**Chapter – 9 Ray Optics and Optical Instruments**

**Reflection And Refraction Of Light At Plane Surfaces**

(i) The focal length and radius of curvature of a plane mirror are infinite. This means that the **power of a plane mirror is zero.**

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

(iii) The magnification of a plane mirror is 1, i.e., size of the image = size of the object.

(iv) The image is as far behind the mirror as the source is in front of it.

(v) The left side of the object appears as the right side of the image (i.e., lateral inversion or perversion).

(vi) If the object moves with speed **u** towards a fixed mirror, the image also moves towards the mirror with speed a. The speed of the image relative to the object in this case is **2u**.

(vii) If the mirror moves with speed **u** towards or away from a fixed object, then the image appears to move towards or away from the object with speed **2u**.

(viii) If the mirror moves away or towards an object by a distance d, then the image moves away or towards the object by a distance 2d.

(ix) When the plane mirror is rotated through a certain angle, the reflected ray turns through double the angle.

(x) On reflection from a plane mirror, a ray is deviated through an angle δ= (180 - 2i) where i is the angle of incidence. If α is the glancing angle (i.e., angle between the plane mirror and the incident ray), then the deviation on reflection δ =2α.

(xi) When two plane mirrors are kept facing each other at an angle θ and an object is placed between them, multiple images of the object are formed as a result of multiple successive reflections.

(a) If (360/θ) is an even integer, then the number of images (n) is given by: **n = (360/θ) – 1**

(b) If (360/θ) is an odd integer, then the number of images (n) is decided according to the following two situations:

(I) If the object lies symmetrically, then n: (360/θ) -1

(II) If the object lies asymmetrically, then n = (360/θ)

(c) When two plane mirrors are placed parallel to each other, then n = (360/Zero) = ∞

(xii) On reflection, the velocity, wavelength and frequency of light do not change. But **amplitude or intensity** of the reflected ray is less than that of incident ray.

(xiii) (a) Reflection from a smooth plane surface is called regular reflection. In this type of reflection, a beam of parallel rays is reflected as a beam of parallel rays.

(b) Reflection from a rough plane surface is called irregular reflection. In this type of reflection, a beam of parallel rays gets diffused on reflection.

(xiv) Reflection from a denser medium causes a phase difference of π.

(xv) (a) *The minimum size of the mirror required to see full size image of oneself is equal to half the height of the observer.*

(b) The minimum size of the mirror required to be fixed on the wall of a room, so that an observer in the middle of the room can see full image of wall behind him is **one-third of the height of the wall**.

4. **Refraction of light:**

(i) The ratio of the sine of the angle of incidence to the sine of the angle of refraction is a constant whose value depends on the nature of the two mediums. This is called as **Snell's law**. According to this law,

sin i/sin r = v1/v2 = n2/n1 = 1n2

(ii) If the medium 1 is vacuum, then v1 = c and the index of refraction of the medium w.r.t. the vacuum is:

n = c/v ;It is also called absolute refractive index.

(iii)*The frequency of a light wave remains unchanged as it passes across the boundary separating two mediums*, because there are the same number of wavefronts passing from medium I into medium 2.

(iv) Because the speed of light is different in different mediums and frequency remains unchanged on passing from one medium to other, hence wavelength of light gets changed with change in medium. The relation is:

λmed  = λair/n

*Thus, when a light ray from a rarer medium is refracted into a denser medium, its velocity decreases and wavelength decreases but the frequency does not change.*

(v) If a ray lies along the normal, then angle of incidence i is equal to zero and hence the angle of refraction r

must also be zero and there is no deviation of this ray.

(vi) The deviation of the incident ray when it is refracted is represented by an angle δ = i - r

(vii) For air n =1.0003 which may be taken as 1.Therefore, when light passes from air into any transparent solid the refractive index is always > 1.

(viii) The refractive index of medium 2 with respect to medium 1 is given by: n2/n1 = 1n2

(ix) The value of refractive index depends on:

(a) nature of media of incidence and refraction, (b) temperature of the medium, and

(c) wavelength or colour of light.

(x) *Refractive index is independent of the angle of incidence.*

(xi) Refractive index decreases with increase in temperature.

(xii) When the medium is same on both sides of a glass slab, then the deviation of the emergent ray is zero

That is the emergent ray goes parallel to the incident ray and

*lateral displacement of the emergent ray = t sin(i –r)/cosr* where t is the thickness of the slab.

(xiii) **Cauchy's formula**: The refractive index of a material depends on the wavelength of light according

to the relation:

n=A + B /λ2 (where A and B are constants)

This relation is known as Cauchy's formula According to this formula, **nred <nyellow < nviolet**

(xiv) According to principle of reversibility of light, 1 /2n1 = 1n2

(xv) If we know the refractive index of two media w.r.t air, then we can always write: 1n2 =an2/an1

e.g.,if ang and anw are the refractive indices of glass and water w.r.t. air respectively, then refractive index of glass w.r.t. water is: wng =ang/anw

5. **Real and apparent depth**:

(i) When one looks into a pool of water, it does not appear to be as deep as it really is. Also when one looks into a slab of glass, the material does not appear to be as thick as it really is. This all happen due to refraction of light.

(ii) If a beaker is filled with water and a point lying at its bottom is observed by someone located in air, then the bottom point appears raised. The apparent depth tap is less than the actual depth tac.lt can be shown that apparent depth (tap ) = actual depth (tac)/ refractive index (n)

(iii) If there is an ink spot at the bottom of a glass slab, it appears to be raised by a distance

d=tap - tac =t – t/n = t( 1 -1/n)

where t is the thickness of the glass slab and n is its refractive index.

(iv) If a beaker is filled with immiscible transparent liquids of refractive indices n1, n2 & n3 and individual depth d1, d2, d3 respectively, then the apparent depth of the beaker is found to be:

tap = d1/n1 +d2/n2 +d3/n3

6.**Total internal reflection:**

(i) For the phenomenon of total internal reflection to take place, it is necessary that:

(a) a light ray must travel from a denser medium to a rarer medium, and

(b) the angle of incidence in the denser medium must be greater the **critical angle** for the given two media.

(ii) The critical angle is that angle of incidence for which the angle of refraction becomes 900. It is given by

sin ic = 1/1n2 = 1/rnd

If the rarer medium is air or vacuum, then sin ic = 1/n

(iii) When i>ic, then there is no refraction of light and the ray of light is totally internally reflected.

(iv) **Critical angle for red light is more than that for blue light**.

(v) Critical angle increases with the increase in temperature of the medium.

(vi) Critical angle depends on:(a) nature of medium, (b) temperature of medium, and (c) wavelength of light.

(vii) Air bubbles in glass appear silvery white due to total internal reflection

(viii) A diver in water at a depth *d* sees the world outside through a horizontal circle of radius

*r =d tanic = d/ √(n2-1)*

(ix) The brilliance of diamond is due to the phenomenon of total internal reflection.

(x) Mirages in deserts are also due to refraction and total internal reflection.

(xi) The critical angle for water-air interface is 490. A fish under water could observe the things above the water surface within an angular ring of 980.

(xii) *The working of optical fibre is based on the phenomenon of total internal reflection.*

7. **Optical fibre:**

(i) It is a glass fibre through which light is transmitted by total internal reflections from one end to the other

end.

(ii) An optical fibre may be between 0.01 mm and 0.002 mm in diameter and may be used in bundles with the same relative positions at both the ends. It is also called as light pipe.

(iii) For working of the optical fibre, the angle of incidence should be according to following relation:

sin i ≤ √(n22 –n12) ;

where n1 is the refractive index of the material used for cladding of the pipe and n2 is the refractive index of the core of the pipe.

(iv) Optical fibres are used in the field of communications and computers for transmitting and receiving signals converted into light pulses. They also have medical uses such as in Endoscopy.

**Reflection And Refraction of Light at Spherical Surfaces (Mirrors and Lenses)**

Mirror formula for all spherical mirrors 1/u +1/v =2/R =1/f

-The convex mirror always forms a diminished and erect image, irrespective of the position of the object. Because of this, it is used as a rear view mirror

-**Magnification due to a mirror**

- Transverse or linear magnification m is defined as m= size of image/size of object

m = -v/u = f/(f-u) = (f-v)/u

-longitudinal magnification is given by mlong = -v2/u2

**Spherical refracting surface:**

μ2/v - μ1/u = (μ2- μ1)/R This formula is applicable for convex as well as concave spherical curved surfaces.

Lens Maker's formula and thin lens formula:

1/f = 1/v -1/u = (1μ2 -1) ( 1/r1 - 1/r2)

Linear magnification due to a lens: m = v/u = f/(f+u) = (f-v)/f

Equivalent focal length of two thin lenses in contact: 1/f =1/f1 +1/f2 +1/f3



The power of the combination of two lenses in contact P =P1 + P2

-If two thin lenses are *separated by a small distance d*, then the focal length of the combination is

1/f =1/f1 +1/f2 - d/f1f2

**Silvering a lens on one side:**

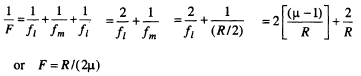
(i) When one surface of a thin lens is silvered, then the focal length F of effective lens is expressed as:

1/F = Σ 1/f1 where f1 is the focal length of the lens or mirror to be repeated as many times as the refraction or reflection respectively is repeated.

(ii) **Focal length of plano-convex lens when silvered at its plane surface(fig 24.4):** When an object is placed infront of such a lens, the rays is first of all refracted from the convex surface, then reflected from the polished plane surface and again refracts out from convex surface. If fL and fm be the focal lengths of lens (convex surface) and mirror (plane polished surface) respectively, then effective focal length of the lens F is given by:

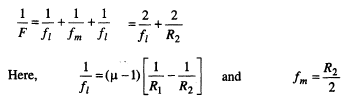


(iii)**Focal length of plano-convex lens when silvered at convex surface(fig 24.5)**. In this case





(iv) **Focal length of convex lens whose convex surface of radius R2 is silvered(fig 24.6)** : In this case, first the light will pass through the lens and it will form the image I1; then the image I1 will act as an object for silvered surface which acts as a curved mirror and forms an image I2 of object I1; finally the light after reflection from the silvered surface will again pass through the lens and the lens will form final image I3 of object I2.



**Some more important points about lenses:**

(i) When a lens is kept in a medium other than air, then

where μm, is the refractive index of the medium in which lens is placed.



where fm is the focal length of the lens in medium and fa is the focal length of lens in air.

(a) When a lens is placed in a medium for which μ is less than that of the lens, its focal length increases and power decreases. The nature of the lens remains unchanged.

(b) When the lens is placed in a medium for which μ is equal to that of the lens, the focal length of the lens becomes infinity and power becomes zero. The lens behaves like a plane glass plate.

(c) When the lens is placed in a medium for which μ is greater than that of the lens, the nature of the lens changes. (Air bubble in water behaves as a divergent lens.)

(ii) *When a lens of focal length f is cut into two equal halves perpendicular to principal axis, then each part of the lens has a focal length 2f.*

(iii)When a lens of focal length f is cut into two equal halves parallel to principal axis, then each part has a focal length f. The intensity of image is decreased.

(iv) (a) If a plano-convex lens of focal length f is silvered on the plane surface, it behaves like a concave mirror of focal length f/2.

(b) When a plano-convex lens of focal length f is silvered at convex surface, it behaves like a convex mirror.

**Focal length of convex lens by displacement method:**

(i) When the distance between object and screen is greater than 4f , then there are two positions of the lens for which the image of the object on the screen is distinct and clear. In these two positions of lens, the distances of object and image from the lens are interchanged.

(ii) Here, I1 and I2 are the lengths of images in first and second position of lens L.O is the length of the object.

In first position of lens,m1= v/u= I1/O

In second position, the magnification of the lens is given by: ,

m2 = u/v =I2/O

therefore m1m2 = I1I2/O2 = 1 or O = √(I1I2)

(iii) Further, m1/m2 = v2/u2 ; from figure u + x + u =d or u = (d-x) /2

According to sign convention, u = - (d-x) /2 ; similarly v = d –u = (d+x)/2

using lens formula 1/v – 1/u = 1/f ; we get f = (d2 –x2)/4d

**Dispersion of Light And Chromatic Aberration**

Refraction through a **prism**:

(i) A prism is a homogeneous, transparent medium bounded by two plane surfaces inclined at an angle A with each other. These surfaces are called as the refracting surfaces and the angle between them is called as the angle of prism (A).

(ii) Figure 25.1 shows the refraction of monochromatic light through a prism. Here, i and e represent the angle of incidence and angle of emergence respectively. r1 and r2 are two angles of refraction. If μ is the refractive index of the material of the prism,

then μ = sin i /sin r1 = sin e /sin r2

(iii) The angle between the incident ray and the emergent ray is known as the angle of deviation δ. For refraction through a prism it is found that

*i + e = A + δ and r1 +r2 = A*

(iv)Important point: ***If sin r2 ≥ 1/μ , then the ray will be totally internally reflected at the second refracting surface.*** For A = 600 and μ = 1.5, if i <280, total internal reflection will occur at face AC and then δ will be meaningless

(v) **Minimum angle of deviation (δm):** When the angle of incidence i in a prism is increased, the value of angle of deviation δ first decreases and then increases. The minimum value of deviation is called the angle of minimum deviation. This situation arises when i=e, i.e., **at the point of minimum deviation, the light ray passes symmetrically through the prism and r1 = r2.**

(vi) **Refractive index**: In the position of minimum deviation, as i = e, hence i =(A +δm )/ 2 and because r1 = r2 = r, hence r = A/2. Therefore, the refractive index of the material of the prism is

(vii) If the refracting angle of the prism is small, then the angles, i.e.,r1 and r2, will also be small and we may write

μ = (i/r1) and μ = (e/r2) or i + e = μ (r1 +r2) or A + δ = μ A or **δ = (μ -1 )A**

**The deviation is therefore independent of the angle of incidence and depends on the refractive angle of the prism and the refractive index for monochromatic light. For small angle A, δ will also be small and δm =(μ - 1)A.**

(viii) **Some other important facts regarding prism:**

(a) The refracted ray inside a prism bends towards the base.

(b) In minimum deviation position, the refracted ray inside a prism is parallel to the base and the ray passes symmetrically through the prism.

(c) For minimum deviation by a prism, the angle of incidence must be 900 (grazing incidence).

(d) In equilateral prism (A = 600 ), when the ray suffers minimum deviation, r1 = r2 =300.

(e) If angle of prism A is greater than twice the critical angle (i.e., 2C ) of glass of which the prism is made, then there will be no emergent ray. The angle A is then called as the **limiting angle of prism.**

**(f)** When a ray of light is to emerge grazingly at the second surface of the prism,the angle of incidence at the first surface should be **Limiting angle of Incidence.** For limiting angle of incidence

ilim= sinA [ √ (µ2-1) ] -cosA



**Dispersion of light:**

(i) When a ray of white light passes through a prism, it gets split into rays of constituent colours or wavelengths. This phenomenon of separation of white light into its component colours is called as the dispersion of light.

(ii) *Dispersion occurs because the refractive index is not strictly constant for a particular material but rather varies slightly with the wavelength of light*. For example, μ of crown glass is l.51 for red light (7000A); whereas it is 1.53 for violet light (4000A), i.e., μ decreases with the increase of wavelength. The band of colours obtained as a result of dispersion of white light is known as a **spectrum**.

(iii) For small angled prism, δred =(μred -1)A and δviolet =(μviolet -l)A. Because μv > μr, it implies that δv >δr. *The violet colour suffers greater deviation in comparison to red.* For the seven colours of VIBGYOR, δ is maximum for violet colour but minimum for red colour.

(iv) **Angular dispersion** (θ): It is defined as the difference in deviations suffered by the two extreme colours, i.e., red and violet. Hence, θ = δv - δr = (μv - μr)A

(v) **Dispersive power** (*w*): The ratio of angular dispersion between two colours to the deviation of mean ray (i.e., ray of yellow colour) produced by a prism is called as the dispersive power of the material of the prism for those colours.

Dispersive power, w = θ /δy = (δv - δr )/δy = (μv - μr) /(μy -1 )

(a) *For small A, the dispersive power depends on the material of the prism only but not on the angle of prism*.

(b) *w* can be greater than or equal to zero but cannot be less than zero. It is zero for vacuum, nearly equal to zero for air and greater than zero for all other refracting media.

**Deviation without dispersion:**

(i) Two prisms of different materials (one made of crown glass and other made of flint glass) and different angles (Ac and AF) can be combined in such a manner that no dispersion takes place although the incident beam may be deviated. This can be achieved by keeping two prisms of different materials in opposite manner (crossed prisms).

(ii) The condition for deviation without dispersion is that net dispersion should be zero, i.e.,

θc +θF =0 or (μCV - μCR)AC + (μFV - μFR)AF  = 0 or AC = - (μFV - μFR)AF/(μCV - μCR)

The minus sign indicates that the prism must be placed in opposite manner.

(iii) Above condition can also be written as follows in terms of dispersive powers:

*w*C δcy + *w*F δFy =0 or *w*C / *w*F = δFy/δcy

i.e., for no dispersion the materials and the angles of the two prisms should be so chosen that their dispersive powers are in the inverse ratio of the deviations suffered by mean light through them.

**Dispersion without deviation:**

(i) Two prisms of different materials and different angles can be combined in such a manner that the net deviation of the incident rays becomes zero, but net dispersion is not zero. This happens by using two prisms of different materials (i.e., one made of crown glass and other of flint glass) in opposite manner.

(ii) The condition for dispersion without deviation is : δF +δC =0 or AF(μF -1) + AC (μC -1) =0

or AC = - AF(μF -1) /(μC -1)

Because μF > μC, AF < AC, i.e., angle of prism for crown glass should be more.

(iii) The net angular dispersion is found to be: θ =AC(μC -1)(*w*C –*w*F)

As *w*C < *w*F the net angular dispersion is negative. This shows that the order of the colours in the spectrum is ,reversed.

**Some important facts about spectrum and spectrometer:**

(i) Pure spectrum: The coloured pattern obtained on the screen after dispersion of light is called spectrum. If there is no overlapping of colours in the spectrum, it is called a pure spectrum.

(ii) Impure spectrum: If various colours in the spectrum mix with one another, it is called an impure spectrum.

(iii) To obtain pure spectrum, one needs the following arrangement:

(a) a source of light in the form of a narrow slit.

(b) a convex lens for making the incident beam, a beam of parallel rays.

(c) a prism in the position of minimum deviation.

(d) another convex lens for focussing the emergent rays.

(iv) Two main types of spectrum are: (a) Emission spectrum; (b) Absorption spectrum.

(v) Emission (or absorption) spectrum is of three types:

(a) Continuous spectrum: It consists of a wide range of un separated wavelengths. Dense hot gases and while hot solids give continuous spectrum. The sun emits a continuous spectrum.

(b) Line spectrum: This spectrum consists of sharp lines of definite wavelengths. Substances in atomic state (sodium vapour lamp, mercury vapour lamp, gases in discharge tubes) give line spectrum.

(c) Band spectrum: This spectrum consists of bright bands each having a sharp edge. Incandescent vapours in the molecular state, calcium or barium salts in the Bunsen burner flame, nitrogen in molecular state in vacuum tube give band spectra.

(vi) According to Kirchhoff’s law, any substance at a lower temperature will absorb the radiations of those wavelengths which it will emit when excited.

(viii) The range of visible spectrum is from 4200A, to 7800 A.

**Chromatic aberration in a lens:**

(i) What is chromatic aberration? The inability of a lens to form a white and distinct image of a white object is called chromatic aberration

(ii) The chromatic aberration arises due to variation of focal length f of a lens with refractive index μ as given ahead:

1/f = (μ -1) (1/R1 -1/R2)

Now, as μ changes with wavelength λ, in accordance with Cauchy's equation, μ = A +B/λ2 and λR >λV

Hence, μV > μR and fV <fR

Hence, for a white object, images of different colours are formed at different places and are of different sizes. These defects are called longitudinal chromatic aberration and lateral chromatic aberration respectively.

(iii) **Longitudinal chromatic aberration**: It is given by the axial distance between the red and violet images and is equal to (Vr -Vv).It is given by:

Vr -Vv = *wv*2/f

where *w* = dispersive power, Vr = distance of the red image , Vv = distance of the violet image and *v* = mean distance of the yellow image.

- If the object is at infinity, Vr =fr, Vv =fv and *v* = f. So, fr - fv =*w*f2/f = *w*f

Because for a lens, neither *w* nor f is zero, hence fr - fv can never be equal to zero, i.e., a single lens cannot give an image free from chromatic aberration.

(iv) **Lateral chromatic aberration**: The formation of images of different colours in different sizes gives rise to lateral chromatic aberration. This is given by the difference in the sizes of the images of red and violet colours.

IR-IV= vRO/u - vVO/u = (vR –vV)O/u = *wv*2.O/uf

**Achromatism:**

(i) The phenomenon of removing the longitudinal and lateral chromatic aberrations in the image formed by a lens is called as achromatism. The combination of lenses free from chromatic aberrations is called an achromatic combination.

(ii) Two thin lenses of focal lengths f1 and f2 and of materials of dispersive powers *w*1 and *w*2 placed in contact form an achromatic combination if,

*w*1/f1 +*w*2/f2 =0 or *w*1P1 +*w*2P2 =0

(iii) In order to obtain an achromatic combination of two lenses, following four requirements are essential.

(a) One lens must be convex, the other must be concave.

(b) The two lenses must be made of different materials.

(c) Power of convex lens must be greater than that of concave lens.

(d) Convex lens must be made of crown glass while concave lens of flint glass.

(iv) Two thin lenses of same material and focal lengths f1 and f2 form an achromatic combination when the

separation d between them is:

d =(f1 +f2 )/2

Rainbow:

(i) A rainbow is observed during or after a light drizzle.

(ii) The common rainbow is made of a number of concentric coloured arcs with concave side violet and convex side red. The centres of circular arcs lie along the line joining the sun and the observer but on the opposite side of the sun. It is formed due to two refractions and one total internal reflection of light falling on the raindrops.

(iii) Sometimes an additional rainbow is also observed. It is concentric with the first one but has larger size with colours in reverse order, i.e., violet being on the convex side and red on the concave side. This is called **secondary** rainbow. The secondary rainbow is less intense than the primary rainbow. The secondary rainbow is formed due to two refractions and two internal reflections of light falling on raindrops.

(iv) The primary rainbow has an angular width of 20 at an average angle of elevation of 410 from the axis of the bow but the secondary rainbow has an angular width of 3.50 at an average elevation of 52.750.

(v) The primary rainbow is visible only when the altitude of the sun is less than 420. However, if the sun's elevation is greater than 420, the primary rainbow is never observed but the secondary rainbow may still be observed if sun's elevation is less than 530.

(vi) A complete rainbow can be seen while flying in an aeroplane at higher altitudes.

**Scattering of light:**

(i) Rayleigh scattering: When light waves are scattered from smaller bodies whose size is smaller than the wavelength of light, the scattered radiation has the same wavelength as the incident radiation in all directions. However, the intensity of scattered radiation is inversely proportional to the fourth power of the wavelength of the incident wave. When white light from the sun passes through the earth's atmosphere, blue colour is scattered far more than red, hence the sky appears blue. As blue is removed from direct white light from the sun, the transmitted light is poorer in blue, i.e., is left richer in red. So, morning sun appears red.

**Human Eye and optical Instruments**

1. **Human eye:**

(i) The ability of eye to adjust the convexity of its lens with a view to focussing the objects at different distances, on the retina, is called as its *power of accommodation*.

(ii) For a normal eye, (a) near point or least distance of distinct vision (D) =25 cm and (b) far point = ∞.

(iii) Maximum refraction takes place at the cornea. In twilight, eye is most sensitive to bluish-green region. In broad day-light, eye is most sensitive to greenish-yellow region.

2. **Defects of vision**:

(i) **Myopia**: In myopia or near-sightedness, the patient can see the near objects but not the far objects. In order to calculate the focal length of the correcting lens, u = - ∞ and v = - (distance of the far point from the defective eye). *Hence, the defect is corrected by using a concave lens.*

(ii) **Hypemetropia**: In hypermetropia or longsightedness, the patient can see far objects clearly but not the near objects. In order to calculate the focal length of the correcting lens, u= -25 cm and v = - (near point of defective eye). Hence, the defect is corrected by using a convex lens.

(iii) Presbyopia: In presbyopia, the patient can neither see the near objects nor the far objects clearly. This is due to decrease in the compressibility of the eye lens with advancing age. This leads to a gradual decrease in the power of accommodation. This defect is corrected with the use of bifocal lenses.

(iv) Astigmatism: In astigmatism, the cornea, the refracting surface in front of the eye, has widely varying curvatures in different planes; the rays from an object in one plane are brought to focus by the eye in another plane. This is corrected with the use of cylindrical or spherocylindrical lenses.

**Simple microscope:**

(i) A simple microscope is a double convex lens of small focal length. The object is placed between the lens and its principal focus.

(ii) Magnifying power, M = (angle subtended by image at the eye)/angle subtended by the object at the eye

or M = tanβ/tanα = β/α

(where both the object and image are situated at the least distance of distinct vision.)



(iii)If an object is kept at a distance u from a convex lens and the image is formed at least distance of distinct vision D, then magnifying power,

m =(D/u)

(iv)Magnifying power when the image is formed at the least distance of distinct vision is:

M = 1+D/f

(v)Magnifying power when the image is formed at infinity (far point adjustment):

M =D/f

(vi)The magnifying power of a lens of power P dioptre is: M =l + 0.25P

(vii) If the eye is kept at a distance *x* from the lens, then M =1+ (D-*x*)/f

(viii) The image formed by a simple microscope is virtual, erect, magnified and is formed on the same side of

the object.

(ix) The magnification of a simple microscope is less than 20.

(x) To increase the magnification of a simple microscope, a lens of shorter focal length should be used.

(xi) Its magnifying power decreases when immersed in water (due to decrease in focal length).

**Compound microscope:**

(i) A compound microscope consists of an objective of small focal length fo, and small aperture and an eye-piece of comparatively larger focal length fe, and larger aperture.

(ii) Magnification of the compound microscope, M =mo x me = (vo/uo) x (-D/ue)

for distinct vision M = (vo/uo) x ( 1+ D/fe)



(iii) Also,

where uo and vo represent the distance of the object and the image from the objective.

(iv) When the final image is formed at infinity M=LD/fofe (approximately) where L is the length of the microscope.

(v) (a) In near point adjustment, length of the compound microscope is: L =vo + ue.

(b) In normal adjustment, length of the compound microscope is: L= vo + fe. .

(vi) In compound microscope, the eye-piece behaves as the simple microscope.

(vii) The object lies in between F and 2F of the objective.

(viii) The image formed by the objective is real, inverted and magnified with respect to the object.

(ix) The final image is virtual, inverted and magnified with respect to the object.

(x) For greater magnification, the focal length of the objective and eye-piece must be small and distance between them must be large.

(xi) Magnification upto 200 can be obtained from a compound microscope.

(xii) Compound microscope is mainly used in biological laboratories.

**Astronomical telescope:**

(i) An astronomical telescope consists of an objective of convex lens of long focal length fo and large aperture and an eye-piece of small focal length fe, and small aperture.

(ii) General formula for the magnifying power M of a telescope is given by: M = vo/ue

(a) For normal vision: M = - fo/fe

(b) For distinct vision: M = - (fo/fe )(1 +fe/D)

(iii) (a) In near point adjustment, length of the telescope, L = vo +ue

(b) In normal adjustment, length of the telescope, L=fo +fe

(iv) The image formed by the objective is real, inverted, point size and lies on the focal plane of the objective.

(v) The final image is virtual, inverted and appears to be magnified, because the object is seen nearer which increases the visual angle.

(vi) The magnifying power of a telescope M implies that the distant object seen through the telescope is at a distance (1/m)th of the original distance.

(vii) The eye-piece behaves as a simple microscope.

(viii) Telescope is used to observe astronomical bodies like sun, star, moon and planets where inversion of the image makes no difference.

**Terrestrial telescope:**

(i) If the telescope is in near point adjustment, magnifying power, M = -(fo/fe )(1 +fe/D)

Length of the telescope, L =fo + 4f + ue, where f is the focal length of the erecting lens.

(ii) If the telescope is in far point adjustment, magnifying power, M =- fo/fe

Length of the telescope L=fo + 4f + fe

(iii) In addition to the objective and eye-piece, terrestrial telescope contains another convex lens of very small focal length f. This lens is called the erecting lens.

(iv) fo > fe >f

(v) The magnification of the erecting lens is equal to l.

(vi) The erecting lens makes the inverted image formed by the objective to be erect without changing the magnification.

(vii) The final image is virtual, erect and appears to be magnified.

**Galileo's terrestrial telescope:**

(i) It consists of an objective which is a convex lens of large focal length and an eye-piece which is a concave lens of short focal length (fo>fe).

(ii) The final image is virtual, erect and appears to be magnified.

(iii) If the image is formed at the least distance of distinct vision, then magnifying power,

M = (fo/fe )(1 - fe/D) ; Length of the telescope L =fo - ue

(iv) In the normal adjustment, magnifying power, m= fo/fe, and length of the telescope, L =fo -fe.

**Newton's reflecting telescope:**

(i) The objective is a concave mirror of large focal length and the eye-piece is a convex lens of short focal length.

(ii) Reflecting telescopes are free from chromatic aberrations because light does not undergo refraction.

(iii) By using paraboloidal mirrors, spherical aberrations can be eliminated in reflecting telescopes.

(iv) Image formed in this telescope is more bright as the loss of intensity of light is less in reflection than in refraction

**Photometry and Velocity of Light**

1. Photometry: The branch of physics which deals with the measurements of power of emitting light energy of a light source and illumination produced on the surface, is called as photometry.

2. Radiant flux: The amount of visible and invisible radiant energy emitted per second by a light source is called radiant flux. The unit of radiant flux is watt and dimensions are [ML2T-3] ,

3. Luminous flux: The visible radiant energy emitted per second by a light source is called luminous flux. This is also known as photometric power. The unit of luminous flux F is lumen and dimensions are [ML2T-3].

4. Solid angle:

(i) Solid angle is defined as normal area divided by the square of the distance,

i.e.,Solid angle = normal area/(distance)2

(ii) The unit of solid angle is steradian. One steradian is the solid angle subtended by a part of the surface of a sphere at the centre of the sphere, when the area of the part is equal to the square of the radius of the sphere.

(iii) The surface area of a sphere is 4πr2. Hence, the solid angle subtended by the whole sphere at its centre is: *w* = 4πr2/r2 =4π

(iv) If θ be the angle between positive direction of normal at spherical surface and distance r, then

∆*w* = ∆Acosθ/r2

Luminous intensity of source:

(i) The luminous intensity I of a light source in any direction is defined as the luminous flux emitted by the source in unit solid angle in that direction

Mathematically, I =∆F/∆*w* - 1

where ∆F is the luminous flux emitted by light source in solid angle ∆*w*.

(ii) The unit of the luminous intensity is lumen/steradian. This is also called as candela.

l candela=1 lumen/1 steradian

(iii) As ∆F = I∆*w* hence total flux F for an isotropic source is given by: F = Σ∆F = ΣI ∆*w*

(for an isotropic source, the luminous flux is uniform in all directions).

As Σ ∆*w* = total solid angle for all directions = 4π,therefore F =4Iπ - 2

6. Efficiency of light source: It is defined as follows:

Efficiency = output/input = luminous flux emitted /power consumed in watt

The unit of efficiency is lumen per watt. When power consumption of one watt results in emission of 685 lumens, then the luminous efficiency is said to be 100 per cent.

7. Illuminance or brightness of a surface:

(i) Illuminance E is defined as the luminous flux falling per unit area of the surface. Mathematically, the source in unit solid angle in Mathematically,

E =∆F/∆A -3

(ii) The unit of illuminance E is lumen/metre2. This is also called lux in MKS system. If a luminous flux of 1 lumen is falling on an area of 1metre2 of a surface, then the illuminance of that surface will be 1 lux.

(iii) If we divide eqn. (3) by eqn. (1), we get; E/I =∆*w*/∆A

But ∆*w* = (∆A cosθ)/r2 ;therefore E/I = cosθ/r2 or E = I cosθ/r2

Above law is called **Lambert's cosine law** (where θ is the angle of incidence and r is the distance of the source from the screen).

(iv) The unit of E is candela /metre2 in MKS, lux in SI and candela/cm2 in CGS.

One (candela/cm2 ) = one phot

and One (candela/metre2 ) = one lux

1 lux =10-4 phot

8.Luminance of a surface: Luminance of a surface represents the luminous flux reflected by a unit area of the surface.

Luminance = illuminance x reflection coefficient

**Home Assignment- Ray Optics**

1. Write the Laws of Reflection ?
2. What are the properties of image formed by a plane mirror ?
3. Write the formula for number of images formed when two plane mirrors are held at an angle θ with each other ?
4. Define the radius of curvature and principal focus of convex mirror ?
5. With the help of a diagram explain different sign conventions for optics ?
6. Write different rules for behaviour of light in case of convex mirror ?
7. Write the full table along with ray diagrams for different cases of position of object for concave and convex mirror ?
8. What are different uses of concave & convex mirror ?
9. Derive relation between focal length and radius of curvature ?
10. Derive mirror formula and formula for magnification for mirrors ?
11. Write relation between the speed of the object and speed of the image formed by a spherical mirror?
12. An object is placed at (i) 10 cm, (ii) 5 cm in front of a concave mirror of radius of curvature 15 cm. Find the position, nature, and magnification of the image in each case. (v= -30cm , m=-3 ; v =-15cm ,m=3 – ncert solved)
13. Suppose while sitting in a parked car, you notice a jogger approaching towards you in the side view mirror of *R* = 2 m. If the jogger is running at a speed of 5 m/s, how fast the image of the jogger appear to move when the jogger is (a) 39 m, (b) 29 m, (c) 19 m, and (d) 9 m away. (ncert solved)
14. Name the mirrors for the following cases ; m=1 , m= -1 & m always <1 ?
15. A convex mirror used for rear-view on an automobile has a radius of curvature of 3.00 m. If a bus is located at 5.00 m from this mirror, find the position, nature and size of the image. (v= 1.15 cm , m= 0.23 , virtual, erect and smaller in size by a factor of 0.23.)
16. An object, 4.0 cm in size, is placed at 25.0 cm in front of a concave mirror of focal length 15.0 cm. At what distance from the mirror should a screen be placed in order to obtain a sharp image? Find the nature and the size of the image.( *v* = – 37.5 cm , *h*′ = – 6.0 cm , image is inverted and enlarged.)
17. Write different laws of refraction ?
18. What do you mean by optical density ?
19. Draw and label different angles and rays for refraction thru a plane glass slab ?
20. Prove that angle of incidence is equal to angle of emergence in refraction thru plane glass slab ?
21. Write a relation between the apparent depth and real depth?
22. Explain the reason of early sunrise and delayed sunset?
23. Define *total internal reflection & critical angle ?*
24. Name some effects caused due to *total internal reflection* in day to day life?
25. Define the radius of curvature and principal focus of concave lens ?
26. Why does there are two focii for a convex lens whereas there is only one for convex mirror ?
27. Derive relation between u,v & R for refraction taking place from medium 1 (*n*1) to medium 2(*n*2) ?
28. Derive lens formula ?
29. Write the full table along with ray diagrams for different cases of position of object for concave and convex lens ?
30. A concave lens has focal length of 15 cm. At what distance should the object from the lens be placed so that it forms an image at 10 cm from the lens? Also, find the magnification produced by the lens.( u =-30 cm ,m=0.33)
31. A 2.0 cm tall object is placed perpendicular to the principal axis of a convex lens of focal length 10 cm. The distance of the object from the lens is 15 cm. Find the nature, position and size of the image. Also find its magnification. (*v* = + 30 cm , *h*′ = – 4.0 cm ,m= -2)
32. Define & derive a relation for the power of a lens ?
33. Define 1 Dioptre ?
34. What is relationship for the equivalent power and magnification of a combination of lenses ?
35. Write expression for Newton’s relation to find position of images by displacement method (Conjugate points)
36. Derive relation **δ = (*i1* + *i2)* – *A or δ = i + e – A*** for refraction thru a prism?
37. What do you mean by angle of minimum deviation?
38. Derive relation **δ = (µ-1) A**for refraction thru a thin prism?
39. Define dispersion ? Also elaborate the reason for this phenomenon ?
40. Write Cauchy’s formula?
41. Define and write an expression for angular dispersion?
42. Define and write an expression for Dispersive power?
43. Write Rayleigh’s Law of scattering?
44. What do you mean by Raman effect?
45. Explain with the help of a ray diagram the formation of rainbow ?
46. Explain the following phenomenon : Blue of the sky , Red sun in morning and evening .
47. With the help of a labelled diagram explain in brief different parts of human eye ?
48. Define power of Accommodation , near point & far point of human eye ?
49. Define stereopsis ?
50. Explain different eye defects alongwith their cause and rectification using a neat ray diagram
51. Light from a point source in air falls on a spherical glass surface (*n* = 1.5 and radius of curvature = 20 cm). The distance of the light source from the glass surface is 100 cm. At what position the image is formed? (ncert solved )
52. A magician during a show makes a glass lens with *n* = 1.47 disappear in a trough of liquid. What is the refractive index of the liquid? Could the liquid be water? (ncert solved)
53. . (i) If *f* = 0.5 m for a glass lens, what is the power of the lens? (ii) The radii of curvature of the faces of a double convex lens are 10 cm and 15 cm. Its focal length is 12 cm. What is the refractive index of glass? (iii) A convex lens has 20 cm focal length in air. What is focal length in water? (Refractive index of air-water = 1.33, refractive index for air-glass = 1.5.) (ncert solved)
54. What focal length should the reading spectacles have for a person for whom the least distance of distinct vision is 50 cm? (ncert solved)
55. .(a) The far point of a myopic person is 80 cm in front of the eye. What is the power of the lens required to enable him to see very distant objects clearly?

(b) In what way does the corrective lens help the above person? Does the lens magnify very distant objects? Explain carefully.

(c) The above person prefers to remove his spectacles while reading a book. Explain why? (ncert solved)

1. Derive an expression for the magnification produced by a simple microscope for different positions of the image ?
2. What do you mean by a compound microscope ?Derive an expression for magnification produced by it ?
3. What is the difference between the objective and eyepiece for a compound microscope and a telescope ?
4. What is the magnification of a simple astronomical telescope ?
5. What are the main considerations of an astronomical telescope?
6. Draw a neat labelled diagram of Cassegrain reflecting telescope ?
7. What are the advantages of Cassegrain reflecting telescope over normal refracting telescope ?
8. Double-convex lenses are to be manufactured from a glass of refractive index 1.55, with both faces of the same radius of curvature. What is the radius of curvature required if the focal length is to be 20cm? (ncert)
9. A compound microscope consists of an objective lens of focal length 2.0cm and an eyepiece of focal length 6.25cm separated by a distance of 15cm. How far from the objective should an object be placed in order to obtain the final image at (a) the least distance of distinct vision (25cm), and (b) at infinity? What is the magnifying power of the microscope in each case? (ncert unsolved)
10. A small telescope has an objective lens of focal length 144cm and an eyepiece of focal length 6.0cm. What is the magnifying power of the telescope? What is the separation between the objective and the eyepiece? (ncert)
11. A screen is placed 90cm from an object. The image of the object on the screen is formed by a convex lens at two different locations separated by 20cm. Determine the focal length of the lens. (ncert unsolved)
12. An angular magnification (magnifying power) of 30X is desired using an objective of focal length 1.25cm and an eyepiece of focal length 5cm. How will you set up the compound microscope? (ncert unsolved)

**Questions from Exemplar :**

1. Will the focal length of a lens for red light be more, same or less than that for blue light?
2. The near vision of an average person is 25cm. To view an object with an angular magnification of 10, what should be the power of the microscope?
3. Three immiscible liquids of densities *d*1 > *d*2 > *d*3 and refractive indices μ1 > μ2 > μ3 are put in a beaker. The height of each liquid column is *h/*3. A dot is made at the bottom of the beaker. For near normal vision, find the apparent depth of the dot.
4. A myopic adult has a far point at 0.1 m. His power of accommodation is 4 diopters. (i) What power lenses are required to see distant objects? (ii) What is his near point without glasses? (iii) What is his near point with glasses? (Take the image distance from the lens of the eye to the retina to be 2 cm.)

**Objective Questions**

**Reflection And Refraction Of Light At Plane Surfaces**

1. When light travels from glass to air, the incident angle is θ1 and the refracted angle is θ2. The true relation is : (a) θ1 =θ2 (b) θ1 < θ2 (c) θ1 > θ2 (d) not predictable

2. When a ray of light enters a glass slab from air:

(a) its wavelength decreases (b) its wavelength increases

(c) its frequency increases (d) neither wavelength nor frequency changes

3. A clock hung on a wall has marks instead of numerals on its dial. On the adjoining wall, there is a plane mirror and the image of the clock in the mirror indicates the time 7:10.Then the time on the clock is:

(a) 7.10 (b) 4.50 (c) 5.40 (d) 10.7

4. A plane glass slab is kept over various coloured letters; the letter which appears least raised is:

(a) blue (b) violet (c) green (d) red

5. How many images will be formed if two mirrors are fitted on adjacent walls and one mirror on roof?

(a) 2 (b) 5 (c) 7 (d) 10

6. A ray of light from a denser medium strikes a rarer medium at an angle of incidence i. If the angle of reflection is r and the angle of refraction is r' and the reflected and refracted rays make an angle of 900 with each other, then the critical angle will be

(a) sin-1(tan r) (b) sin-1(tan r' ) (c) tan -1(sin r) (d) tan-1(sin r')

7. The wavelength of light diminishes μ times in the medium. A diver from inside water (μ = 1.33) looks at an object whose natural colour is green. He sees the object as:(a) green (b) blue (c) yellow (d) red

8. Air has refractive index of 1.0003. The thickness of air column, which will have one more wavelength of yellow light (6000 A0) than in the same thickness of vacuum is: (a)2mm (b)2cm (c)2m (d) 0.2 mm

9.A ray of light travelling inside a rectangular glass block of refractive index √2 is incident on the glass-air interface at an angle of incidence of 450. The refractive index of air is one. Under these conditions the ray:

(a) will emerge into the air without any deviation (b) will be reflected back into glass

(c) will be absorbed (d) will emerge into the air with an angle of refraction equal to 900

10. The critical angle for light going from medium *x* into medium y is θ. The speed of light in medium *x* is v. The speed of light in medium y is : (a) v(1-cosθ) (b)v/sinθ (c)v/cosθ (d) vcosθ

11. Monochromatic light of wavelength 1,1 travelling in a medium of refractive index nl enters a denser medium of refractive index n2.The wavelength in the second medium IS:

(a) λ1n1/n2 (b) λ1n2/n1 (c) λ1(n2-n1)/n2 (d) λ1(n2-n1)/n1

12. When seen in green light, the saffron and green portions of our national flag will appear to be:

(a) black (b) black and green respectively (c) green (d) green and yellow respectively

13. Light travels through a glass plate of thickness t and having refractive index μ. If c be the velocity of light in vacuum, the time taken by the light to travel this thickness of glass is

(a) t/μc (b) tμc (c) μt/c (d) tc/μ

14. If es and lro tre the electric permittivity and the magnetic permeability in a free space, e and p are the corresponding quantities in the medium, the index of refraction of the medium is :

(a) [∈oμ/∈μo]½ (b) [∈/∈o]½ (c) [∈oμo/∈μ]½ (d) [∈μ/∈oμo]½

15. A perfectly reflecting mirror has an area of 1cm2. Light energy is allowed to fall on it for one hour at the rate of 10 W/cm2. The force that acts on the mirror is

(a) 3.35 x 10-8 N (b) 6.7 x 10-8 N (c) 1.34 x l0-7 N (d) 2.4x 10-4 N

16. A point source of light is placed 4 m below the surface of water of refractive index 5/3. The minimum diameter of a disc, which should be placed over the source, on the surface of water to cut-off all light coming out of water is : (a) 1m (b) 4m (c) 3m (d) 6m

17. A transparent cube of 15 cm edge contains a small air bubble. Its apparent depth when viewed through one face is 6 cm and when viewed through the opposite-face is 4 cm. Then the refractive index of the material of prism is : (a) 2 (b) 1.5 (c) 1.6 (d) 2.5

18. The wavelength of red light from He-Ne laser is 633 nm in air but 474 nm in the aqueous humor inside the eye ball. Then the speed of red light through the aqueous humor is

(a)3 x 108 m/s (b) 1.34 x 108 m/s (c) 2.25 x 108 m/s (d) 2.5 x 108 m/s (e) 2.75 x 108 m/s

19. A point source of light is kept at a depth of h in water of refractive index 4/3.The radius of the circle at the surface of water through which light emits is : (a) 3h/√7 (b) h√7/3 (c) h√3/7 (d) 7h/√3



20. A light beam is travelling from Region I to Region IV (refer figure 23.22). The refractive index in Region I, II, III and IV are n0, n0/2 ,n0/6 and n0/8 respectively. The angle of incidence θ for which the beam just misses entering region IV is :(a) sin-1(3/4) (b) sin-1(1/8 ) (c) sin -1(1/4) (d) sin-1(1/3)

21. A ray reflected successively from two plane mirrors inclined at a certain angle undergoes a deviation of 2400. Then, the number of images observable is: (a) 3 (b) 5 (c) 7 (d) 9

22.A ball is dropped from a height of 20 m above the surface of water in a lake. The refractive index of water is 4/3. A fish inside the lake, in the line of fall of the ball, is looking at the ball. At an instant, when the ball is 12.8 m above the water surface, the fish sees the speed of ball as: [IIT2009]

(a)9 m/s (b) 12 m/s (c) 16 m/s (d) 21.33 m/s



23. A transparent solid cylinder rod has a refractive index of 2/√3.It is surrounded by air. Alight ray is incident at the mid point of one end of the rod as shown in the fig(23.23).The incident angle θ for which the light ray grazes along the wall of the rod is : (a) sin-1(½) (b) sin-1(√3/2) (c) sin -1(2/√3) (d) sin-1(1/√3)

24. A ray of light is incident on a surface of glass slab at an angle of 450. If the lateral shift produced per unit thickness is 1/√3 m, the angle of refraction produced is:

(a) tan-1(√3/2) (b) tan -1[1- √(2/3)] (c) sin -1[1- √(2/3)] (d) tan -1 [2/(√3 -1)]½

25. Monochromatic light of wavelength 589 nm is incident from air on a water surface. The refractive index of water is 1.33. The wavelength of the refracted light is: (a) 589 nm (b) 443 nm (c) 333 nm (d) 221 nm

26. If a transparent parallel plate of uniform thickness t and refractive index μ is interposed perpendicularly in the path of a light beam, the optical path is:

(a) increased by (μ -1)t (b) decreased by μt (c) decreased by (μ -1)t (d) increased by μt

27. Two mirrors at an angle θ produce 5 images of a point. The number of images produced when θ is decreased to θ -300 is : (a) 9 (b) 10 (c) 1l (d) 12

28. A ray of light strikes a transparent rectangular slab (of refractive index √2) at an angle of incidence of 450. The angle between the reflected and refracted rays is: (a) 750 (b) 900 (c) 1050 (d) 1200

29. The speed of light in media M1 and M2 are l.5 x 108 m/s and 2.0 x 108 m/s respectively. A ray of light enters from medium M1 to M2 at an incidence angle i. If the ray suffers total internal reflection, the value of i is: (a) equal to sin-1(⅔) (b) equal to or less sin-1(3/5)

(c) equal to or greater than sin-1(¾) (d) less than sin-1(⅔)

30. An object moving at a speed of 5 m/s towards a concave n mirror of focal length f =l m, is at a distance of 9 m. The average speed of the image is: (a)1/5 m/s (b) 0.1 m/s (c) 5/9 m/s (d) 0.4 m/s

31. A vessel of depth *x* is half-filled with oil of refractive index μ1 and the other half is filled with water of refractive index μ2. The apparent depth of the vessel when viewed from above is :



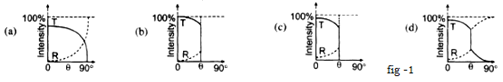
32.A ,B & C are the parallel sided transparent media of refractive index n1,n2 & n3 respectively. They are arranged as shown in the fig 23.24. A ray is incident at an angle θ on the surface of separation of A and B which is as shown in the figure. After the refraction into the medium B, the ray grazes the surface of separation of the media B and C. Then sinθ is equal to:

(a)n3/n1 (b) n1/n3 (c) n2/n3 (d) n1/n2

33. A boat has green light of wavelength λ = 500 nm on the mast. What wavelength would be measured and what colour would be observed for this light as seen by a diver submerged in water by the side of the boat? (Given nw = 4/3) : (a) Green of wavelength 376 nm (b) Red of wavelength 665 nm

(c) Green of wavelength 500 nm (d) Blue of wavelength 376 nm

34. A light ray travelling in a glass medium is incident on glass-air interface at an angle of incidence θ. The reflected(R) and transmitted (T) intensities, both as function of θ are plotted (fig -1). The correct figure is: (IIT 2011)



35. Let the x-y plane be the boundary between two transparent media. Medium 1 in z ≥ 0 has a refractive index of √2 and medium 2 with z<0 has a refractive index of √3. A ray of light in medium I given by the vector **A** = 6√3 **i** + 8√3 **j** -10 **k** is incident on the plane of separation. The angle of refraction in medium 2, is:

(AIEEE 20ll) (a) 300 (b) 450  (c) 600 (d) 750

36. Light travels in two media A and B with speeds of 1.8 x108 m/s and 2.4 x108 m/s respectively. Then the

critical angle between them, is: (a) sin-1(2/3) (b) tan-1(¾) (c) tan -1(2/3) (d) sin-1(¾) (e) sin-1(¼)

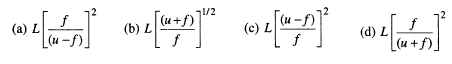
**Reflection And Refraction of Light at Spherical Surfaces (Mirrors and Lenses)**

37. A concave mirror of focal length *f* produces an image n times the size of the object. If the image is real, then the distance of the object from the mirror is :

(a) (n -1) f (b) [(n-1)/n]f (c) [(n+1)/n]f (d)(n+1)f

38. A convex mirror of focal length f produces an image (l/n)th of the size of the object. The distance of the object from the mirror is: (a) nf (b) f/n (c) (n+1)f (d)(n-1)f

39. A short linear object of length L lies on the axis of a spherical mirror of focal length f at a distance u from the mirror. Its image has an axial length L' equal to:



40. A thin convergent glass lens (μg =1.5) has a power of +5.0 D. When this lens is immersed in a liquid of refractive index μ1 it acts as a divergent lens of focal length 100 cm. The value of μ1 must be:

(a) 4/3 (b) 5/3 (c) 5/4 (d) 6/5

41.A lens behaves as a converging lens in air and a diverging lens in water. The refractive index of the material is:(a) equal to unity (b) equal to 1.33

(c) between unity and 1.33 (d) greater than 1.33

42. The sun (diameter = D) subtends an angle of θ radians at the pole of a concave mirror of focal length f. The diameter of the image of the sun formed by the mirror is:

(a) *f* θ (b) 2 *f* θ (c) *f2* θ/D (d) Dθ

43. A double convex lens of focal length 6 cm is made of glass of refractive index 1.5. The radius of curvature of one surface is double that of the other surface. The value of smaller radius of curvature is:

(a) 6 cm (b) 4.5 cm (c) 9 cm (d) 4 cm

44.A thin lens has focal length *f* and its aperture has diameter d. It forms an image of intensity I. Now, the central part of the aperture upto diameter (d/2) is blocked by an opaque paper. The focal length and image intensity will change to: (a) *f/*2 and (I/2) (b) *f* and (I/4) (c) 3*f/*4 and (I/2) (d) *f* and (3I/4)

45. Diameter of a plano-convex lens is 6 cm and thickness at the centre is 3 mm. If the speed of light in the material of the lens is 2 x 108 m/s, the focal length of the lens is: (a) 15 cm (b) 20 cm (c) 30 cm (d) 10 cm

46. A luminous point is moving at speed vo towards a spherical mirror, along its axis. Then the speed at which the image of this point object is moving is given by: (with R = radius of curvature and u = object distance): (a) *vi = -vo* (b) *vi = -voR*/(2u-R) (c) *vi = -vo* (2u-R) / *R* (d) *vi = -voR2*/(2u-R)2

47. A square object of area 100 sq. cm is placed perpendicular to the principal axis of a concave mirror. If the lateral magnification of the mirror, for the above object position, is 0.4, then the area of the image will be:

(a) 16 sq. cm (b) 40 sq. cm (c) 100 sq. cm (d) 250 sq. cm



48. An equiconvex glass lens has a focal length *f* and power P. It is cut into two symmetrical halves by a plane containing the principal axis. The two pieces are recombined as shown in fig 24.8(iii).The power of the new combination is (a) P (b) P/2 (c) 2P (d) zero

49. Given aμg = 3/2 and aμw = 4/3.There is an equiconvex lens with radius of each surface equal to 20cm.There is air in the object space and water in the image space. The focal length of lens is : (a) 80 cm (b) 40 cm (c) 20 cm (d) 10 cm

50. A real image is formed by a convex lens. If we put it in contact with a concave lens and the combination again forms a real image, which of the following is true for the new image from the combination?

(a) Shifts towards the lens system (b) Shifts away from the lens system

(c) Remains at the original position (d) No image is formed

51. Focal length of a convex lens will be maximum for:

(a) blue light (b) yellow light (c) green light (d) red light

52. A concave mirror of focal length f in air is used in a medium of refractive index 2. What will be the focal length of the mirror in the medium? (a) 4f (b) 2f (c) f/2 (d) none of these

53. A luminous object is placed at a distance of 30 cm from a convex lens of focal length 20 cm. On the other side of the lens, at what distance from the lens must a convex mirror of radius of curvature 10 cm be placed in order to have an upright image of the object coincident with it?

(a) 12 cm (b) 30 cm (c) 50 cm (d) 60 cm

54. The far-point of a short-sighted eye is 200 cm. The power of the lens is:

(a) -0.5 D (b) 2 D (c)l D (d) - l.5D

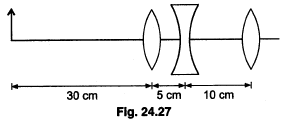
55. The near point of a short-sighted person is l0cm and he desires to read a book 30 cm away from him. The power of the lens to be used by him is : (a) -3.33 D (b) -10 D (c) -6.66 D (d) - 5D

56. The distance between an object and the screen is 100 cm. A lens produces an image on the screen when placed at either of the positions 40 cm apart. The power of the lens is (a) ≈3D (b)≈5D (c) ≈ 7D (d) ≈ 9 D

57. A thin equiconvex lens has focal length 10 cm and refractive index 1.5. One of its face is now silvered and for an object placed at a distance u in front of the lens , the image coincides with the object. The value of u is : (a) l0 cm (b)5 cm (c) 20 cm (d)15 cm

58. An object is placed at a distance of 40 cm infront of a concave mirror of focal length 20 cm. The image produced is : (a) real, inverted and smaller in size (b) real, inverted and of same size

(c) real and erect (d) virtual and inverted



59. The position of final image formed by the given lens combination(f1 = +10 cm , f2 = -10 cm , f3 = +30 cm fig. 24.27) from the third lens will be at a distance of :(a) 15 cm (b) infinity (c) 45 cm (d) 30 cm (e) 35 cm

60. Two thin equiconvex lenses each of focal length 0.2 m are placed coaxially with their optic centres 0.5 m apart. Then the focal length of the combination is: (a) -0.4 m (b) 0.4 m (c) -0.1 m (d) 0.1 m

61. In an experiment to determine the focal length (*f* ) of a concave mirror by the u-v method, a student places the object pin A on the principal axis at a distance *x* from the pole P. The student looks at the pin and its inverted image from a distance keeping his eye in line with PA. When the student shifts his eye towards left, the image appears to the right of the object pin. Then:

(a) x <f (b)f < x<2f (c) x = 2f (d) x > 2f



62. A convex mirror, a plane mirror and a needle object (AB) are placed on an optical bench as shown in the figure(24.30) so that the images of the object needle due to the convex mirror and the plane mirror are formed one above the other without parallax. Then in the convex mirror formula 1/v + 1/u =1/f , which of the following are correct ?

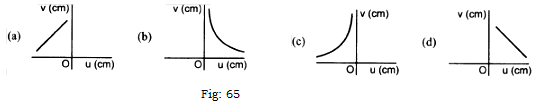
1. *u* = OP 2. *v* = OM – MP 3. *f* = MP . Select the correct answer using the code given below (a) 1 and 2 (b) 2 and 3 (c) 1 and 3 (d) 1, 2 and 3



63.The cross-section of a hollow glass (μ=1.5) tube of internal radius 3 cm and external radius 5 cm is shown in the adjoining figure(24.31). What is the apparent internal radius? (a) 2 cm (b) 4 cm (c) 4.5 cm (d) 5 cm

64. Two converging lenses with focal lengths *f* and 2*f* are positioned at a distance 3*f* apart. A parallel beam of light is incident on the lens with focal length *f* . If *d* is the incident beam width, what is the width of the emerging beam? (a) d/2 (b) d (c) 2d (d) 4d

65. A student measures the focal length of a convex lens by putting an object pin at a distance *u* from the lens and measuring the distance *v* of the image pin. The graph between *u* and *v* plotted by the student should look like(fig 65): [AIEEE 2008]



66. The refractive index of a material of a plano-concave lens is 5/3, the radius of curvature is 0.3 m. The focal length of the lens in air is (a) -0.45 m (b) -0.6 m (c) -0.75 m (d) -1.0 m

67. The radius of curvature of a concave mirror is 24 cm and the image is magnified by 1.5 times. The object distance is:(a) 20 cm (b) 8 cm (c) 16 cm (d) 24 cm

68. A concave mirror of focal length *f* in vacuum is placed in a medium of refractive index 2. Its focal length in the medium is : (a) f/2 (b) f (c) 2f (d) 4f

69. A transparent cube of 0.21m edge contains a small air bubble. Its apparent distance when viewed through one face of the cube is 0.10 m and when viewed from the opposite face is 0.04 m. The actual distance of the bubble from the second face of the cube is: (a) 0.06 m (b) 0.17 m (c) 0.05 m (d) 0.04 m

70. A diverging meniscus lens of 1.5 refractive index has concave surfaces of radii 3 and 4 cm. The position of the image, if an object is placed 12 cm infront of the lens, is: (a) 7 cm (b)-8cm (c) 9 cm (d) 10 cm

71. A convex lens made of glass has focal length 0.15 m in air. If the refractive index of glass is 3/2 and that of water is 4/3, the focal length of lens when immersed in water is :

(a) 0.45 m (b) 0.15 m (c) 0.30 m (d) 0.6 m

**Dispersion of Light and Chromatic Aberration**

72. A ray of light suffers minimum deviation when incident on a 600 prism of refractive index √2. The angle of incidence is: (a) sin-1(0.8) (b) 600 (c) 450 (d) 300

73. A ray is incident at an angle of incidence *i* on one face of a prism of small angle A and emerges normally from the opposite surface. If the refractive index of the material of the prism is μ, the angle of incidence *i* is nearly equal to:(a) A/μ (b) A/2μ (c) μ A (d) μA/2

74. A ray of light passes through an equilateral prism of glass in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to (3/4) of the angle of prism. The angle of deviation is: (a) 450 (b) 700 (c) 390 (d) 300

75. If one face of a prism of prism angle 300 and μ =√2 is silvered, the incident ray retraces its initial path. The angle of incidence is: (a) 600 (b) 300 (c) 450 (d) 900

76. Angle of a prism is A and its one surface is silvered. Light rays falling at an angle of incidence of 2A on first surface return back through the same path after suffering reflection at the second silvered surface. Refractive index of the material is: (a) 2 sin A (b) 2 cosA (c)(½)cosA (d) tan A



77. An isosceles prism of prism angle 1200 has a refractive index of 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown in figure(25.4). The rays emerging from the opposite faces: (a) are parallel to each other (b) are diverging

(c) make an angle 2 [sin-1 (0.72)] with each other

(d) make an angle 2 [sin-1 (0.72) -300] with each other



78. The angle of prism is 600 and its refractive index is 1.5.There will be no emergent light if the angle of incidence on the first face is:

(a) equal to 300 (b) less than 270 (c) more than 300 (d) equal to 600

79. A glass prism of refractive index 1.5 is immersed in water (refractive index 4/3)fig (25.5). A light beam incident normally on the face AB is totally reflected to reach the face AC if:(a) sinθ >8/9 (b) 2/3 < sinθ < 8/9 (c) sinθ < 2/3 (d) sinθ ≥ 8/9 (e) sinθ ≤ 2/3

80. The angle of a prism is A and if the angle of minimum deviation is 180 - 2A, then the refractive index of the material of the prism is(a)sin A/2 (b) cos A/2 (c)tan A/2 (d) cot A/2

81. An equilateral prism is placed on the prism table of a spectrometer in the position of minimum deviation. If the angle of incidence is 600, the angle of deviation of the rays is: (a) 900 (b) 600 (c) 450 (d) 300

82. A ray falls on a prism ABC (AB =BC) and travels as shown in the figure(25.6). The minimum refractive index of the material should be: (a) 4/3 (b)√2 (c) 1.5 (d)√3

83. Three glass prisms A, B and C of the same refractive index are placed in contact with each other as shown in the diagram(25.7) below with no air gap between the prisms. A monochromatic ray of light OP passes through the prism assembly and emerges as QR. The conditional minimum deviation is satisfied in the prisms:

(a) A and C (b) B and C (c) A and B (d) A, B and C

84.Angle of minimum deviation for a prism of refractive index 1.5 is equal to the angle of prism. The angle of the prism is (Given cos 410 ≈ 0.75): (a) 620 (b) 410 (c) 820 (d) 310

85. A prism (μ =1.5) has the refractive angle of 300. The deviation of a monochromatic ray incident normally on its one surface will be: (sin 48036' = 0.75): (a) 48036' (b) 22038' (c) 180 (d) 2201'

86. A thin prism P1 with angle 40 and made from glass of refractive index 1.54 is combined with another thin prism P2 made from glass of refractive index 1.72 to produce dispersion without deviation. The angle of the prism P2 is : (a) 5.330 (b) 40 (c) 30 (d) 2.60

87. At what angle will a ray of light be incident on one face of an equilateral prism, so that the emergent ray may graze the second surface of the prism (μ =l.5)? (a) 180 (b) 280 (c) 320 (d) 380

88. Two identical prisms 1 and 2, each with angles of 300, 600 and 900 are placed in contact as shown in figure(25.8). A ray of light passes through the combination in the position of minimum deviation and suffers a deviation of 300. If the prism 2 is removed, then the angle of deviation of the same ray is:

(a) equal to 150 (b) smaller than 150 (c) more than 150 (d) equal to 300

89.The angle of a prism is 300. The rays incident at an angle of 600 at one refracting face suffer a deviation of 300. Then the angle of emergence is: (a) 00  (b) 300  (c) 600  (d) 900

90.A parallel beam of white light falls on a convex lens. Images of blue, yellow and red light are formed on the other side of the lens at a distance of 20 cm, 20.5 cm and 21.4 cm respectively. The dispersive power of the material of the lens will be: (a) 14/205 (b) 9/200 (c) 5/214 (d) 619/1000

91.An achromatic combination of lenses produces:

(a) images in black and white (b) coloured images

(c) images unaffected by variation of refractive index with wavelength (d) highly enlarged image

92. If the ratio of amounts of scattering of two light waves is 1 : 4, the ratio of their wavelengths is:

(a) 1:2 (b) √2 :1 (c) 1:√2 (d) 1:1 (e) 2:1

93. A ray of light is incident at 600 on one face of a prism of angle 300 and the emergent ray makes 300 with the incident ray. The refractive index of the prism is:

(a) 1.732 (b) 1.414 (c) 1.5 (d) 1.33 (e) 1.6

94. A prism has a refracting angle 600. A ray of given monochromatic light suffers minimum deviation of 380 in passing through the prism. The refractive index of the material of the prism is: (sin 490 = 0.7547)

(a) 2.425 (b) 0.7849 (c) 1.3 (d) 1.5094

95.A liquid is placed in a hollow prism of angle 600. If angle of minimum deviation is 300, what is the refractive index of the liquid? (a) 1.41 (b) 1.5 (c) 1.65 (d) 1.95

96. We have a right-angled isosceles prism. Its refractive index is 1.5. If a ray is incident normally on one of the two perpendicular surfaces, which of the following phenomena will take place?

(a) Dispersion (b) Total internal reflection (c) Refraction (d) None of these

97.A prism is made up of a material of refractive index √3.The angle of the prism is A0. If the angle of minimum deviation is equal to the angle of the prism, then the value of A is:

(a) 300 (b) 450  (c) 600  (d) 750

98. In a spectrometer experiment three prisms A, B and C with same angle of prism but of different materials of refractive indices μA =1.33, μB =1.55 and μC =1.44 are used. The corresponding angles of minimum deviation DA,DB, DC measured will be such that :

(a) DA > DB > DC (b) DA < DB < DC (c) DA < DC < DB (d) none of these



99. Light is incident normally on face AB of a prism as shown in figure(25.10). A liquid of refractive index μ is placed on face AC of the prism. The prism is made of glass of refractive index 3/2. The limits of μ for which total internal reflection takes place on face AC is :

(a) μ > √3 /2 (b) μ< 3√3 /4 (c) μ> √3 (d) μ < √3 /2



100. A prism having an apex angle 40 and refractive index 1.5 is located in front of a vertical plane mirror as shown in figure(25.11). Through what total angle is the ray deviated after reflection from the mirror?

(a) 1760 (b) 40 (c) 1780 (d) 20

**Human Eye and Optical Instruments**

101. If the ratio of magnifications produced by a simple microscope in near point adjustment and far point

adjustment is 6/5, then the focal length of the lens is:(take D =25 cm)

(a) 5 cm (b) 10 cm (c) 55 cm (d) 0.2 cm

102. When the length of a telescope increases its magnifying power:

(a) decreases (b) increases (c) does not change

(d) may increase or decrease depending on the observer and the place of observation

103. The focal lengths of the objective and the eye-piece of a compound microscope are 1 cm and 5 cm respectively. An object is placed at a distance of 1.1 cm from the objective. If the final image is formed at the least distance of distinct vision, the magnifying power is: (a) 60 (b) 50 (c) 40 (d) none of these

104. The focal lengths of the objective and the eye-piece of a compound microscope are 1 cm and 5 cm respectively. An object is placed at a distance of 1.1 cm from the objective. If the final image is formed at the least distance of distinct vision, what is the distance between the two lenses?

(a) 16 cm (b) 15.17 cm (c) 11 cm (d) 6 cm

105. The focal lengths of the objective and the eye-piece of a compound microscope are 1 cm and 5 cm respectively. An object is placed at a distance of 1.1 cm from the objective. if the final image is formed at infinity, the magnifying power and the distance between the lenses are respectively given by:

(a) 60, 16 cm (b) 50, 16 cm (c) 50, 15.7 cm (d) 60, 16.7 cm

106. In a compound microscope the objective and eye-piece have focal lengths of 0.95 cm and 5 cm respectively, and are kept at a distance of 2O cm. The last image is formed at a distance of 25 cm from eye-piece. What is the total magnification of the microscope? (a) 95 (b) 94 (c) 94/6 (d) None of these

107. Four lenses of focal length +15 cm, +20 cm, +150 cm and +250cm are available for making an astronomical telescope. To produce the largest magnification, the focal length of the eye-piece should be:

(a) +15 cm (b) +20 cm (c) +150 cm (d) +250 cm

108. A person cannot see objects clearly beyond 50 cm. The power of the lens to correct the vision is

(a) +5 dioptre (b) - 0.5 dioptre (c) -2 dioptre (d) +2 dioptre

109. A presbyopic patient has near point as 30 cm and far point as 40 cm. The dioptric power for the corrective lens for seeing distant objects is: (a) 40 (b) 4 (c) -2.5 (d) 0.25

110. A presbyopic patient has near point as 30 cm and far point as 40 cm. The dioptric power for the corrective lens for seeing near objects is: (a) 40 (b) 30 (c) +2.5 (d) +2/3

111. A terrestrial telescope is made by introducing an erecting lens of focal length *f* between the objective and eye-piece lenses of an astronomical telescope. This causes the length of the telescope tube to increase by an amount equal to: (a) *f*  (b) *2f* (c) *3f* (d) *4f*

112. The length of a telescope is 36 cm. The focal lengths of its lenses can be:

(a) 30 cm, 6 cm (b) -30 cm, - 6 cm (c) 30 cm, - 6 cm (d) -30 cm, 6 cm

113. An astronomical telescope of ten-fold angular magnification has a length of 44 cm. The focal length of the objective is: (a) 4 cm (b) 40 cm (c) 44 cm (d) 440 cm

114. A simple telescope, consisting of an objective of focal length 60 cm and a single eye lens of focal length 5 cm is focussed on :a distant object in such a'way that parallel rays emerge from the eye lens. If the object subtends an angle of 2o at the objective, the angular width of the image is:

(a) 100 (b) 240 (c) 500 (d) (1/6) 0

115. Opera glasses have a minimum length of 20 cm and a magnifying power of 5 when viewing distant objects. The focal lengths of lenses used are:

(a) 25 cm, 5 cm (b) 25 cm, -5 cm (c) (10/5) cm, (50/3) cm (d) all of these

116. An astronomical telescope having an objective of focal length 100 cm is focussed on the moon. Find the distance through which the eye-piece should be pulled back to focus an object situated at a distance 80 m from the objective: (a) 8000/79 cm (b) 100/79 cm (c) 10/79 cm (d) none of these

117. In a terrestrial telescope the focal length of erecting lens is 2 cm. The length of the telescope is 96 cm. If the magnifying power of the telescope is 10, then the focal lengths of eye-piece and objective are respectively:

(a) 8 cm, 80 cm (b)96/11cm ,960/11cm (c) 6 cm, 90 cm (d) none of these

118. Two convex lenses of focal lengths 0.3 m and 0.05 m are used to make a telescope. The distance kept between them in order to obtain an image at infinity is equal to:

(a) 0.35 m (b) 0.25 m (c) 0.175 m (d) 0.15 m

119. The diameter of the moon is 3.5 x 103 km and its distance from the earth is 3.8 x 105 km seen by a telescope, having the focal lengths of the objective and the eye-piece as 4 m and 10 cm respectively; the diameter of the image of the moon will be approximately: (a) 20 (b) 210 (c) 400 (d) 50 0

120. The aperture of the largest telescope in the world is 5 m. If the separation between the moon and the earth is 4 x 105 km and the wavelength of visible light is 5000 A0; then the minimum separation between the objects on the surface of the moon which can be just resolved is approximately:

(a)lm (b) l0 m (c) 50 m (d) 200 m

121. The focal length of the objective lens of a telescope is 30 cm and that of its eye lens is 3 cm. It is focussed on a scale 2 metres distant from it. The distance of the objective lens from the eye lens to see with relaxed eye is: (a) 33 cm (b) 65.3 cm (c) 38.3 cm (d) 40.3 cm

122. A good photographic print is obtained by an exposure of two seconds at a distance of 20 cm from the lamp. The time of exposure required to get an equally good result at a distance of 40 cm is:

(a) 1 second (b) 2 second (c) 4 second (d) 8 second

123.A camera objective has an aperture diameter *d*. lf the aperture is reduced to diameter *d/2* the exposure time under identical conditions of light should be made: (a) √2 fold (b) 2 fold (c) 2√2 fold (d) 4 fold

124. A film projector magnifies a 100 cm2 film strip on a screen. If the linear magnification is 4, the area of the magnified film on the screen is: (a) 1600 cm2 (b) 400 cm2 (c) 800 cm2 (d) 200 cm2

125. The resolution limit of the eye is 1 minute. At a distance *x* km from the eye, two persons stand with a lateral separation of 3 metre. For the two persons to be just resolved by the naked eye, *x* should be

(a) 10 km (b) 15 km (c) 20 km (d) 30 km

126. The minimum light intensity that can be perceived by the eye is about 10-10 watt/m2. The number of photons of wavelength5.6 x l0-7 m that must enter the pupil of area 10-4 m2/s for vision is approximately equal to:(a) 3 x 102 photons (b) 3 x 103 photons (c) 3 x 104 photons (d) 3 x 105 photons

127. An observer looks at a tree of height 15 metres with a telescope of magnifying power 10. To him the tree appears: (a) 10 times taller (b) 15 times taller (c) 10 times nearer (d) 15 times nearer

128. The distance between the eye lens and cross-wires in Ramsden's eye-piece which has a field lens of focal length 1.2 cm is: (a)1.1cm (b) 1.2 cm (c) 2.2 cm (d) 2.4 cm

129. If an astronomical telescope has objective and eye-piece of focal lengths 200 cm and 4 cm respectively, then the magnifying power of the telescope for the normal vision is:(a) 42 (b) 50 (c) 58 (d) 204

130. An astronaut is looking down on earth's surface from a space shuttle at an altitude of 400 km. Assuming that the astronaut's pupil diameter is 5 mm and the wavelength of visible light is 500 nm, the astronaut will be able to resolve linear objects of the size of about : (a) 0.5 m (b)5m (c) 50 m (d) 500 m

131. If an astronomical telescope has objective and eye-piece of focal lengths 200 cm and 4 cm respectively, the magnifying power of the telescope for distinct vision is:(a) 42 (b) 50 (c) 58 (d) 204

**Photometry**

132.An electric bulb illuminates a plane surface. The intensity of illumination on the surface at a point 2 m away from the bulb is 5 x 10-4 phot (lumen/cm2).The line joining the bulb to the point makes an angle 600 with the normal to the surface. The intensity of the bulb (in candela) is:

(a) 40√3 (b) 40 (c) 20 (d) 40 x 10-4

133. A 60 watt bulb is hung over the centre of a table 4' x 4' at a height of 3'. The ratio of the intensities of illumination at a point on the centre of the edge and on the corner of the table is:

(a) (17/13)3/2 (b) 2/1 (c) 17/13 (d) 5/4

134. A point light source is to be suspended above the centre of a circular table of radius R. In order to produce maximum illumination at the edges of the table, the height of the light source must be:

(a) R (b) 2R (c) R/√2 (d) R√2

135. In a cinema hall, the distance between the projector and the screen is increased by 2%, everything else remaining unchanged; then the intensity of illumination on the screen is:

(a) decreased by 4% (b) decreased by 2% (c) increased by 2% (d) increased by 4%

136. A source of 500 candela is placed at the centre of a piece of spherical surface of area 0.5 m2. If the radius of surface be 5 m, what is the luminous flux through the surface?

(a) 5 lumen (b) l0 lumen (c) 25lumen (d) 50 lumen

137. If the distance between a projector and the screen is decreased by 25%, the intensity of illumination will be increased by: (a) 12.5 % (b) 25% (c) 50% (d) more than 75%

138. To prepare a print with 40 watt lamp at 25 cm, it requires 3 seconds. If the distance is increased to 50 cm, how much time will be required to prepare the print? (a)6s (b)9s (c) 12 s (d)1s

139. If the luminous intensity of a unidirectional bulb is 100 candela, then total luminous flux emitted from the bulb is: (a) 861 lumen (b) 986 lumen (c) 1256lumen (d) 1561 lumen

140. If luminous efficiency of a lamp is 2 lumen/watt and its luminous intensity is 42 candela, then power of the lamp is: (a) 62 W (b) 76 W (c) 138 W (d) 264 W

141. The maximum illumination on a screen at a distance of 2 m from a lamp is 25 lux. The value of total luminous flux emitted by the lamp is: (a) 1256 lumen (b) 1600 lumen (c) 100 candela (d) 400 lumen

142. The illumination on a screen 5 m away from a source of light is 10 lux. What is the luminous intensity of the source? (a) 5 candela (b) 10 candela (c) 50 candela (d) 250 candela

143. An illuminance of 2.5 x 105 lumen/m2 is produced by sunlight falling normally on the surface of the earth. The distance of the earth from the sun is 1.5 x 108 km. The lumen flux of the sun is:

(a) 3.5 x 1028 lumen (b) 3.56 x 1027 lumen (c) 7.065 x 1028 lumen (d) 8 x l029 lumen

144. The luminous intensity of a 100 W unidirectional bulb is 100 candela. The luminous efficiency of the bulb (in lumen/watt) is: (a) 12 (b) 12.56 (c) 13 (d) l5

**Answers Objective (Ray Optics)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 1. B | 1. A | 1. B | 1. D | 1. C | 1. A |
| 1. B | 1. A | 1. D | 1. B | 1. A | 1. B |
| 1. C | 1. D | 1. B | 1. C | 1. B | 1. C |
| 1. A | 1. B | 1. B | 1. C | 1. D | 1. B |
| 1. B | 1. A | 1. C | 1. C | 1. C | 1. A |
| 1. A | 1. A | 1. D | 1. C | 1. B | 1. D |
| 1. C | 1. D | 1. A | 1. B | 1. C | 1. A |
| 1. B | 1. D | 1. C | 1. D | 1. A | 1. D |
| 1. B | 1. B | 1. D | 1. D | 1. C | 1. A |
| 1. C | 1. B | 1. B | 1. B | 1. D | 1. A |
| 1. B | 1. A | 1. A | 1. B | 1. C | 1. A |
| 1. A | 1. B | 1. A | 1. B | 1. D | 1. C |
| 1. C | 1. D | 1. C | 1. B | 1. D | 1. B |
| 1. A | 1. D | 1. B | 1. B | 1. C | 1. C |
| 1. A | 1. C | 1. B | 1. A | 1. A | 1. A |
| 1. C | 1. B | 1. A | 1. D | 1. A | 1. B |
| 1. C | 1. C | 1. C | 1. C | 1. A | 1. A |
| 1. A | 1. B | 1. B | 1. B | 1. A | 1. C |
| 1. C | 1. D | 1. D | 1. A | 1. B | 1. B |
| 1. B | 1. B | 1. A | 1. A | 1. B | 1. C |
| 1. C | 1. D | 1. D | 1. A | 1. A | 1. C |
| 1. C | 1. A | 1. B | 1. C | 1. C | 1. B |
| 1. A | 1. C | 1. A | 1. B | 1. D | 1. C |
| 1. C | 1. D | 1. A | 1. D | 1. C | 1. B |

**Answers Explanations Objective Questions- Ray Optics**

