the separating the two media. If the angle if incident increases further, all the ray gets reflected into the same medium. This phenomenon is called total internal reflection.

25) What is TIR?
The phenomenon of reflection of light when a ray of light travelling from a denser to rarer medium is sent back to the same denser medium completely provided it strikes the interface of the denser & rarer media at an angle greater than the critical angle.

26) Define critical angle and obtain relation between critical angle and refractive index of the media



Critical angle is the angle of incident of light ray travels from denser to rarer at which angle of reflection is 90 °
From snells law

$$n_{12} = \frac{\sin i}{\sin r};$$

$$Sub\, i = C\, then\, r = 90$$

$$n_{12} = \frac{\sin C}{\sin 90} = SinC$$

$$n_{21} = \frac{1}{n_{12}} = \frac{1}{\sin C} = \frac{V_1}{V_2}$$

where V_1 and V_2 are the speed of light in rarer med and denser med respectively.

27) How will the critical angle change when i) refractive index of the medium (denser) increases ii) refractive index of the surrounding medium increases iii) wavelength of light used increases? Justify your answer

28) Under what condition the snell's law is not valid?

Reference

******Substance medium Refractive index Critical angle**

Water	1.33	48.75°
Crown glass	1.52	41.14°
Diamond	2.42	24.41

29) Explain the optical illusion mirage

30) Draw a suitable ray diagram using prism to get image which is rotated by i) 90 ° ii) 180 ° two times TIR iii) 180 ° one time TIR

31) Explain the phenomenon brilliance of diamond

32) Why suitable cut glass will glitter but suitably cut diamond will glitter?

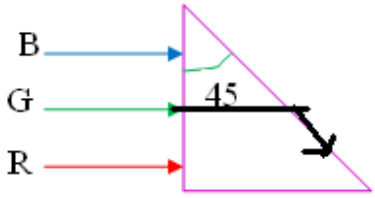
33) Explain the working principle of optical fibre with diagram. Give two uses.

34) Explain how an optical fibre can be used to act as an optical pipe

35) What is the main requirement in fabricating optical fibres?

question no 29 to 35 Refer NCERT page no :321 to 323

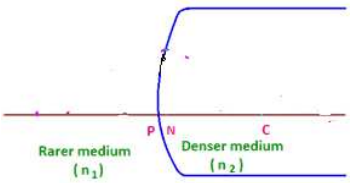
36) Complete the ray diagram

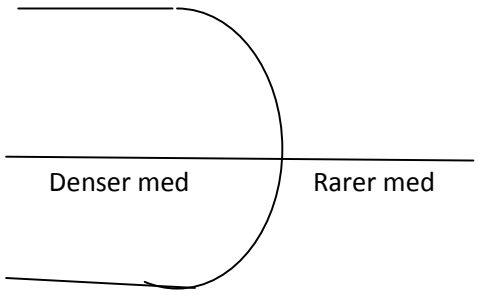


SPHERICAL REFRACTING SURFCAE

37) What is concave spherical refracting surface?

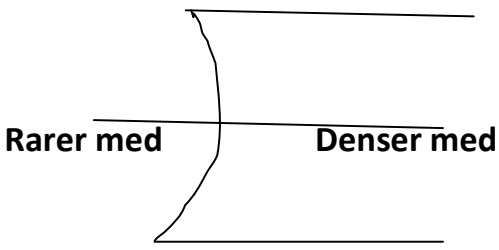
A spherical refracting surface in which concave surface facing towards rarer medium





38) What is convex spherical refracting surface?

A spherical refracting surface in which convex surface is facing towards rarer medium.



39) Write the assumption used in the derivation of SRS?

(1) The aperture of the spherical refracting surface is small.
(2) The object is a point object and lies on the principal axis
(3) The incident ray, the refracted ray and the normal to the spherical surface make small angles with the principal axis.

40) What is the Sign Conventions used in SRS?

(1) All distances are measured from the pole of the spherical refracting surface.
(2) The distances measured in the direction of incident light is taken as +ve& the distances measured opposite to the direction of incident light is taken as –ve.

41) Obtain relation relating object distance, image distance , radius of curvature and refractive indices for a medium when a ray travels from rarer to denser in CONVEX S R S

42) Obtain relation relating object distance, virtual image distance , radius of curvature and refractive indices for a medium when a ray travels from rarer to denser in CONCAVE S R S

43) Obtain relation relating object distance, image distance , radius of curvature and refractive indices for a medium when a ray travels from denser to rarer in CONVEX S R S

44) Derive lens makers formula fro CONVEX LENS with neat ray diagram

45) Derive lens makers formula fro CONCVAE LENS with neat ray diagram

LENS

46) Define focus of convex lens and concave lens

- Several rays of light parallel to the principal axis are falling on a convex lens. These rays, after refraction from the lens, are converging to a point on the principal axis. This point on the principal axis is called the principal focus of the lens
- Several rays of light parallel to the principal axis are falling on a concave lens. These rays, after refraction from the lens, are appearing to diverge from a point on the principal axis. This point on the principal axis is called the principal focus of the concave lens.
- Distance between focus and optic centre of the lens is called focal length of lens

47) State the rules for the formation of images in lens

- A ray of light from the object, parallel to the principal axis, after refraction from a convex lens, passes through the principal focus on the other side of the lens, in case of a concave lens, the ray appears to diverge from the principal focus located on the same side of the lens
- A ray of light passing through a principal focus, after refraction from a convex lens, will emerge parallel to the principal axis. A ray of light appearing to meet at the principal focus of a concave lens, after refraction, will emerge parallel to the principal axis.
- A ray of light passing through the optical centre of a lens will emerge without any deviation

48) Write the sign convention used in thin lens formula

- All measurements are taken from the optical centre of the lens
- All measurement of distances in the direction of incident is taken as positive and in the opposite direction is taken as negative

- If the measurement of height is above principal axis, taken as positive and below the principle it is taken as negative

49) Derive an expression for the thin lens formula for convex lens real image

50) Derive an expression for the thin lens formula for convex lens virtual image [Home work]

51) Derive an expression for the thin lens formula for concave lens virtual image

52) Obtain an expression for the linear magnification of convex lens real image

53) **Obtain an expression for the linear magnification of convex lens virtual image [Home work]**

54) **Obtain an expression for the linear magnification of concave lens virtual image [Home work]**

55) How will the focal length of convex lens change when

i) Refractive index of the lens increases ii) refractive index of surrounding medium slightly increases iii) Thickness of lens increases iv) Blue colour of light is replaced by red light V) Lens is cut into two equal halves normal to principal axis Vi) Lens is cut into two equal halves parallel to principal axis Justify your answer

56) Complete the ray diagram

i) A parallel beam of light is incident on Convex lens of refractive index n_1 is placed in a medium of refractive index n_2 if i) $n_1 > n_2$ ii) $n_1 < n_2$ iii) $n_1 = n_2$

ii) **A parallel beam of light is incident on Concave lens of refractive index n_2 is placed in a medium of refractive index n_1 if i) $n_1 > n_2$ ii) $n_1 < n_2$ iii) $n_1 = n_2$**

57) Define power of lens and obtain an expression for it

58) Define SI unit of power of lens

59) What is the power of convex lens of focal length 20cm and concave lens of focal length 40cm

60) How will you express lens makers formula interms of power [Home work]

61) Obtain an expression for the combination of lenses in contact with ray diagram

62) Two lenses one if convex of focal length f_1 and other one is concave lens of focal length f_2 are in contact. Give an expression for focal of combination of theses two lenses. How does the combination behave if $f_1 > f_2$

63) How will you find the net power and net magnification of lenses in contact?

64) Why do you want to combine the lenses in contact?

- Combination of lenses helps to obtain diverging or converging lenses of desired magnification.
- It also enhances sharpness of the image.
- It makes the final image erect
- It reduces certain aberration

65) What is the use of combination of lenses in contact?

In designing lenses for cameras, microscopes, telescopes and other optical instruments