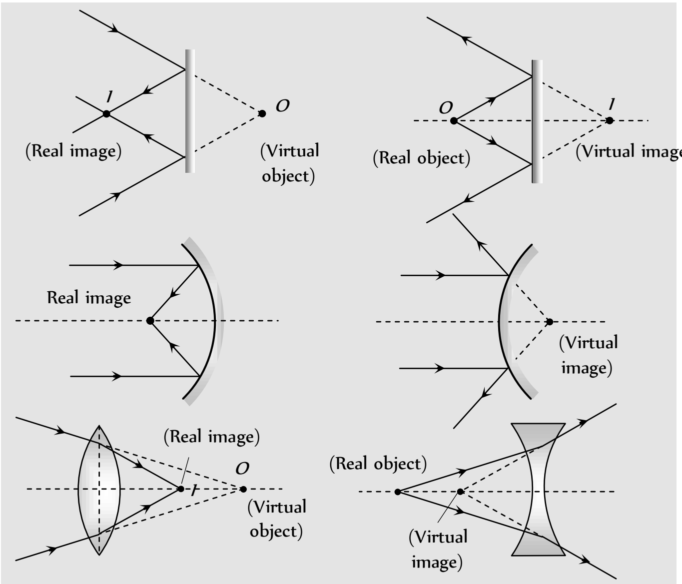
Chapter
29
Ray Optics

Real and Virtual Images

If light rays, after reflection or refraction, actually meets at a point then real image is formed and if they appears to meet virtual image is formed.



Reflection of Light

When a ray of light after incidenting on a boundary separating two media comes back into the same media, then this phenomenon, is called reflection of light.

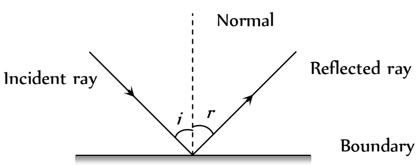


Fig. 29.1

(1) $\angle i = \angle r$

(2) After reflection, velocity, wave length and frequency of light remains same but intensity decreases.

(3) There is a phase change of π if reflection takes place from denser medium.

Reflection From a Plane Surface (Plane Mirror)

The image formed by a plane mirror is virtual, erect, laterally inverted, equal in size that of the object and at a distance equal to the distance of the object in front of the mirror.

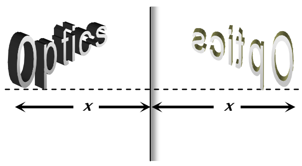


Fig. 29.2

(1) Deviation produced by a plane mirror and by two inclined plane mirrors.

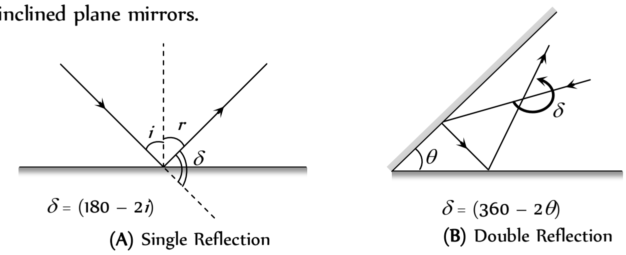


Fig. 29.3

(2) **Images by two inclined plane mirrors :** When two plane mirrors are inclined to each other at an angle θ, then number of images (n) formed of an object which is kept between them.

(i) $n = \left(\dfrac{360^o}{\theta} - 1\right)$; If $\dfrac{360^o}{\theta}$ = even integer

(ii) If $\dfrac{360^o}{\theta}$ = odd integer then there are two possibilities

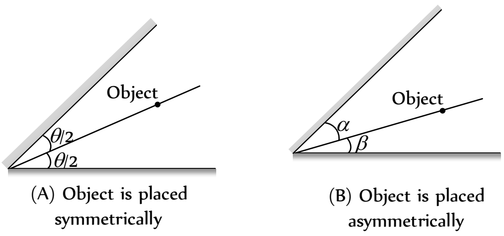


Fig. 29.4

$$n = \left(\frac{360}{\theta} - 1\right) \qquad\qquad n = \frac{360}{\theta}$$

(3) **Other important informations**

(i) When the object moves with speed u towards (or away) from the plane mirror then image also moves towards (or away) with speed u. But relative speed of image *w.r.t.* object is $2u$.

(ii) When mirror moves towards the stationary object with speed u, the image will move with speed $2u$ in same direction as that of mirror.

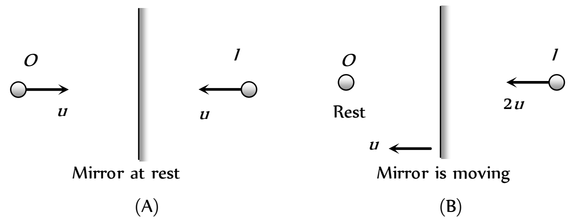


Fig. 29.5

(iii) A man of height h requires a mirror of length at least equal to $h/2$, to see his own complete image.

(iv) To see complete wall behind himself a person requires a plane mirror of at least one third the height of wall. It should be noted that person is standing in the middle of the room.

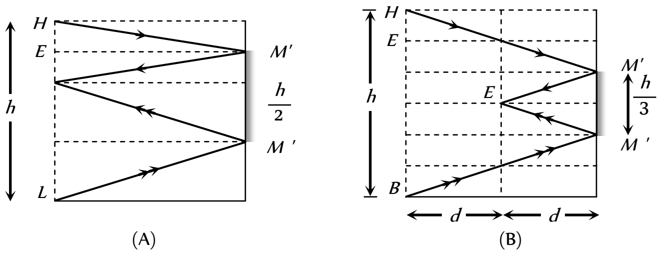


Fig. 29.6

Curved Mirror

It is a part of a transparent hollow sphere whose one surface is polished.

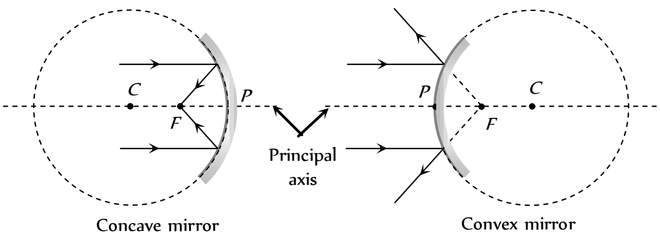


Fig. 29.7

Concave mirror converges the light rays and used as a shaving mirror, In search light, in cinema projector, in telescope, by E.N.T. specialists etc.

Convex mirror diverges the light rays and used in road lamps, side mirror in vehicles *etc*.

(1) **Terminology**

(i) Pole (P) **:** Mid point of the mirror

(ii) Centre of curvature (C) : Centre of the sphere of which the mirror is a part.

(iii) Radius of curvature (R): Distance between pole and centre of curvature. ($R_{concave} = -ve$, $R_{convex} = +ve$, $R_{plane} = \infty$)

(iv) Principle axis : A line passing through P and C.

(v) Focus (F) : An image point on principle axis for an object at ∞.

(vi) Focal length (f) : Distance between P and F.

(vii) Relation between f and R : $f = \frac{R}{2}$

($f_{concave} = -ve$, $f_{convex} = +ve$, $f_{plane} = \infty$)

(viii) Power : The converging or diverging ability of mirror

(ix) Aperture : Effective diameter of light reflecting area. Intensity of image $\propto$ Area $\propto$ (Aperture)^2

(x) Focal plane : A plane passing from focus and perpendicular to principle axis.

(2) **Sign conventions :**

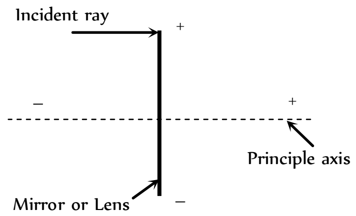


Fig. 29.8

(i) All distances are measured from the pole.

(ii) Distances measured in the direction of incident rays are taken as positive while in the direction opposite of incident rays are taken negative.

(iii) Distances above the principle axis are taken positive and below the principle axis are taken negative.

Table 29.1 : Useful sign

Concave mirror		Convex mirror
Real image ($u \geq f$)	Virtual image ($u < f$)	
Distance of object $u \rightarrow -$	$u \rightarrow -$	$u \rightarrow -$
Distance of image $v \rightarrow -$	$v \rightarrow +$	$v \rightarrow +$
Focal length $f \rightarrow -$	$f \rightarrow -$	$f \rightarrow +$
Height of object $O \rightarrow +$	$O \rightarrow +$	$O \rightarrow +$
Height of image $I \rightarrow -$	$I \rightarrow +$	$I \rightarrow +$
Radius of curvature $R \rightarrow -$	$R \rightarrow -$	$R \rightarrow +$
Magnification $m \rightarrow -$	$m \rightarrow +$	$m \rightarrow +$

Image Formation by Curved Mirrors

Concave mirror : Image formed by concave mirror may be real or virtual, may be inverted or erect, may be smaller, larger or equal in size of object.

(1) When object is placed at infinite (*i.e.* $u = \infty$)

Image

⟶ At F

⟶ Real

⟶ Inverted

⟶ Very small in size

⟶

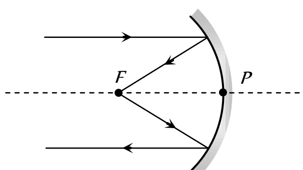


Fig. 29.9

Magnification $m << -1$

(2) When object is placed between infinite and centre of curvature (*i.e.* $u > 2f$)

Image
⟶ Between F and C
⟶ Real
⟶ Inverted
⟶ Small in size
⟶ $m < -1$

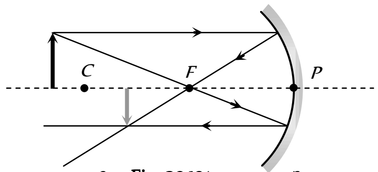


Fig. 29.10

(3) When object is placed at centre of curvature (*i.e.* $u = 2f$)

Image
⟶ At C
⟶ Real
⟶ Inverted
⟶ Equal in size
⟶ $m = -1$

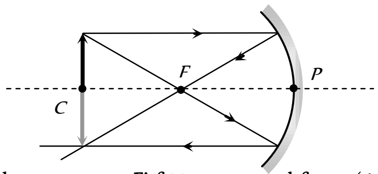


Fig. 29.11

(4) When object is placed between centre of curvature and focus (*i.e.* $f < u < 2f$)

Image
⟶ Between $2f$ and ∞
⟶ Real
⟶ Inverted
⟶ Large in size
⟶ $m > -1$

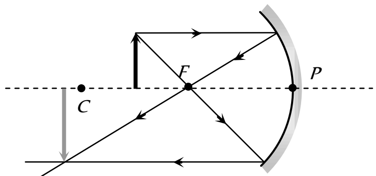


Fig. 29.12

(5) When object is placed at focus (*i.e.* $u = f$)

Image
⟶ At ∞
⟶ Real
⟶ Inverted
⟶ Very large in size
⟶ $m >> -1$

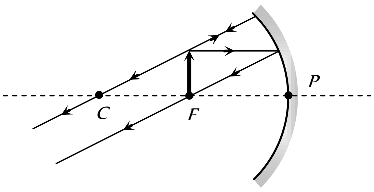


Fig. 29.13

(6) When object is placed between focus and pole (*i.e.* $u < f$)

Image
⟶ Behind the mirror
⟶ Virtual
⟶ Erect
⟶ Large in size
⟶ $m > +1$

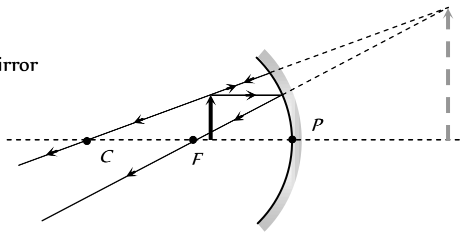


Fig. 29.14

Convex mirror : Image formed by convex mirror is always virtual, erect and smaller in size.

(1) When object is placed at infinite (*i.e.* $u = \infty$)

Image
⟶ At F
⟶ Virtual
⟶ Erect
⟶ Very small in size
⟶ Magnification $m << +1$

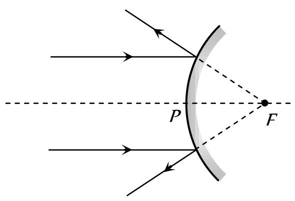


Fig. 29.15

(2) When object is placed any where on the principal axis

Image
⟶ Between P and F
⟶ Virtual
⟶ Erect
⟶ Small in size
⟶ Magnification $m < +1$

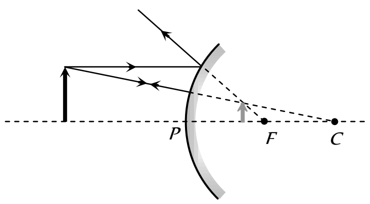


Fig. 29.16

Mirror Formula and Magnification

For a spherical mirror if u = Distance of object from pole, v = distance of image from pole, f = Focal length, R = Radius of curvature, O = Size of object, I = size of image

(1) **Mirror formula :** $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

(2) **Lateral magnification :** When an object is placed perpendicular to the principle axis, then linear magnification is called lateral or transverse magnification.

$$m = \frac{I}{O} = -\frac{v}{u} = \frac{f}{f-u} = \frac{f-v}{f}$$

(* Always use sign convention while solving the problems)

Axial magnification : When object lies along the principle axis then its axial magnification $m = \frac{I}{O} = \frac{-(v_2 - v_1)}{(u_2 - u_1)}$

If object is small; $m = -\frac{dv}{du} = \left(\frac{v}{u}\right)^2 = \left(\frac{f}{f-u}\right)^2 = \left(\frac{f-v}{f}\right)^2$

Areal magnification : If a $2D$-object is placed with it's plane perpendicular to principle axis. It's Areal magnification

$$m_s = \frac{\text{Area of image } (A_i)}{\text{Area of object} (A_o)} \Rightarrow m_s = m^2 = \frac{A_i}{A_o}$$

Refraction of Light

The bending of the ray of light passing from one medium to the other medium is called refraction.

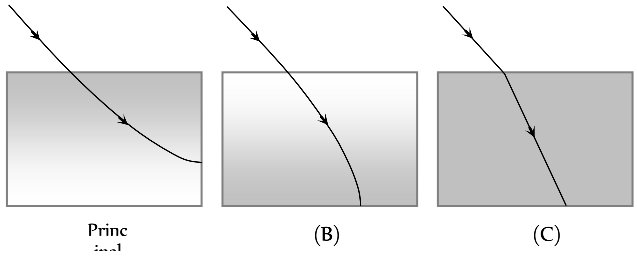


Fig. 29.17

(1) The refraction of light takes place on going from one medium to another because the speed of light is different in the two media.

(2) Greater the difference in the speeds of light in the two media, greater will be the amount of refraction.

(3) A medium in which the speed of light is more is known as optically rarer medium and a medium is which the speed of light is less, is known as optically denser medium.

(4) When a ray of light goes from a rarer medium to a denser medium, it bends towards the normal.

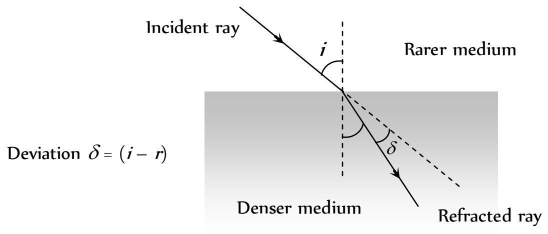


Fig. 29.18

(5) When a ray of light goes from a denser medium to a rarer medium, it bends away from the normal.

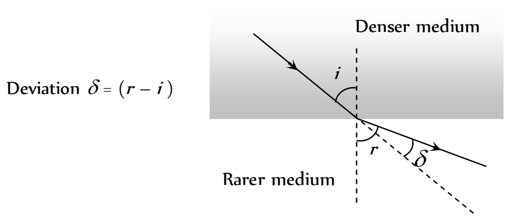


Fig. 29.19

(6) **Snell's law :** The ratio of sine of the angle of incidence to the angle of refraction (r) is a constant called refractive index

i.e. $\frac{\sin i}{\sin r} = \mu$ (a constant). For two media, Snell's law can be written as ${}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r}$

$\Rightarrow$ $\mu_1 \times \sin i = \mu_2 \times \sin r$ *i.e.* $\mu \sin\theta =$ constant

Also in vector form : $\hat{\boldsymbol{i}} \times \hat{\boldsymbol{n}} = \mu(\hat{\boldsymbol{r}} \times \hat{\boldsymbol{n}})$

Refractive Index

(1) Refractive index of a medium is that characteristic which decides speed of light in it.

(2) It is a scalar, unit less and dimensionless quantity.

(3) **Absolute refractive index :** When light travels from vacuum to any transparent medium then refractive index of medium *w.r.t.* vacuum is called it's absolute refractive index *i.e.* ${}_{\text{vacuum}}\mu_{\text{medium}} = \frac{c}{v}$

Absolute refractive indices for glass, water and diamond are respectively $\mu_g = \frac{3}{2} = 1.5, \mu_w = \frac{4}{3} = 1.33$ and $\mu_D = \frac{12}{5} = 2.4$

(4) **Relative refractive index :** When light travels from medium (1) to medium (2) then refractive index of medium (2) *w.r.t.* medium (1) is called it's relative refractive index *i.e.* ${}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}$ (where v_1 and v_2 are the speed of light in medium 1 and 2 respectively).

(5) When we say refractive index we mean absolute refractive index.

(6) The minimum value of absolute refractive index is 1. For air it is very near to 1. ($\cong 1.003$)

(7) Cauchy's equation : $\mu = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + ...$

$(\lambda_{\text{Red}} > \lambda_{\text{violet}}$ so $\mu_{\text{Red}} < \mu_{\text{violet}})$

(8) If a light ray travels from medium (1) to medium (2), then

${}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{\lambda_1}{\lambda_2} = \frac{v_1}{v_2}$

(9) **Dependence of Refractive index**

(i) Nature of the media of incidence and refraction.

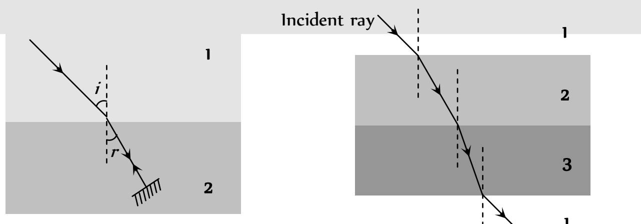
(ii) Colour of light or wavelength of light.

(iii) Temperature of the media : Refractive index decreases with the increase in temperature.

Table 29.2 : Indices of refraction for various substances, Measured with light of vacuum wavelength λ_0 = 589 *nm*

Substance	Refractive index	Substance	Refractive index
Solids at 20°*C*		**Liquids at 20°*C***	
Diamond (C)	2.419	Benzene	1.501
Fluorite (CaF_2)	1.434	Carbon disulfide	1.628
Flused quartz (SiO_2)	1.458	Carbon tetrachloride	1.461
Glass, crown	1.52	Ethyl alcohol	1.361
Glass, flint	1.66	Glycerine	1.473
Ice (H_2O) (at 0°*C*)	1.309	Water	1.333
Polystyrene	1.49	**Gases at 0°*C*, 1 *atm***	
Sodium chloride	1.544	Air	1.000293
Zircon	1.923	Carbon dioxide	1.00045

(10) **Reversibility of light and refraction through several media**



${}_1\mu_2 \times {}_2\mu_3 \times {}_3\mu_1 = 1$

(A) ${}_1\mu_2 = \frac{1}{{}_2\mu_1}$

(B) or ${}_2\mu_3 = \frac{{}_1\mu_3}{{}_1\mu_2}$

Fig. 29.20

Real and Apparent Depth

If object and observer are situated in different medium then due to refraction, object appears to be displaced from it's real position.

(1) **When object is in denser medium and observer is in rarer medium**

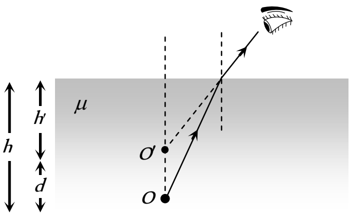


Fig. 29.21

(i) $\mu = \dfrac{\text{Real depth}}{\text{Apparent depth}} = \dfrac{h}{h'}$

(ii) Real depth > Apparent depth

(iii) Shift $d = h - h' = \left(1 - \dfrac{1}{\mu}\right)h$. For water $\mu = \dfrac{4}{3} \Rightarrow d = \dfrac{h}{4}$;

For glass $\mu = \dfrac{3}{2} \Rightarrow d = \dfrac{h}{3}$

(iv) Lateral magnification : consider an object of height x placed vertically in a medium μ such that the lower end (B) is a distance h from the interface and the upper end (A) at a distance ($h - x$) from the interface.

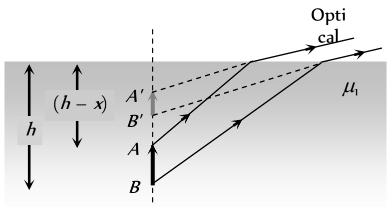


Fig. 29.22

Distance of image of B (*i.e.* B') from the interface $= \dfrac{\mu_2}{\mu_1} h$

Distance of image of A (*i.e.* A') from the interface $= \dfrac{\mu_2}{\mu_1}(h - x)$

Therefore, length of the image $\dfrac{\mu_2}{\mu_1} x$

or, the lateral magnification of the object $m = \dfrac{\mu_2}{\mu_1} = \dfrac{1}{\mu}$

(v) If a beaker contains various immiscible liquids as shown then

Apparent depth of bottom $= \dfrac{d_1}{\mu_1} + \dfrac{d_2}{\mu_2} + \dfrac{d_3}{\mu_3} + ...$

$\mu = \dfrac{d_{AC}}{d_{App.}} = \dfrac{d_1 + d_2 + ...}{\dfrac{d_1}{\mu_1} + \dfrac{d_2}{\mu_2} + ...}$

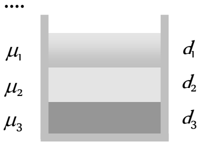
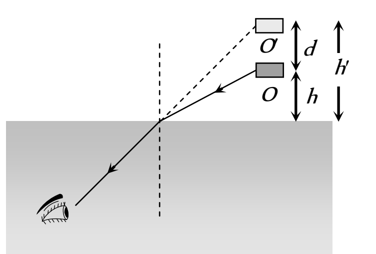


Fig. 29.23

(In case of two liquids if $d_1 = d_2$ than $\mu = \dfrac{2\mu_1\mu_2}{\mu_1 + \mu_2}$)

(2) **Object is in rarer medium and observer is in denser medium**



(i) $\mu = \dfrac{h'}{h}$

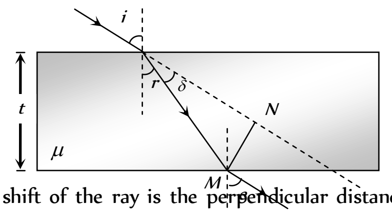
(ii) Real depth < Apparent depth.

(iii) $d = (\mu - 1)h$

(iv) Shift for water $d_w = \dfrac{h}{3}$; Shift for glass $d_g = \dfrac{h}{2}$

Refraction Through a Glass Slab

(1) **Lateral shift :** The refracting surfaces of a glass slab are parallel to each other. When a light ray passes through a glass slab it is refracted twice at the two parallel faces and finally emerges out parallel to it's incident direction *i.e.* the ray undergoes no deviation $\delta = 0$. The angle of emergence (e) is equal to the angle of incidence (i)



The Lateral shift of the ray is the perpendicular distance between the incident and the emergent ray, and it is given by

Fig. 29.25

$MN = t \sec r \sin (i - r)$

(2) **Normal shift :** If a glass slab is placed in the path of a converging or diverging beam of light then point of convergence or point of divergence appears to be shifted as shown

Normal shift

$OO' = x = \left(1 - \dfrac{1}{\mu}\right)t$

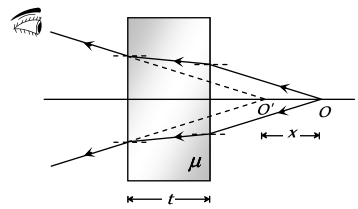


Fig. 29.26

(3) **Optical path :** It is defined as distance travelled by light in vacuum in the same time in which it travels a given path length in a medium.

Time taken by light ray to pass through the medium $= \dfrac{\mu x}{c}$; where x = geometrical path and μx = optical path

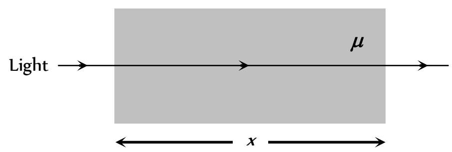
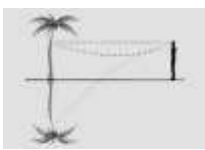


Fig. 29.27

Total Internal Reflection (TIR)


When a ray of light goes from denser to rarer medium it bends away from the normal and as the angle of incidence in denser medium increases, the angle of refraction in rarer medium also increases and at a certain angle, angle of refraction becomes 90°, this angle of incidence is called critical angle (C).

When Angle of incidence exceeds the critical angle than light ray comes back in to the same medium after reflection from interface. This phenomenon is called Total internal reflection (TIR).

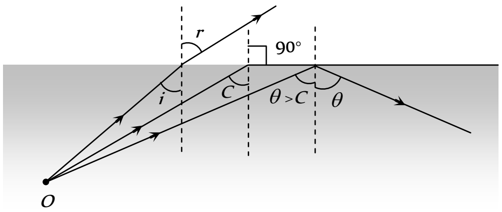


Fig. 29.28

(1) $\mu = \dfrac{1}{\sin C} = \text{cosec } C$ where $\mu \rightarrow {}_{\text{Rarer}}\mu_{\text{Denser}}$

(2) **Conditions for TIR**

(i) The ray must travel from denser medium to rarer medium.

(ii) The angle of incidence i must be greater than critical angle C

(3) **Dependence of critical angle**

(i) Colour of light (or wavelength of light) : Critical angle depends upon wavelength as $\lambda \propto \dfrac{1}{\mu} \propto \sin C$

(a) $\lambda_R > \lambda_V \Rightarrow C_R > C_V$

(b) Sin $C = \dfrac{1}{{}_R\mu_D} = \dfrac{\mu_R}{\mu_D} = \dfrac{\lambda_D}{\lambda_R} = \dfrac{v_D}{v_R}$ (for two media)

(ii) Nature of the pair of media : Greater the refractive index lesser will be the critical angle.

(a) For (glass- air) pair $\rightarrow C_{\text{glass}} = 42^o$

(b) For (water-air) pair $\rightarrow C_{\text{water}} = 49^o$

(c) For (diamond-air) pair $\rightarrow C_{\text{diamond}} = 24^o$

(iii) Temperature : With temperature rise refractive index of the material decreases therefore critical angle increases.

Common Examples of TIR

(1) **Looming :** An optical illusion in cold countries

(2) **Mirage :** An optical illusion in deserts

Fig. 29.29

(3) **Brilliance of diamond :** Due to repeated internal reflections diamond sparkles.

(4) **Optical fibre :** Optical fibres consist of many long high quality composite glass/quartz fibres. Each fibre consists of a core and cladding.

(i) The refractive index of the material of the core (μ) is higher than that of the cladding (μ).

(ii) When the light is incident on one end of the fibre at a small angle, the light passes inside, undergoes repeated total internal reflections along the fibre and finally comes out. The angle of incidence is always larger than the critical angle of the core material with respect to its cladding.

(iii) Even if the fibre is bent, the light can easily travel through along the fibre

(iv) A bundle of optical fibres can be used as a 'light pipe' in medical and optical examination. It can also be used for optical signal transmission. Optical fibres have also been used for transmitting and receiving electrical signals which are converted to light by suitable transducers.

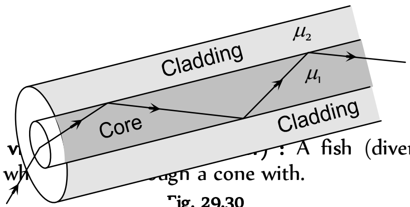


Fig. 29.30

(5) **Field of v**... : A fish (diver) inside the water can see the wh... ugh a cone with.

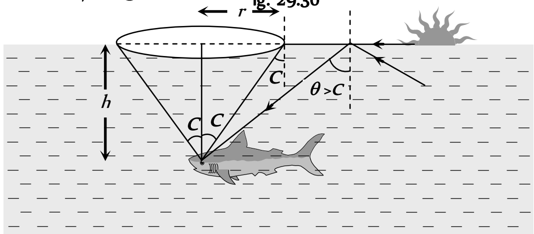


Fig. 29.31

(a) Apex angle $= 2C = 98^o$

(b) Radius of base $r = h\tan C = \dfrac{h}{\sqrt{\mu^2 - 1}}$; for water $r = \dfrac{3h}{\sqrt{7}}$

(c) Area of base $A = \dfrac{\pi h^2}{(\mu^2 - 1)}$; for water $a = \dfrac{9\pi}{7}h^2$

(6) **Porro prism :** A right angled isosceles prism, which is used in periscopes or binoculars. It is used to deviate light rays through 90^o and 180^o and also to erect the image.

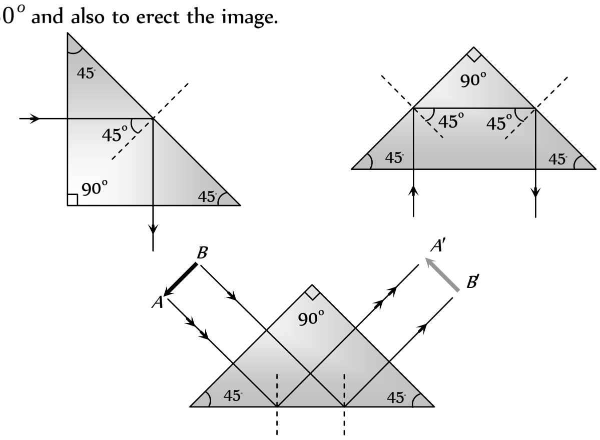


Fig. 29.32

Refraction From Spherical Surface

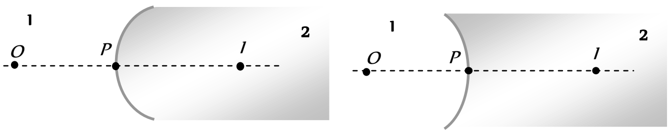


Fig. 29.33

(1) **Refraction formula :** $\dfrac{\mu_2-\mu_1}{R}=\dfrac{\mu_2}{v}-\dfrac{\mu_1}{u}$

Where μ_1 = Refractive index of the medium from which light rays are coming (from object).

μ_2 = Refractive index of the medium in which light rays are entering.

u = Distance of object, v = Distance of image, R = Radius of curvature

(2) **Lateral magnification :** The lateral magnification m is the ratio of the image height to the object height

or $m=\left(\dfrac{h_i}{h_0}\right)=\left(\dfrac{\mu_1}{\mu_2}\right)\left(\dfrac{v}{u}\right)$

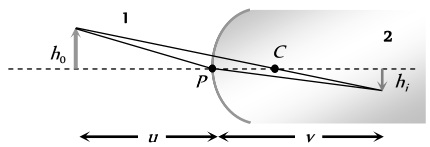


Fig. 29.34

Lens

(1) Lens is a transparent medium bounded by two refracting surfaces, such that at least one surface is curved. Curved surface can be spherical, cylindrical etc.

(2) Lenses are of two basic types convex which are thicker in the middle than at the edges and concave for which the reverse holds.

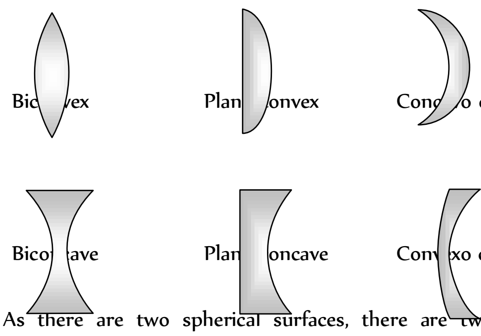


Fig. 29.35

(3) As there are two spherical surfaces, there are two centres of curvature C_1 and C_2 and correspondingly two radii of curvature R_1 and R_2

(4) The line joining C_1 and C_2 is called the principal axis of the lens. The centre of the thin lens which is on the principal axis, is called the optical centre.

(5) A ray passing through optical centre proceeds undeviated through the lens.

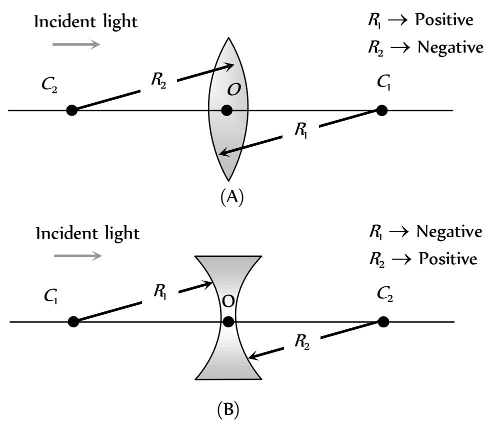


Fig. 29.36

(6) **Principal focus :** We define two principal focus for the lens. We are mainly concerned with the second principal focus (F). Thus wherever we write the focus, it means the second principal focus.

First principal focus : An object point for which image is formed at infinity.

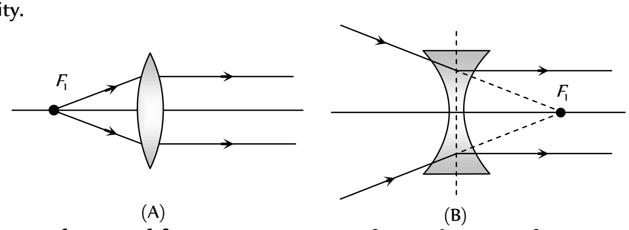


Fig. 29.37

Second principal focus : An image point for an object at infinity.

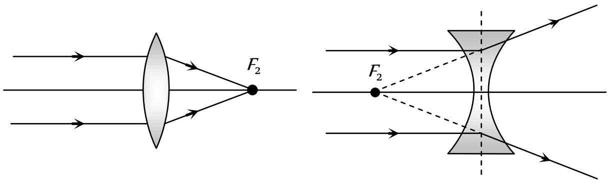


Fig. 29.38

Focal Length, Power and Aperture of Lens

(1) **Focal length (f) :** Distance of second principle focus from optical centre is called focal length

$f_{\text{convex}} \to$ positive, $f_{\text{concave}} \to$ negative, $f_{\text{plane}} \to \infty$

(2) **Aperture :** Effective diameter of light transmitting area is called aperture. $\text{Intensity of image} \propto (\text{Aperture})^2$

(3) **Power of lens (P) :** Means the ability of a lens to deviate the path of the rays passing through it. If the lens converges the rays parallel to the principal axis its power is positive and if it diverges the rays it is negative.

Power of lens $P=\dfrac{1}{f(m)}=\dfrac{100}{f(cm)}$; Unit of power is Diopter (D)

$P_{\text{convex}} \to \text{positive}, P_{\text{concave}} \to \text{negative}, P_{\text{plane}} \to \text{zero}$.

Rules of Image Formation by Lens

Convex lens : The image formed by convex lens depends on the position of object.

(1) When object is placed at infinite (*i.e.* $u = \infty$)

Image

⟶ At F

⟶ Real

⟶ Inverted

⟶ Very small in size

⟶ Magnification $m << -1$

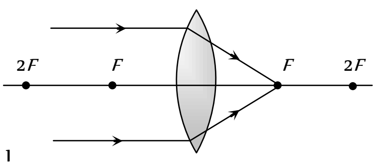


Fig. 29.39

(2) When object is placed between infinite and $2F$ (*i.e.* $u > 2f$)

Image

⟶ Between F and $2F$

⟶ Real

⟶ Inverted

⟶ Very small in size

⟶ Magnification $m < -1$

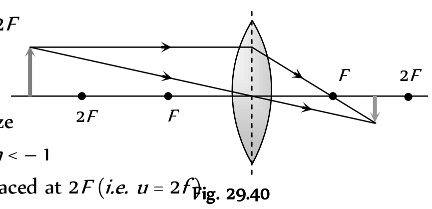


Fig. 29.40

(3) When object is placed at $2F$ (*i.e.* $u = 2f$)

Image

⟶ At $2F$

⟶

⟶

⟶

⟶

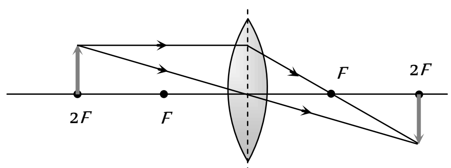


Fig. 29.41

Real

Inverted

Equal in size

Magnification $m = -1$

(4) When object is placed between F and $2F$ (*i.e.* $f < u < 2f$)

Image

→ Beyond $2F$

→ Real

→ Inverted

→ Large in size

→ Magnification $m > -1$

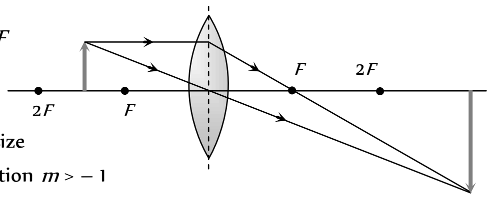


Fig. 29.42

(5) When object is placed at F (*i.e.* $u = f$)

Image

→ At ∞

→ Real

→ Inverted

→ Very large in size

→ Magnification $m >> -1$

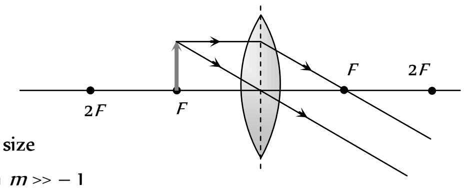


Fig. 29.43

(6) When object is placed between F and optical center (*i.e.* $u < f$)

Image

→ Same side as that of object

→ Virtual

→ Erect

→ large in size

→ Magnification $m > 1$

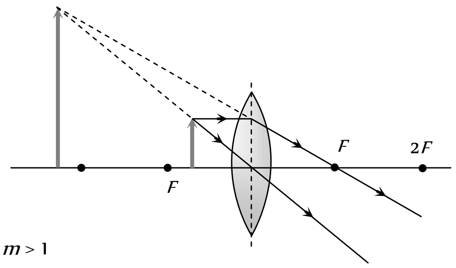


Fig. 29.44

Concave lens : The image formed by a concave lens is always virtual, erect and diminished (like a convex mirror)

(1) When object is placed at ∞

Image

→ At F

→ Virtual

→ Erect

→ Point size

→ Magnification $m << +1$

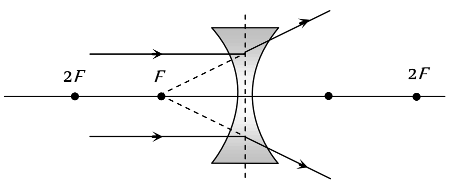


Fig. 29.45

(2) When object is placed any where on the principal axis

Image

→ Between optical centre and focus

→ Virtual

→ Erect

→ Smaller in size

→ Magnification $m < +1$

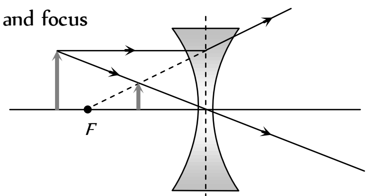


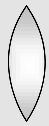
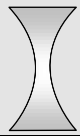
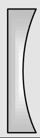
Fig. 29.46

Lens Maker's Formula and Lens Formula

(1) **Lens maker's formula :** If R_1 and R_2 are the radii of curvature of first and second refracting surfaces of a thin lens of focal length f and refractive index μ (*w.r.t.* surrounding medium) then the relation between f, μ, R_1 and R_2 is known as lens maker's formula.

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

Table 29.3 : Focal length of different lenses

Lens	Focal length	For $\mu = 1.5$
Biconvex lens $R_1 = R$ $R_2 = -R$ 	$f = \frac{R}{2(\mu - 1)}$	$f = R$
Plano-convex lens $R_1 = \infty$ $R_2 = -R$ 	$f = \frac{R}{(\mu - 1)}$	$f = 2R$
Biconcave $R_1 = -R$ $R_2 = +R$ 	$f = -\frac{R}{2(\mu - 1)}$	$f = -R$
Plano-concave $R_1 = \infty$ $R_2 = R$ 	$f = \frac{-R}{(\mu - 1)}$	$f = -2R$

(2) **Lens formula :** The expression which shows the relation between u, v and f is called lens formula.

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

Magnification

The ratio of the size of the image to the size of object is called magnification.

(1) Transverse magnification : $m = \frac{I}{O} = \frac{v}{u} = \frac{f}{f+u} = \frac{f-v}{f}$ (use sign convention while solving the problem)

(2) Longitudinal magnification : $m = \frac{I}{O} = \frac{v_2 - v_1}{u_2 - u_1}$. For very small object $m = \frac{dv}{du} = \left(\frac{v}{u}\right)^2 = \left(\frac{f}{f+u}\right)^2 = \left(\frac{f-v}{f}\right)^2$

(3) Areal magnification : $m_s = \frac{A_i}{A_o} = m^2 = \left(\frac{f}{f+u}\right)^2$,

(A_i = Area of image, A_o = Area of object)

(4) **Relation between object and image speed :** If an object moves with constant speed (V_o) towards a convex lens from infinity to focus, the image will move slower in the beginning and then faster. Also $V_i = \left(\frac{f}{f+u}\right)^2 . V_o$

Newton's Formula

If the distance of object (x) and image (x) are not measured from optical centre, but from first and second principal foci then Newton's formula states $f^2 = x_1 x_2$

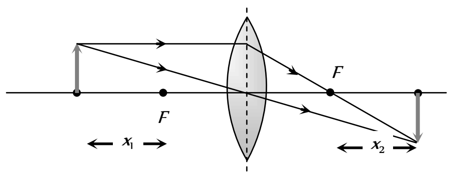


Fig. 29.47

Lens Immersed in a Liquid

If a lens (made of glass) of refractive index μ is immersed in a liquid of refractive index μ_l then its focal length in liquid, f_l is given by

$$\frac{1}{f_l} = ({}_l\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad ......(i)$$

If f_a is the focal length of lens in air, then

$$\frac{1}{f_a} = ({}_a\mu_g - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad ......(ii)$$

$$\Rightarrow \quad \frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)}$$

(1) If $\mu_g > \mu_l$, then f_l and f_a are of same sign and $f_l > f_a$.

That is the nature of lens remains unchanged, but it's focal length increases and hence power of lens decreases.

(2) If $\mu_g = \mu_l$, then $f_l = \infty$. It means lens behaves as a plane glass plate and becomes invisible in the medium.

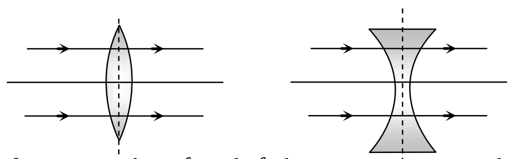


Fig. 29.48

(3) If $\mu_g < \mu_l$, then f_l and f_a have opposite signs and the nature of lens changes *i.e.* a convex lens diverges the light rays and concave lens converges the light rays.

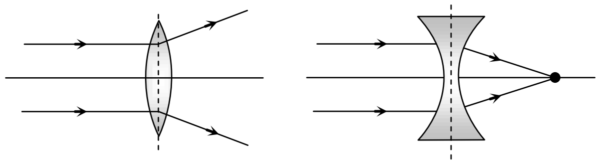


Fig. 29.49

Displacement Method

By this method focal length of convex lens is determined.

Consider an object and a screen placed at a distance D (> $4f$) apart. Let a lens of focal length f be placed between the object and the screen.

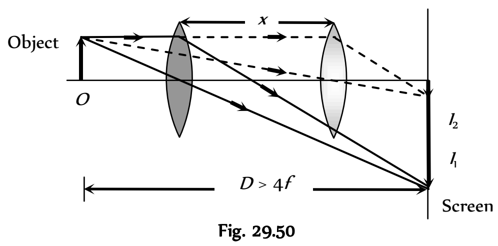


Fig. 29.50

(1) For two different positions of lens two images $(I_1$ and $I_2)$ of an object are formed at the screen.

(2) Focal length of the lens $f = \frac{D^2 - x^2}{4D} = \frac{x}{m_1 - m_2}$

where $m_1 = \frac{I_1}{O}$; $m_2 = \frac{I_2}{O}$ and $m_1 m_2 = 1$.

(3) Size of object $O = \sqrt{I_1 . I_2}$

Cutting of Lens

(1) A symmetric lens is cut along optical axis in two equal parts. Intensity of image formed by each part will be same as that of complete lens. Focal length is double the original for each part.

(2) A symmetric lens is cut along principle axis in two equal parts. Intensity of image formed by each part will be less compared as that of complete lens.(aperture of each part is $\frac{1}{\sqrt{2}}$ times that of complete lens). Focal length remains same for each part.

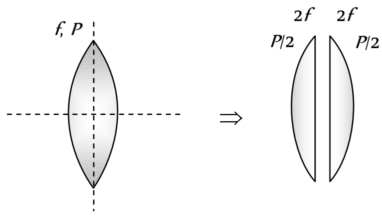


Fig. 29.51

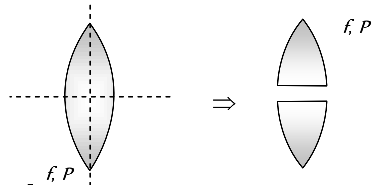


Fig. 29.52

Combination of Lens

(1) For a system of lenses, the net power, net focal length and magnification are given as follows :

$$P = P_1 + P_2 + P_3 ...., \qquad \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} + \frac{1}{f_3} + ..., $$

$$m = m_1 \times m_2 \times m_3 \times ....$$

(2) In case when two thin lens are in contact : Combination will behave as a lens, which have more power or lesser focal length.

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow F = \frac{f_1 f_2}{f_1 + f_2} \quad \text{and} \quad P = P_1 + P_2$$

(3) If two lens of equal focal length but of opposite nature are in contact then combination will behave as a plane glass plate and $F_{combination} = \infty$

(4) When two lenses are placed co-axially at a distance d from each other then equivalent focal length (F).

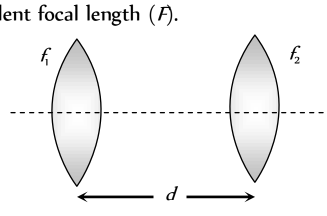


Fig. 29.53

$$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1 f_2} \text{ and } P=P_1+P_2-dP_1P_2$$

(5) Combination of parts of a lens :

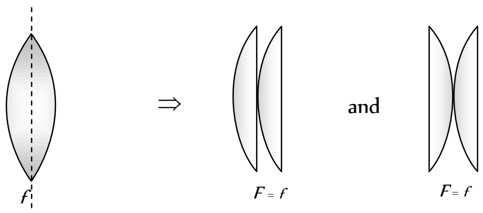


Fig. 29.54

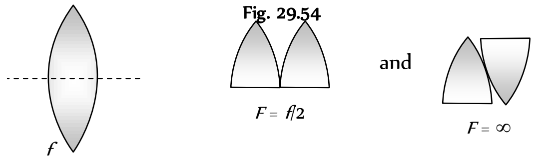


Fig. 29.55

Silvering of Lens

On silvering the surface of the lens it behaves as a mirror. The focal length of the silvered lens is $\frac{1}{F}=\frac{2}{f_l}+\frac{1}{f_m}$

where $f_l =$ focal length of lens from which refraction takes place (twice)

$f_m =$ focal length of mirror from which reflection takes place.

(i) Plano convex is silvered

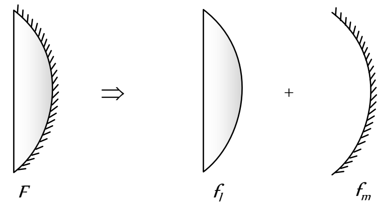


Fig. 29.56

$f_m=\frac{R}{2}$, $f_l=\frac{R}{(\mu-1)}$ so $F=\frac{R}{2\mu}$

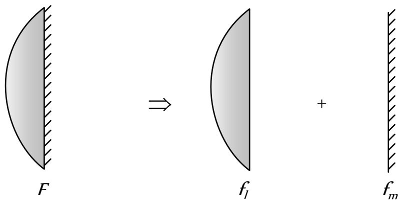


Fig. 29.57

$f_m=\infty$, $f_l=\frac{R}{(\mu-1)}$ so $F=\frac{R}{2(\mu-1)}$

(ii) Double convex lens is silvered

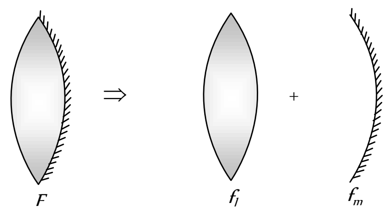


Fig. 29.58

Since $f_l=\frac{R}{2(\mu-1)}$, $f_m=\frac{R}{2}$ so $F=\frac{R}{2(2\mu-1)}$

Defects in Lens

(1) **Chromatic aberration :** Image of a white object is coloured and blurred because μ (hence f) of lens is different for different colours. This defect is called chromatic aberration.

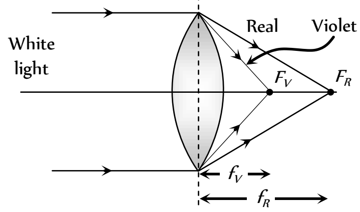


Fig. 29.59

$\mu_V > \mu_R$ so $f_R > f_V$

Mathematically chromatic aberration = $f_R - f_V = \omega f_y$

ω = Dispersive power of lens.

f = Focal length for mean colour $=\sqrt{f_R f_V}$

Removal : To remove this defect *i.e.* for Achromatism we use two or more lenses in contact in place of single lens.

Mathematically condition of Achromatism is : $\frac{\omega_1}{f_1}+\frac{\omega_2}{f_2}=0$ or $\omega_1 f_2 = -\omega_2 f_1$

(2) **Spherical aberration :** Inability of a lens to form the point image of a point object on the axis is called Spherical aberration.

In this defect all the rays passing through a lens are not focussed at a single point and the image of a point object on the axis is blurred.

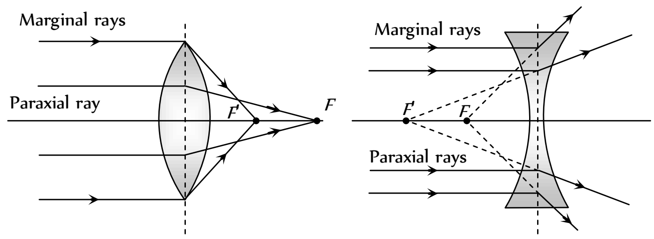


Fig. 29.60

Removal : A simple method to reduce spherical aberration is to use a stop before and infront of the lens. (but this method reduces the intensity of the image as most of the light is cut off). Also by using plano-convex lens, using two lenses separated by distance $d = F - F'$, using crossed lens.

(3) **Coma :** When the point object is placed away from the principle axis and the image is received on a screen perpendicular to the axis, the shape of the image is like a comet. This defect is called Coma.

It refers to spreading of a point object in a plane ⊥ to principle axis.

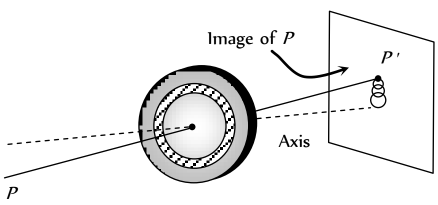


Fig. 29.61

Removal : It can be reduced by properly designing radii of curvature of the lens surfaces. It can also be reduced by appropriate stops placed at appropriate distances from the lens.

(4) **Curvature :** For a point object placed off the axis, the image is spread both along and perpendicular to the principal axis. The best image

is, in general, obtained not on a plane but on a curved surface. This defect is known as Curvature.

Removal : Astigmatism or the curvature may be reduced by using proper stops placed at proper locations along the axis.

(5) **Distortion :** When extended objects are imaged, different portions of the object are in general at different distances from the axis. The magnification is not the same for all portions of the extended object. As a result a line object is not imaged into a line but into a curve.

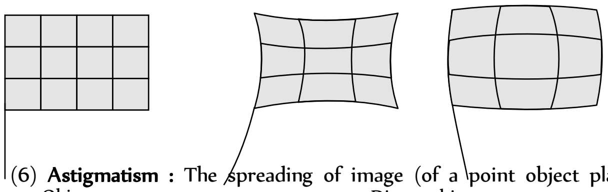


Fig. 29.62

(6) **Astigmatism :** The spreading of image (of a point object placed away from the principal axis) along the principal axis is called Astigmatism.

Prism

Prism is a transparent medium bounded by refracting surfaces, such that the incident surface (on which light ray is incidenting) and emergent surface (from which light rays emerges) are plane and non parallel.

(1) **Refraction through a prism**

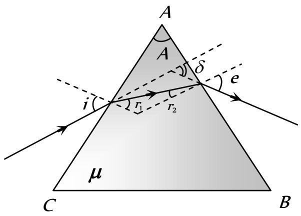


Fig. 29.63

i – Angle of incidence,
e – Angle of emergence,
A – Angle of prism or refracting angle of prism,
r_1 and r_2 – Angle of refraction,
δ – Angle of deviation

$A = r_1 + r_2$ and $i + e = A + \delta$

For surface AC $\mu = \dfrac{\sin i}{\sin r_1}$; For surface AB $\dfrac{1}{\mu} = \dfrac{\sin r_2}{\sin e}$

(2) **Deviation through a prism :** For thin prism $\delta = (\mu - 1)A$. Also deviation is different for different colour light *e.g.* $\mu_R < \mu_V$ so $\delta_R < \delta_V$.

$\mu_{\text{Flint}} > \mu_{\text{Crown}}$ so $\delta_F > \delta_C$

(i) Maximum deviation : Condition of maximum deviation is $\angle i = 90^o \Rightarrow r_1 = C,\ r_2 = A - C$ and from Snell's law on emergent surface

$$e = \sin^{-1}\left[\frac{\sin(A - C)}{\sin C}\right]$$

$$\delta_{\max} = \frac{\pi}{2} + \sin^{-1}\left[\frac{\sin(A - C)}{\sin C}\right] - A$$

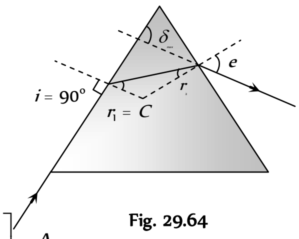


Fig. 29.64

(ii) Minimum deviation : It is observed if $\angle i = \angle e$ and $\angle r_1 = \angle r_2 = r$, deviation produced is minimum.

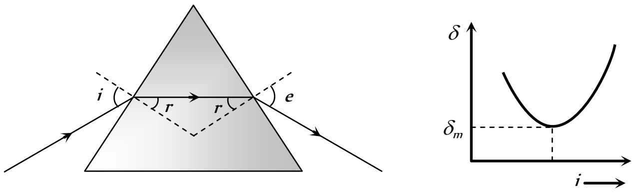


Fig. 29.65

(a) Refracted ray inside the prism is parallel to the base of the prism for equilateral and isosceles prisms.

(b) $r = \dfrac{A}{2}$ and $i = \dfrac{A + \delta_m}{2}$

(c) $\mu = \dfrac{\sin i}{\sin A/2}$ or $\mu = \dfrac{\sin \frac{A + \delta_m}{2}}{\sin A/2}$ (Prism formula).

(3) **Condition of no emergence :** For no emergence of light, TIR must takes place at the second surface

For TIR at second surface $r_2 > C$

So $A > r_1 + C$ (From $A = r_1 + r_2$)

As maximum value of $r_1 = C$

So, $A \geq 2C$. for any angle of incidence.

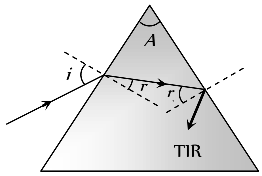


Fig. 29.66

If light ray incident normally on first surface *i.e.* $\angle i = 0°$ it means $\angle r_1 = 0°$. So in this case condition of no emergence from second surface is $A > C$.

$$\Rightarrow \sin A > \sin C \Rightarrow \sin A > \frac{1}{\mu} \Rightarrow \mu > \text{cosec}\, A$$

Dispersion Through a Prism

The splitting of white light into it's constituent colours is called dispersion of light.

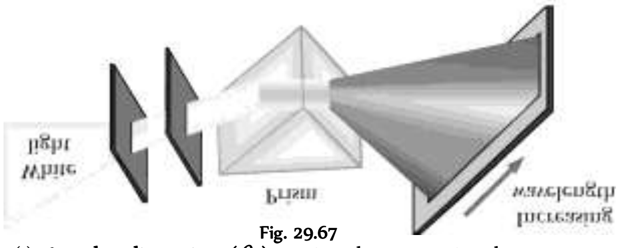


Fig. 29.67

(1) **Angular dispersion (θ) :** Angular separation between extreme colours *i.e.* $\theta = \delta_V - \delta_R = (\mu_V - \mu_R)A$. It depends upon μ and A.

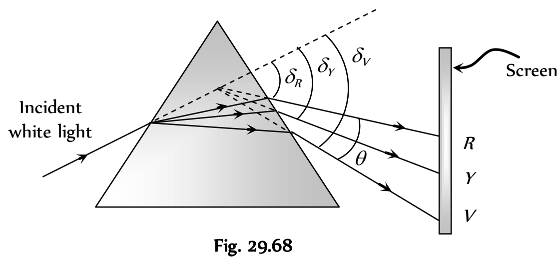


Fig. 29.68

(2) **Dispersive power (ω) :**

$$\omega = \frac{\theta}{\delta_y} = \frac{\mu_V - \mu_R}{\mu_y - 1} \quad \text{wher e} \left\{\mu_y = \frac{\mu_V + \mu_R}{2}\right\}$$

$\Rightarrow$ It depends only upon the material of the prism *i.e.* μ and it doesn't depends upon angle of prism A

(3) **Combination of prisms :** Two prisms (made of crown and flint material) are combined to get either dispersion only or deviation only.

(i) Dispersion without deviation (chromatic combination)

$$\frac{A'}{A} = -\frac{(\mu_y - 1)}{(\mu'_y - 1)}$$

$$\theta_{net} = \theta\left(1 - \frac{\omega'}{\omega}\right) = (\omega\delta - \omega'\delta')$$

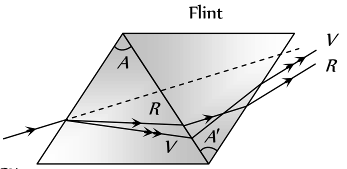


Fig. 29.69

(ii) Deviation without dispersion (Achromatic combination)

$$\frac{A'}{A} = -\frac{(\mu_V - \mu_R)}{(\mu'_V - \mu'_R)}$$

$$\delta_{net} = \delta\left(1 - \frac{\omega}{\omega'}\right)$$

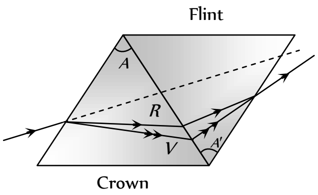


Fig. 29.70

Scattering of Light

Molecules of a medium after absorbing incoming light radiations, emits them in all direction. This phenomenon is called Scattering.

(1) **According to scientist Rayleigh :** Intensity of scattered light $\propto \frac{1}{\lambda^4}$

(2) **Some phenomenon based on scattering :** (i) Sky looks blue due to scattering.

(ii) At the time of sunrise or sunset sun looks reddish.

(iii) Danger signals are made of red colour.

(3) **Elastic scattering :** When the wavelength of radiation remains unchanged, the scattering is called elastic.

(4) **Inelastic scattering (Raman's effect) :** Under specific condition, light can also suffer inelastic scattering from molecules in which it's wavelength changes.

Rainbow

Rainbow is formed due to the dispersion of light suffering refraction and TIR in the droplets present in the atmosphere. Observer should stand with its back towards sun to observe rainbow.

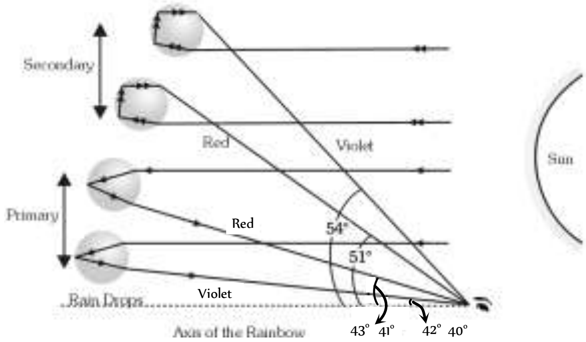


Fig. 29.71

(1) **Primary rainbow :** (i) Two refraction and one TIR. (ii) Innermost arc is violet and outermost is red. (iii) Subtends an angle of 42^o at the eye of the observer. (iv) More bright

(2) **Secondary rainbow :** (i) Two refraction and two TIR. (ii) Innermost arc is red and outermost is violet. (iii) It subtends an angle of 52.5^o at the eye. (iv) Comparatively less bright.

Colours of Objects

Colour is defined as the sensation received by the eye (rod cells of the eye) due to light coming from an object.

(1) **Colours of opaque object :** The colours of opaque bodies are due to selective reflection. *e.g.*

(i) A rose appears red in white light because it reflects red colour and absorbs all remaining colours.

(ii) When yellow light falls on a bunch of flowers, then yellow and white flowers looks yellow. Other flowers looks black.

(2) **Colours of transparent object :** The colours of transperent bodies are due to selective transmission..

(i) A red glass appears red because it absorbs all colours, except red which it transmits.

(ii) When we look on objects through a green glass or green filter then green and white objects will appear green while other black.

(3) **Colour of the sky :** Light of shorter wavelength is scattered much more than the light of longer wavelength. Since blue colour has relatively shorter wavelength, it predominates the sky and hence sky appears bluish.

(4) **Colour of clouds :** Large particles like water droplets and dust do not have this selective scattering power. They scatter all wavelengths alomost equally. Hence clouds appear to the white.

(5) **Colour triangle for spectral colours :** Red, Green and blue are primary colours.

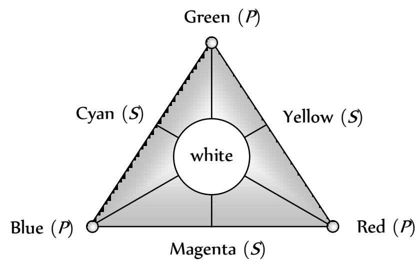


Fig. 29.72

(i) Complementary colours : Green and Magenta, Blue and Yellow, Red and Cyan.

(ii) Combination : Green + Red + Blue = White, Blue + Yellow = White, Red + Cyan = White, Green + Magenta = White

(6) **Colour triangle for pigment and dyes :** Red, Yellow and Blue are the primary colours.

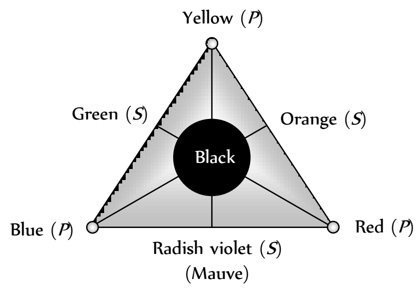


Fig. 29.73

(i) Complementary colours : Yellow and Mauve, Red and Green, Blue and Orange.

(ii) Combination : Yellow + Red + Blue = Black, Blue + Orange = Black, Red + Green = Black, Yellow + Mauve = Black

Spectrum

The ordered arrangements of radiations according to wavelengths or frequencies is called Spectrum. Spectrum can be divided in two parts Emission spectrum and Absorption spectrum.

(1) **Emission spectrum :** When light emitted by a self luminous object is dispersed by a prism to get the spectrum, the spectrum is called emission spectra.

Continuous emission spectrum

(i) It consists of continuously varying wavelengths in a definite wavelength range.

(ii) It is produced by solids, liquids and highly compressed gases heated to high temperature.

(iii) *e.g.* Light from the sun, filament of incandescent bulb, candle flame *etc*.

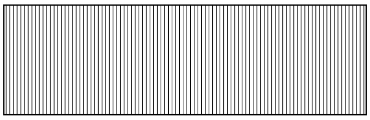


Fig. 29.74

Line emission spectrum

(i) It consist of distinct bright lines.

(ii) It is produced by an excited source in atomic state.

(iii) *e.g.* Spectrum of excited helium, mercury vapours, sodium vapours or atomic hydrogen.

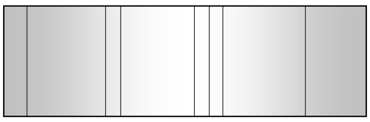


Fig. 29.75

Band emission spectrum

(i) It consist of district bright bands.

(ii) It is produced by an excited source in molecular state.

(iii) *e.g.* Spectra of molecular H_2, CO, NH_3 *etc*.

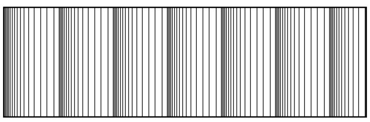


Fig. 29.76

(2) **Absorption spectrum :** When white light passes through a semi-transparent solid, or liquid or gas, it's spectrum contains certain dark lines or bands, such spectrum is called absorption spectrum (of the substance through which light is passed).

(i) Substances in atomic state produces line absorption spectra. Polyatomic substances such as H_2, CO_2 and $KMnO_4$ produces band absorption spectrum.

(ii) Absorption spectra of sodium vapour have two (yellow lines) wavelengths $D_1(5890\,Å)$ and $D_2(5896\,Å)$

(3) **Fraunhoffer's lines :** The central part (photosphere) of the sun is very hot and emits all possible wavelengths of the visible light. However, the outer part (chromosphere) consists of vapours of different elements. When the light emitted from the photosphere passes through the chromosphere, certain wavelengths are absorbed. Hence, in the spectrum of sunlight a large number of dark lines are seen called Fraunhoffer lines.

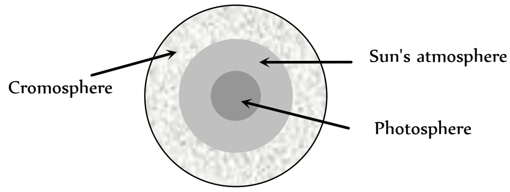


Fig. 29.77

(i) The prominent lines in the yellow part of the visible spectrum were labelled as *D*-lines, those in blue part as *F*-lines and in red part as *C*-line.

(ii) From the study of Fraunhoffer's lines the presence of various elements in the sun's atmosphere can be identified *e.g.* abundance of hydrogen and helium.

(iii) In the event of a solar eclipse, dark lines become bright. This is because of the reason that the presence of an opaque obstacle in between sun and earth cuts the light off from the central region (photo-sphere), while light from corner portion (cromosphere) is still being received. The bright lines appear exactly at the places where dark lines were present.

(4) **Spectrometer :** A spectrometer is used for obtaining pure spectrum of a source in laboratory and calculation of μ of material of prism and μ of a transparent liquid.

It consists of three parts : Collimator which provides a parallel beam of light; Prism Table for holding the prism and Telescope for observing the spectrum and making measurements on it.

The telescope is first set for parallel rays and then collimator is set for parallel rays. When prism is set in minimum deviation position, the spectrum seen is pure spectrum. Angle of prism (*A*) and angle of minimum deviation (δ_m) are measured and μ of material of prism is calculated using prism formula. For μ of a transparent liquid, we take a hollow prism with thin glass sides. Fill it with the liquid and measure (δ_m) and *A* of liquid prism. μ of liquid is calculated using prism formula.

(5) **Direct vision spectroscope :** It is an instrument used to observe pure spectrum. It produces dispersion without deviation with the help of n crown prisms and $(n-1)$ flint prisms alternately arranged in a tabular structure.

For no deviation $n(\mu-1)A=(n-1)\,(\mu'-1)A'$.

Human Eye

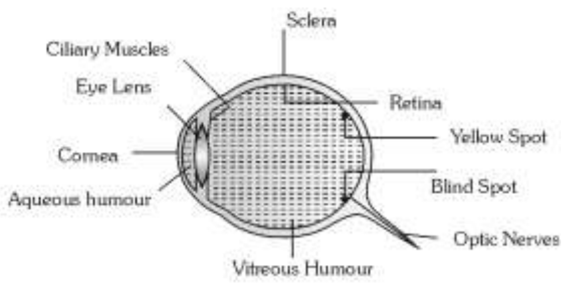


Fig. 29.78

(1) **Eye lens :** Over all behaves as a convex lens of $\mu=1.437$

(2) **Retina :** Real and inverted image of an object, obtained at retina, brain sense it erect.

(3) **Yellow spot :** It is the most sensitive part, the image formed at yellow spot is brightest.

(4) **Blind spot :** Optic nerves goes to brain through blind spot. It is not sensitive for light.

(5) **Ciliary muscles :** Eye lens is fixed between these muscles. It's both radius of curvature can be changed by applying pressure on it through ciliary muscles.

(6) **Power of accomodation :** The ability of eye to see near objects as well as far objects is called power of accomodation.

(7) **Range of vision :** For healthy eye it is 25 *cm* (near point) to ∞ (far point).

A normal eye can see the objects clearly, only if they are at a distance greater than 25 *cm*. This distance is called Least distance of distinct vision and is represented by *D*.

(8) **Persistence of vision :** Is 1/10 *sec. i.e.* if time interval between two consecutive light pulses is lesser than 0.1 *sec*., eye cannot distinguish them separately.

(9) **Binocular vision :** The seeing with two eyes is called binocular vision.

(10) **Resolving limit :** The minimum angular separation between two objects, so that they are just resolved is called resolving limit. For eye it is $1' = \left(\frac{1}{60}\right)^o$.

Defects in Eye

(1) **Myopia (short sightness) :** A short-sighted eye can see only nearer objects. Distant objects are not seen clearly.

(i) In this defect image is formed before the retina and Far point comes closer.

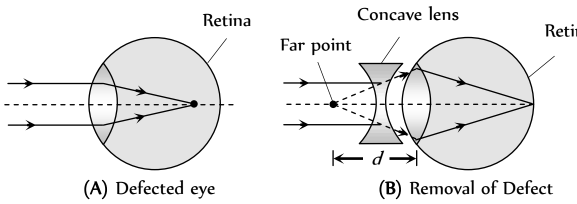


Fig. 29.79

(ii) In this defect focal length or radii of curvature of lens reduced or power of lens increases or distance between eye lens and retina increases.

(iii) This defect can be removed by using a concave lens of suitable focal length.

(iv) If defected far point is at a distance *d* from eye then

Focal length of used lens $f = -d = -$ (defected far point)

(v) A person can see upto distance → *x*, wants to see distance → *y* ($y > x$) so $f = \frac{xy}{x-y}$ or power of the lens $P = \frac{x-y}{xy}$

(2) **Hypermetropia (long sightness) :** A long-sighted eye can see distant objects clearly but nearer object are not clearly visible.

(i) Image formed behind the retina and near point moves away

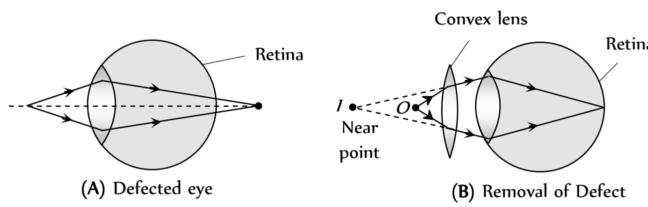


Fig. 29.80

(ii) In this defect focal length or radii of curvature of lens increases or power of lens decreases or distance between eye lens and retina decreases.

(iii) This defect can be removed by using a convex lens.

(iv) If a person cannot see before distance d but wants to see the object placed at distance *D* from eye so $f = \frac{dD}{d-D}$ and power of the lens $P = \frac{d-D}{dD}$

(3) **Presbyopia :** In this defect both near and far objects are not clearly visible. It is an old age disease and it is due to the loosing power of accommodation. It can be removed by using bifocal lens.

(4) **Astigmatism :** In this defect eye cannot see horizontal and vertical lines clearly, simultaneously. It is due to imperfect spherical nature of eye lens. This defect can be removed by using cylindrical lens (Torric lenses).

Lens Camera

(1) In lens camera a converging lens of adjustable aperture is used.

(2) Distance of film from lens is also adjustable.

(3) In photographing an object, the image is first focused on the film by adjusting the distance between lens and film. It is called focusing. After focusing, aperture is set to a specific value and then film is exposed to light for a given time through shutter.

(4) ***f*-number :** The ratio of focal length to the aperture of lens is called *f*-number of the camera.

2, 2.8, 4, 5.6, 8, 11, 22, 32 are the *f*-numbers marked on aperture.

$$f\text{-number} = \frac{\text{Focal length}}{\text{Aperture}} \Rightarrow \text{Aperture} \propto \frac{1}{f\text{-number}}$$

(5) **Time of exposure :** It is the time for which the shutter opens and light enters the camera to expose film.

(i) If intensity of light is kept fixed then for proper exposure

$$\text{Time of exposure } (t) \propto \frac{1}{(\text{Aperture})^2}$$

(ii) If aperture is kept fixed then for proper exposure

$$\text{Time of exposure } (t) \propto \frac{1}{[\text{Intensity}(I)]^2}$$

$$\Rightarrow I\,t = \text{constant} \Rightarrow I_1 t_1 = I_2 t_2$$

(iii) Smaller the *f*-number larger will be the aperture and lesser will be the time of exposure and faster will be the camera.

(6) **Depth of focus :** It refers to the range of distance over which the object may lie so as to form a good quality image. Large *f*-number increase the depth of focus.

Microscope

It is an optical instrument used to see very small objects. It's magnifying power is given by

$$m = \frac{\text{Visual angle with instrument}(\beta)}{\text{Visual angle when object is placed at least distance of distinct vision}(\alpha)}$$

(1) **Simple microscope**

(i) It is a single convex lens of lesser focal length.

(ii) Also called magnifying glass or reading lens.

(iii) Magnification's, when final image is formed at D and ∞ (*i.e.* m_D and m_∞) $m_D = \left(1 + \frac{D}{f}\right)_{max}$ and $m_\infty = \left(\frac{D}{f}\right)_{min}$

(iv) If lens is kept at a distance a from the eye then $m_D = 1 + \frac{D-a}{f}$ and $m_\infty = \frac{D-a}{f}$

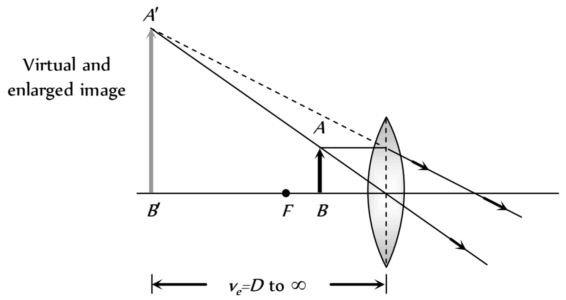


Fig. 29.81

(2) **Compound microscope**

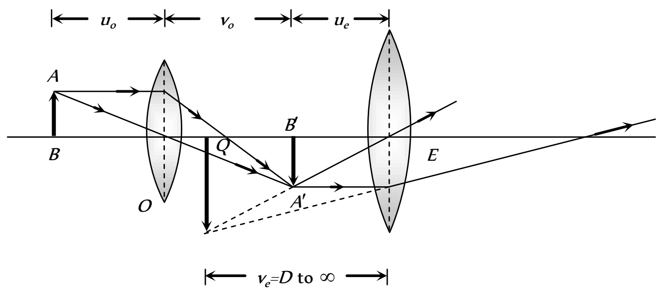


Fig. 29.82

(i) Consist of two converging lenses called objective and eye lens.

(ii) $f_{\text{eye lens}} > f_{\text{objective}}$ and $(\text{diameter})_{\text{eye lens}} > (\text{diameter})_{\text{objective}}$

(iii) Intermediate image is real and enlarged.

(iv) Final image is magnified, virtual and inverted.

(v) u_o = Distance of object from objective (o), v_o = Distance of image $(A'B')$ formed by objective from objective, u_e = Distance of $A'B'$ from eye lens, v_e = Distance of final image from eye lens, f_o = Focal length of objective, f_e = Focal length of eye lens.

(vi) **Final image is formed at D :** Magnification $m_D = -\frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right)$ and length of the microscope tube (distance between two lenses) is $L_D = v_o + u_e$.

Generally object is placed very near to the principal focus of the objective hence $u_o \cong f_o$. The eye piece is also of small focal length and the image formed by the objective is also very near to the eye piece.

So $v_o \cong L_D$, the length of the tube.

Hence, we can write $m_D = \frac{-L}{f_o}\left(1 + \frac{D}{f_e}\right)$

(vii) **Final image is formed at ∞ :** Magnification

$m_\infty = -\frac{v_0}{u_0} \cdot \frac{D}{f_e}$ and length of tube $L_\infty = v_0 + f_e$

In terms of length $m_\infty = \frac{(L_\infty - f_o - f_e)D}{f_o f_e}$

(viii) For large magnification of the compound microscope, both f_o and f_e should be small.

(ix) If the length of the tube of microscope increases, then its magnifying power increases.

(x) The magnifying power of the compound microscope may be expressed as $M = m_o \times m_e$; where m_o is the magnification of the objective and m_e is magnifying power of eye piece.

Astronomical Telescope (Refracting Type)

By astronomical telescope heavenly bodies are seen.

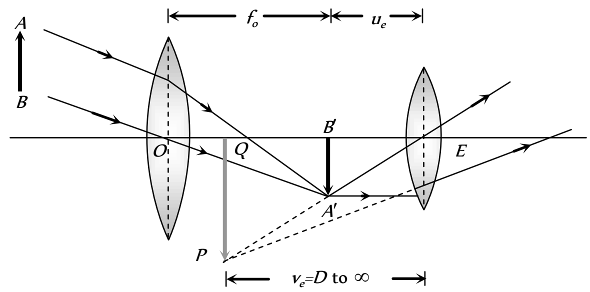


Fig. 29.83

(1) $f_{\text{objective}} > f_{\text{eyelens}}$ and $d_{\text{objective}} > d_{\text{eye lens}}$.

(2) Intermediate image is real, inverted and small.

(3) Final image is virtual, inverted and small.

(4) Magnification : $m_D = -\frac{f_0}{f_e}\left(1 + \frac{f_e}{D}\right)$ and $m_\infty = -\frac{f_o}{f_e}$

(5) Length : $L_D = f_0 + u_e$ and $L_\infty = f_0 + f_e$

Terrestrial Telescope

It is used to see far off object on the earth.

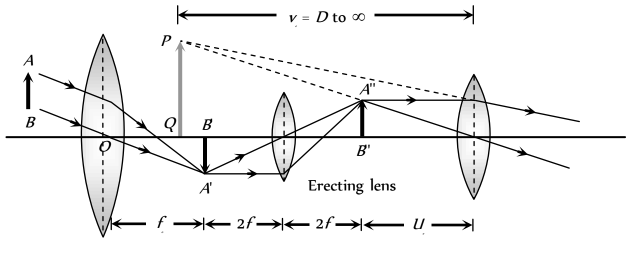


Fig. 29.84

(1) It consists of three converging lens : objective, eye lens and erecting lens.

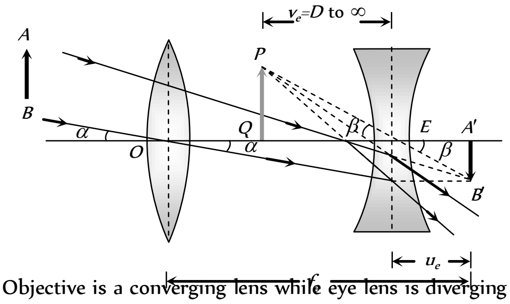
(2) It's final image is virtual, erect and smaller.

(3) Magnification : $m_D = \frac{f_0}{f_e}\left(1+\frac{f_e}{D}\right)$ and $m_\infty = \frac{f_0}{f_e}$

(4) Length : $L_D = f_0 + 4f + u_e$ and $L_\infty = f_0 + 4f + f_e$

Galilean Telescope

It is also type of terrestrial telescope but of much smaller field of view.



(1) Objective is a converging lens while eye lens is diverging lens.

Fig. 29.85

(2) Magnification : $m_D = \frac{f_0}{f_e}\left(1-\frac{f_e}{D}\right)$ and $m_\infty = \frac{f_0}{f_e}$

(3) Length : $L_D = f_0 - u_e$ and $L_\infty = f_0 - f_e$

Reflecting Telescope

Reflecting telescopes are based upon the same principle except that the formation of images takes place by reflection instead of by refraction.

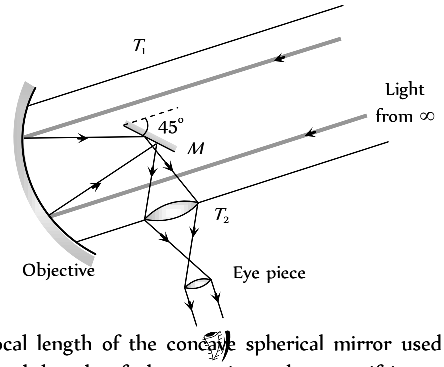


Fig. 29.86

If f_o is focal length of the concave spherical mirror used as objective and f_e the focal length of the eye-piece, the magnifying power of the reflecting telescope is given by $m = \frac{f_o}{f_e}$

Further, if D is diameter of the objective and d, the diameter of the pupil of the eye, then brightness ratio (β) is given by $\beta = \frac{D^2}{d^2}$

Resolving Limit and Resolving Power

(1) **Microscope :** In reference to a microscope, the minimum distance between two lines at which they are just distinct is called Resolving limit (RL) and it's reciprocal is called Resolving power (RP)

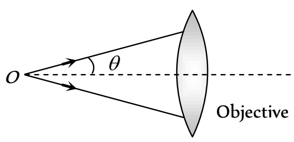


Fig. 29.87

$$R.L. = \frac{\lambda}{2\mu\sin\theta} \text{ and } R.P. = \frac{2\mu\sin\theta}{\lambda} \Rightarrow R.P. \propto \frac{1}{\lambda}$$

λ = Wavelength of light used to illuminate the object,

μ = Refractive index of the medium between object and objective,

θ = Half angle of the cone of light from the point object, $\mu\sin\theta$ = Numerical aperture.

(2) **Telescope :** Smallest angular separations ($d\theta$) between two distant objects, whose images are separated in the telescope is called resolving limit. So resolving limit $d\theta = \frac{1.22\lambda}{a}$

and resolving power $(RP) = \frac{1}{d\theta} = \frac{a}{1.22\lambda} \Rightarrow R.P. \propto \frac{1}{\lambda}$ where a = aperture of objective.

Binocular

If two telescopes are mounted parallel to each other so that an object can be seen by both the eyes simultaneously, the arrangement is called 'binocular'. In a binocular, the length of each tube is reduced by using a set of totally reflecting prisms which provide intense, erect image free from lateral inversion. Through a binocular we get two images of the same object from different angles at same time. Their superposition gives the perception of depth along with length and breadth, *i.e.*, binocular vision gives proper three-dimensional (3D) image.

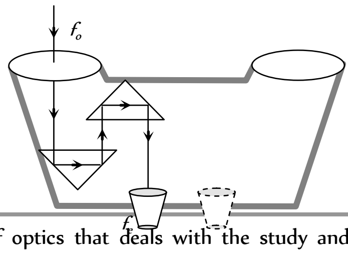


Fig. 29.88

Photometry

The branch of optics that deals with the study and measurement of the light energy is called photometry.

(1) **Radiant flux (R) :** The total energy radiated by a source per second is called radiant flux. It's S.I. unit is **Watt (W)**.

(2) **Luminous flux (ϕ) :** The total light energy emitted by a source per second is called luminous flux. It represents the total brightness producing capacity of the source. It's S.I. unit is **Lumen (lm)**.

(3) **Luminous efficiency (η) :** The Ratio of luminous flux and radiant flux is called luminous efficiency *i.e.* $\eta = \frac{\phi}{R}$.

Table 29.4 : Luminous flux and efficiency

Light source	Flux (lumen)	Efficiency (lumen/watt)
40 W tungsten bulb	465	12
60 W tungsten bulb	835	14
500 W tungsten bulb	9950	20
30 W fluorescent tube	1500	50

(4) **Luminous Intensity (L) :** In a given direction it is defined as luminous flux per unit solid angle *i.e.*

$$L = \frac{\phi}{\omega} \rightarrow \frac{\text{Light energy}}{\text{sec} \times \text{solid angle}} \xrightarrow{\text{S.I. unit}} \frac{\text{lumen}}{\text{steradian}} = \text{candela}\,(Cd)$$

The luminous intensity of a point source is given by : $L = \frac{\phi}{4\pi} \Rightarrow$ $\phi = 4\pi \times (L)$

(5) **Illuminance or intensity of illumination (*I*) :** The luminous flux incident per unit area of a surface is called illuminance. $I = \frac{\phi}{A}$. It's S.I. unit is $\frac{\text{Lumen}}{m^2}$ or Lux (*lx*) and it's C.G.S. unit is Phot. $1\,\text{Phot} = 10^4\,\text{Lux} = \frac{1\,\text{Lumen}}{cm^2}$

(i) Intensity of illumination at a distance *r* from a point source is $I = \frac{\phi}{4\pi r^2} \Rightarrow I \propto \frac{1}{r^2}$.

(ii) Intensity of illumination at a distance *r* from a line source is $I = \frac{\phi}{2\pi r l} \Rightarrow I \propto \frac{1}{r}$

(iii) In case of a parallel beam of light $I \propto r^0$.

(iv) The illuminance represents the luminous flux incident on unit area of the surface, while luminance represents the luminous flux reflected from a unit area of the surface.

(6) **Relation Between Luminous Intensity (*L*) and Illuminance (*I*) :** If S is a unidirectional point source of light of luminous intensity L and there is a surface at a distance r from source, on which light is falling normally.

(i) Illuminance of surface is given by : $I = \frac{L}{r^2}$

(ii) For a given source *L* = constant so $I \propto \frac{1}{r^2}$; This is called. Inverse square law of illuminance.

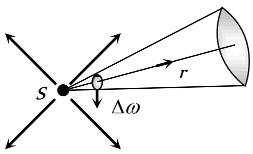


Fig. 29.89

(7) **Lambert's Cosine Law of Illuminance :** In the above discussion if surface is so oriented that light from the source falls, on it obliquely and the central ray of light makes an angle θ with the normal to the surface, then

(i) Illuminance of the surface $I = \frac{L\cos\theta}{r^2}$

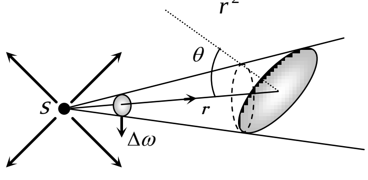


Fig. 29.90

(ii) For a given light source and point of illumination (*i.e.* *L* and *r* = constant) $I \propto \cos\theta$ this is called Lambert's cosine law of illuminance. $\Rightarrow I_{max} = \frac{L}{r^2} = I_o(\text{at}\,\theta = 0^o)$

(iii) For a given source and plane of illuminance (*i.e.* *L* and *h* = constant)

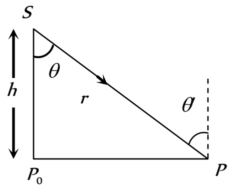


Fig. 29.91

$\cos\theta = \frac{h}{r}$ so $I = \frac{L}{h^2}\cos^3\theta$

or $I = \frac{Lh}{r^3}$ *i.e.* $I \propto \cos^3\theta$ or $I \propto \frac{1}{r^3}$

(8) **Photometer and Principle of Photometry :** A photometer is a device used to compare the illuminance of two sources.

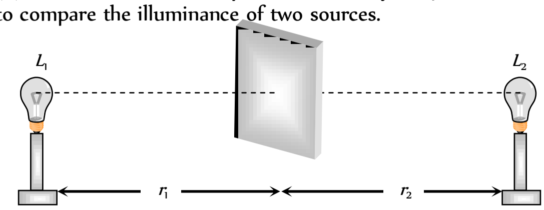


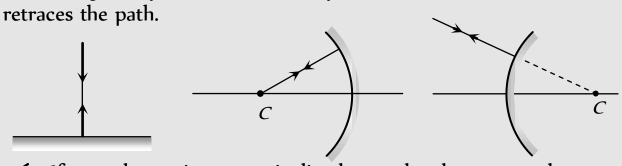
Fig. 29.92

Two sources of luminous intensity L_1, and L_2 are placed at distances r_1 and r_2 from the screen so that their flux are perpendicular to the screen. The distance r_1 and r_2 are adjusted till $I_1 = I_2$. So $\frac{L_1}{r_1^2} = \frac{L_2}{r_2^2} \Rightarrow \frac{L_1}{L_2} = \left(\frac{r_1}{r_2}\right)^2$; This is called principle of photometry.

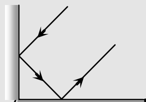
Tips & Tricks

✍ After reflection velocity, wavelength and frequency of light remains same but intensity decreases.

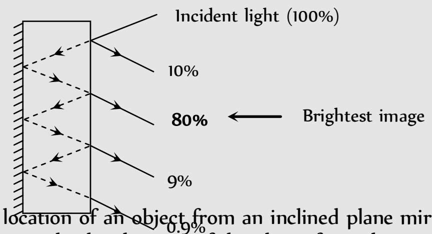
✍ If light ray incident normally on a surface, after reflection it retraces the path.



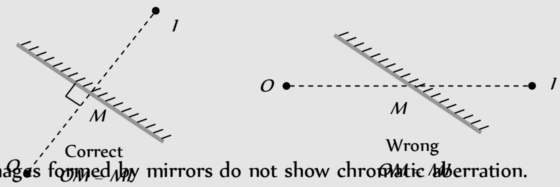
✍ If two plane mirrors are inclined to each other at 90°, the emergent ray is anti-parallel to incident ray, if it suffers one reflection from each. Whatever be the angle to incidence.



✍ We observe number of [illegible] thick plane mirror, out of them only second is brightest.



✍ To find the location of an object from an inclined plane mirror, you have to see the perpendicular distance of the object from the mirror.



✍ Images formed by mirrors do not show chromatic aberration.

✍ In concave mirror, minimum distance between a real object and it's real image is zero. (*i.e.* when *u* = *v* = 2*f*)

✍ If a spherical mirror produces an image '*m*' times the size of the object (m = magnification) then u, v and f are given by the followings

$$u = \left(\frac{m-1}{m}\right)f, \quad v = -(m-1)f \text{ and } f = \left(\frac{m}{m-1}\right)u$$

✍ Focal length of a mirror is independent of material of mirror and medium in which it is placed and wavelength of incident light

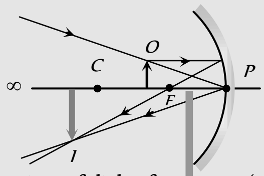
✍ Divergence or Convergence power of a mirror does not change with the change in medium.

✍ If an object is moving at a speed v towards a spherical mirror along it's axis then speed of image away from mirror is

$$v_i = -\left(\frac{f}{u-f}\right)^2 . v_o$$

✍ When object is moved from focus to infinity at constant speed, the image will move faster in the beginning till object moves from f to $2f$, and slower later on, towards the mirror.

✍ As every part of mirror forms a complete image, if a part of the mirror is obstructed, full image will be formed but intensity will be reduced.



✍ In case of refraction of light frequency (and hence colour) and phase do not change (while wavelength and velocity will change).

✍ *In the refraction intensity of incident light decreases as it goes from one medium to another medium.*

✍ A transparent solid is invisible in a liquid of same refractive index (Because of No refraction).

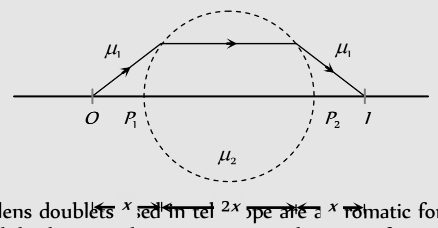
✍ When a glass slab is kept over various coloured letters and seen from the top, the violet colour letters appears closer (Because $\lambda_V < \lambda_R$ so $\mu_V > \mu_R$ and from $\mu = \frac{h}{h'}$ if μ increases then h' decreases i.e. Letter appears to be closer)

✍ Minimum distance between an object and it's real image formed by a convex lens is $4f$.

✍ Component lenses of an achromatic doublet cemented by canada blasam because it is transparent and has a refractive index almost equal to the refractive index of the glass.

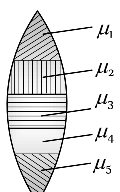
✍ Parabolic mirrors are free from spherical aberration.

✍ If a sphere of radius R made of material of refractive index μ_2 is placed in a medium of refractive index μ_1, then if the object is placed at a distance $\left(\frac{\mu_1}{\mu_2-\mu_1}\right)R$ from the pole, the real image formed is equidistant from the sphere



✍ The lens doublets used in telescope are achromatic for blue and red colours, while these used in camera are achromatic for violet and green colours. The reason for this is that our eye is most sensitive between blue and red colours, while the photographic plates are most sensitive between violet and green colours.

✍ **Composite lens :** If a lens is made of several materials then



Number of images formed = Number of materials used

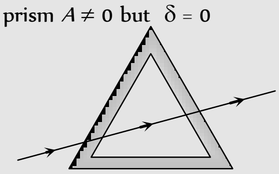
Here no. of images = 5

✍ For the condition of grazing emergence through a prism. Minimum angle of incidence $i_{min} = \sin^{-1}\left[\sqrt{\mu^2 - 1}\sin A - \cos A\right]$.

✍ If a substance emits spectral lines at high temperature then it absorbs the same lines at low temperature. This is Kirchoff's law.

✍ When a ray of white light passes through a glass prism red light is deviated less than blue light.

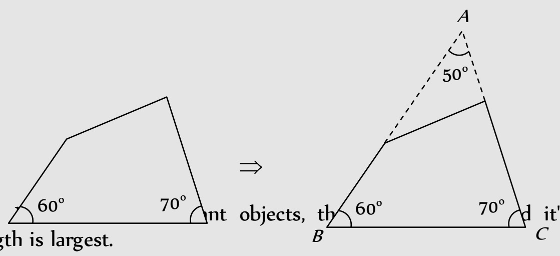
✍ For a hollow prism $A \neq 0$ but $\delta = 0$



✍ If an opaque coloured object or crystal is crushed to fine powder it will appear white (in sun light) as it will lose it's property of selective reflection.

✍ Our eye is most sensitive to that part of the spectrum which lies between the F line (sky green) and the C-line (red) of hydrogen, and the mean refractive index of this part is nearly equal to the refractive index for the D line (yellow) of sodium. Hence for the dispersive power, the following formula is internationally accepted $\omega = \frac{\mu_F - \mu_C}{\mu_D - 1}$

✍ Sometimes a part of prism is given and we keep on thinking whether how should we proceed ? To solve such problems first complete the prism then solve as the problems of prism are solved



✍ ... nt objects, th ... d it's focal length is largest.

✍ Minimum separation (d) between objects, so they can just resolved by a telescope is : $d = \frac{r}{R.P.}$

Where r = distance of objects from telescope.

✍ As magnifying power astronomical telescope is negative, the image seen in astronomical telescope is truly inverted, i.e., left is turned right with upside down simultaneously. However, as most of the astronomical objects are symmetrical this inversion does not affect the observations.

✍ If objective and eye lens of a telescope are interchanged, it will not behave as a microscope but object appears very small.

✍ In a telescope, if field and eye lenses are interchanged magnification will change from (f_o/f_e) to (f_e/f_o), *i.e.,* it will change from m to $(1/m)$, i.e., will become $(1/m)$ times of its initial value.

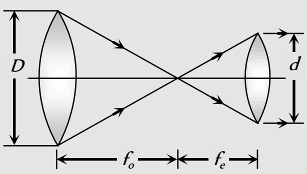
✍ As magnification produced by telescope for normal setting is (f_o/f_e), so to have large magnification, f_o must be as large as practically possible and f_e small. This is why in a telescope, objective is of large focal length while eye piece of small.

✍ In a telescope, aperture of the field lens is made as large as practically possible to increase its resolving power as resolving power of a telescope $\propto (D/\lambda)$. Large aperture of objective also helps in improving the brightness of image by gathering more light from distant object. However, it increases aberrations particularly spherical.

✍ For a telescope with increase in length of the tube, magnification decreases.

✍ In case of a telescope if object and final image are at infinity then :

$m = \frac{f_o}{f_e} = \frac{D}{d}$



✍ If we are given four convex lenses having focal lengths $f_1 > f_2 > f_3 > f_4$. For making a good telescope and microscope. We choose the following lenses respectively.

Telescope $f_1(o), f_4(e)$ Microscope $f_4(o), f_3(e)$

✍ If a parrot is sitting on the objective of a large telescope and we look towards (or take a photograph)of distant astronomical object (say moon) through it, the parrot will not be seen but the intensity of the image will be slightly reduced as the parrot will act as obstruction to light and will reduce the aperture of the objective.

✍ The luminous flux of a source of (1/685) watt emitting monochromatic light of wavelength 5500 Å is called 1 lumen.

✍ While solving the problems of photometry keep in mind.

$R \propto \phi \propto L$ (As $\phi = \eta R = 4\pi L$)

$\Rightarrow \frac{R_1}{R_2} = \frac{\phi_1}{\phi_2} = \frac{L_1}{L_2}$

Ordinary Thinking

Objective Questions

Plane Mirror

1. Two vertical plane mirrors are inclined at an angle of $60°$ with each other. A ray of light travelling horizontally is reflected first from one mirror and then from the other. The resultant deviation is
   (a) $60°$ (b) $120°$
   (c) $180°$ (d) $240°$

2. A plane mirror reflects a pencil of light to form a real image. Then the pencil of light incident on the mirror is
   [MP PMT 1997; DCE 2001, 03]
   (a) Parallel (b) Convergent
   (c) Divergent (d) None of the above

3. What should be the angle between two plane mirrors so that whatever be the angle of incidence, the incident ray and the reflected ray from the two mirrors be parallel to each other
   [KCET 1994; SCRA 1994]
   (a) $60°$ (b) $90°$
   (c) $120°$ (d) $175°$

4. A plane mirror reflecting a ray of incident light is rotated through an angle θ about an axis through the point of incidence in the plane of the mirror perpendicular to the plane of incidence, then
   (a) The reflected ray does not rotate
   (b) The reflected ray rotates through an angle θ
   (c) The reflected ray rotates through an angle 2θ
   (d) The incident ray is fixed

5. A plane mirror is approaching you at a speed of $10\,cm/sec$ You can see your image in it. At what speed will your image approach you [CPMT 1974]
   (a) $10cm/sec$ (b) $5cm/sec$
   (c) $20cm/sec$ (d) $15cm/sec$

6. A light bulb is placed between two plane mirrors inclined at an angle of $60°$. The number of images formed are
   SCRA 1994; AIIMS 1997; RPMT 1999; AIEEE 2002; Orissa JEE 2003; MP PMT 2004; MP PET 2004]
   (a) 6 (b) 2
   (c) 5 (d) 4

7. It is desired to photograph the image of an object placed at a distance of $3m$ from the plane mirror. The camera which is at a distance of $4.5m$ from the mirror should be focussed for a distance of [NCERT 1971]
   (a) $3m$ (b) $4.5m$
   (c) $6m$ (d) $7.5m$

8. A thick plane mirror shows a number of images of the filament of an electric bulb. Of these, the brightest image is the
   (a) First (b) Second
   (c) Fourth (d) Last

9. A man is $180cm$ tall and his eyes are $10cm$ below the top of his head. In order to see his entire height right from toe to head, he uses a plane mirror kept at a distance of $1m$ from him. The minimum length of the plane mirror required is
   [MP PMT 1993; DPMT 2001]
   (a) $180cm$ (b) $90cm$
   (c) $85cm$ (d) $170cm$

10. A person is in a room whose ceiling and two adjacent walls are mirrors. How many images are formed [AFMC 2002]
    (a) 5 (b) 6
    (c) 7 (d) 8

11. When a plane mirror is placed horizontally on a level ground at a distance of $60m$ from the foot of a tower, the top of the tower and its image in the mirror subtend an angle of $90°$ at the eye. The height of the tower will be [CPMT 1984]
    (a) $30m$ (b) $60m$
    (c) $90m$ (d) $120m$

12. A ray of light incidents on a plane mirror at an angle of $30°$. The deviation produced in the ray is
    (a) $30°$ (b) $60°$
    (c) $90°$ [NCERT 1978; CPMT 1991] (d) $120°$

13. A ray of light is incidenting normally on a plane mirror. The angle of reflection will be [MP PET 2000]

(a) $0°$ (b) $90°$

(c) Will not be reflected (d) None of the above

14. When light wave suffers reflection at the interface from air to glass, the change in phase of the reflected wave is equal to [CPMT 1991; J & KCET 2004]

(a) 0 (b) $\frac{\pi}{2}$

(c) π (d) 2π

15. A ray is reflected in turn by three plain mirrors mutually at right angles to each other. The angle between the incident and the reflected rays is [Roorkee 1995]

(a) $90°$ (b) $60°$

(c) $180°$ (d) None of these

16. Two plane mirrors are at right angles to each other. A man stands between them and combs his hair with his right hand. In how many of the images will he be seen using his right hand [MP PMT 1995; UPSEAT 2001]

(a) None (b) 1

(c) 2 (d) 3

17. When a plane mirror is rotated through an angle θ then the reflected ray turns through the angle 2θ then the size of the image

(a) Is doubled (b) Is halved

(c) Remains the same (d) Becomes infinite

18. A plane mirror produces a magnification of [MP PET/PMT 1997]

(a) -1 (b) $+1$

(c) Zero (d) Between 0 and $+\infty$

19. A plane mirror makes an angle of $30°$ with horizontal. If a vertical ray strikes the mirror, find the angle between mirror and reflected ray [RPET 1997]

(a) $30°$ (b) $45°$

(c) $60°$ (d) $90°$

20. A watch shows time as $3:25$ when seen through a mirror, time appeared will be [RPMT 1997; JIPMER 2001, 02]

(a) $8:35$ (b) $9:35$

(c) $7:35$ (d) $8:25$

21. If an observer is walking away from the plane mirror with $6m/sec$. Then the velocity of the image with respect to observer will be [RPMT 1999]

(a) $6m/sec$ (b) $-6m/sec$

(c) $12m/sec$ (d) $3m/sec$

22. A man runs towards mirror at a speed of $15m/s$. What is the speed of his image [CBSE PMT 2000]

(a) 7.5 m/s (b) 15 m/s

(c) 30 m/s (d) 45 m/s

23. A small object is placed 10 cm infront of a plane mirror. If you stand behind the object 30 cm from the mirror and look at its image, the distance focused for your eye will be [KCET (Engg.) 2001]

(a) 60 cm (b) 20 cm

(c) 40 cm (d) 80 cm

24. An object is at a distance of 0.5 m in front of a plane mirror. Distance between the object and image is [CPMT 2002]

(a) 0.5 m (b) 1 m

(c) 0.25 m (d) 1.5 m

25. A man runs towards a mirror at a speed 15 m/s The speed of the image relative to the man is [Kerala PET 2002]

(a) 15 ms^{-1} (b) 30 ms^{-1}

(c) 35 ms^{-1} (d) 20 ms^{-1}

26. The light reflected by a plane mirror may form a real image [KCET (Engg. & Med.) 2002]

(a) If the rays incident on the mirror are diverging

(b) If the rays incident on the mirror are converging

(c) If the object is placed very close to the mirror

(d) Under no circumstances

27. Two plane mirrors are inclined at an angle of 72^0. The number of images of a point object placed between them will be [KCET (Engg. & Med.)1999;

(a) 2 (b) 3

(c) 4 (d) 5

28. To get three images of a single object, one should have two plane mirrors at an angle of [AIEEE 2003]

(a) 30° (b) 60°

(c) 90° (d) 150°

29. A man of length h requires a mirror, to see his own complete image of length at least equal to [MP PET 2003]

(a) $\frac{h}{4}$ (b) $\frac{h}{3}$

(c) $\frac{h}{2}$ (d) h

30. Two plane mirrors are at $45°$ to each other. If an object is placed between them, then the number of images will be [MP PMT 2003]

(a) 5 (b) 9

(c) 7 (d) 8

31. A man having height 6 m. He observes image of 2 m height erect, then mirror used is [BCECE 2004]

(a) Concave (b) Convex

(c) Plane (d) None of these

32. A light beam is being reflected by using two mirrors, as in a periscope used in submarines. If one of the mirrors rotates by an angle θ, the reflected light will deviate from its original path by the angle [UPSEAT 2004]

(a) 2θ (b) 0^o

(c) θ (d) 4θ

33. Focal length of a plane mirror is [RPMT 2000]

(a) Zero (b) Infinite

(c) Very less (d) Indefinite

34. A ray of light is incident at 50° on the middle of one of the two mirrors arranged at an angle of 60° between them. The ray then touches the second mirror, get reflected back to the first mirror, making an angle of incidence of [MP PET 2005]

(a) 50° (b) 60°

(c) 70° (d) 80°

Spherical Mirror

1. A convex mirror of focal length *f* forms an image which is $\frac{1}{n}$ times the object. The distance of the object from the mirror is

(a) $(n-1)f$ (b) $\left(\frac{n-1}{n}\right)f$

(c) $\left(\frac{n+1}{n}\right)f$ (d) $(n+1)f$

2. A diminished virtual image can be formed only in [MP PMT 2002]

(a) Plane mirror (b) A concave mirror

(c) A convex mirror (d) Concave-parabolic mirror

3. Which of the following could not produce a virtual image

(a) Plane mirror

(b) Convex mirror

(c) Concave mirror

(d) All the above can produce a virtual image

4. An object $5cm$ tall is placed $1m$ from a concave spherical mirror which has a radius of curvature of $20cm$ The size of the image is

(a) $0.11cm$ (b) $0.50cm$

(c) $0.55cm$ (d) $0.60cm$

5. The focal length of a concave mirror is $50cm$. Where an object be placed so that its image is two times and inverted

(a) 75 *cm* (b) 72 *cm*

(c) 63 *cm* (d) 50 *cm*

6. An object of size $7.5cm$ is placed in front of a convex mirror of radius of curvature $25cm$ at a distance of $40cm$. The size of the image should be

(a) $2.3cm$ (b) $1.78cm$

(c) $1cm$ (d) $0.8cm$

7. The field of view is maximum for

(a) Plane mirror (b) Concave mirror

(c) Convex mirror (d) Cylindrical mirror

8. The focal length of a concave mirror is *f* and the distance from the object to the principle focus is *x*. The ratio of the size of the image to the size of the object is [Kerala PET 2005]

(a) $\frac{f+x}{f}$ (b) $\frac{f}{x}$

(c) $\sqrt{\frac{f}{x}}$ (d) $\frac{f^2}{x^2}$

9. Image formed by a convex mirror is [MP PET 1993]

(a) Virtual (b) Real

(c) Enlarged (d) Inverted

10. In a concave mirror experiment, an object is placed at a distance x_1 from the focus and the image is formed at a distance x_2 from the focus. The focal length of the mirror would be

(a) x_1x_2 (b) $\sqrt{x_1x_2}$

(c) $\frac{x_1+x_2}{2}$ (d) $\sqrt{\frac{x_1}{x_2}}$

11. A convex mirror is used to form the image of an object. Then which of the following statements is wrong [CPMT 1973]

(a) The image lies between the pole and the focus

(b) The image is diminished in size

(c) The image is erect

(d) The image is real

12. Given a point source of light, which of the following can produce a parallel beam of light [CPMT 1974; KCET 2005]

(a) Convex mirror

(b) Concave mirror

(c) Concave lens

(d) Two plane mirrors inclined at an angle of $90°$

13. The image formed by a convex mirror of focal length $30cm$ is a quarter of the size of the object. The distance of the object from the mirror is [MP PET 1993]

(a) $30cm$ (b) $90cm$

(c) $120cm$ (d) $60cm$

14. A boy stands straight infront of a mirror at a distance of $30cm$ away from it. He sees his erect image whose height is $\frac{1}{5}th$ of his real height. The mirror he is using is [MP PMT 1993]

(a) Plane mirror (b) Convex mirror

(c) Concave mirror (d) Plano-convex mirror

15. A person sees his virtual image by holding a mirror very close to the face. When he moves the mirror away from his face, the image becomes inverted. What type of mirror he is using

(a) Plane mirror (b) Convex mirror

(c) Concave mirror (d) None of these

16. Which one of the following statements is true

(a) An object situated at the principle focus of a concave lens will have its image formed at infinity

(b) Concave mirror can give diminished virtual image

(c) Given a point source of light, a convex mirror can produce a parallel beam of light

(d) The virtual image formed in a plane mirror can be photographed

17. The relation between the linear magnification m, the object distance u and the focal length f is

(a) $m = \frac{f-u}{f}$ (b) $m = \frac{f}{f-u}$

(c) $m = \frac{f+u}{f}$ (d) $m = \frac{f}{f+u}$

18. While using an electric bulb, the reflection for street lighting should be from

(a) Concave mirror (b) Convex mirror

(c) Cylindrical mirror (d) Parabolic mirror

19. A concave mirror is used to focus the image of a flower on a nearby well $120cm$ from the flower. If a lateral magnification of 16 is desired, the distance of the flower from the mirror should be

(a) $8cm$ (b) $12cm$

(c) $80cm$ (d) $120cm$

20. A virtual image larger than the object can be obtained by [MP PMT 1986]

(a) Concave mirror (b) Convex mirror

(c) Plane mirror (d) Concave lens

21. An object is placed $40cm$ from a concave mirror of focal length $20cm$. The image formed is [MP PET 1986; MP PMT/PET 1998]

(a) Real, inverted and same in size

(b) Real, inverted and smaller

(c) Virtual, erect and larger

(d) Virtual, erect and smaller

22. A virtual image three times the size of the object is obtained with a concave mirror of radius of curvature $36cm$. The distance of the object from the mirror is [MP PET 1986]

(a) $5cm$ (b) $12cm$

(c) $10cm$ (d) $20cm$

23. Radius of curvature of concave mirror is $40cm$ and the size of image is twice as that of object, then the object distance is [AFMC 1995]

(a) $60cm$ (b) $20cm$

(c) $40cm$ (d) $30cm$

24. All of the following statements are correct except [Manipal MEE 1995]

(a) The magnification produced by a convex mirror is always less than one

(b) A virtual, erect, same-sized image can be obtained using a plane mirror

(c) A virtual, erect, magnified image can be formed using a concave mirror

(d) A real, inverted, same-sized image can be formed using a convex mirror

25. If an object is placed $10cm$ infront of a concave mirror of focal length $20cm$, the image will be [MP PMT 1995]

(a) Diminished, upright, virtual

(b) Enlarged, upright, virtual

(c) Diminished, inverted, real

(d) Enlarged, upright, real

26. Which of the following form(s) a virtual and erect image for all positions of the object [IIT-JEE 1996]

(a) Convex lens (b) Concave lens

(c) Convex mirror (d) Concave mirror

27. A convex mirror has a focal length f. A real object is placed at a distance f in front of it from the pole produces an image at [MP PET 1986]

(a) Infinity (b) f

(c) $f/2$ (d) $2f$

28. An object $1cm$ tall is placed $4cm$ infront of a mirror. In order to produce an upright image of $3cm$ height one needs a

(a) Convex mirror of radius of curvature $12cm$

(b) Concave mirror of radius of curvature $12cm$

(c) Concave mirror of radius of curvature $4cm$

(d) Plane mirror of height $12cm$

29. Match List I with List II and select the correct answer using the codes given below the lists : [SCRA 1998]

List I	List II
(Position of the object)	(Magnification)
(I) An object is placed at focus before a convex mirror	(A) Magnification is $-\infty$
(II) An object is placed at centre of curvature before a concave mirror	(B) Magnification is 0.5
(III) An object is placed at focus before a concave mirror	(C) Magnification is $+1$
(IV) An object is placed at centre of curvature before a convex mirror	(D) Magnification is – 1
	(E) Magnification is 0.33

Codes :

(a) I-B, II-D, III-A, IV-E (b) I-A, II-D, III-C, IV-B

(c) I-C, II-B, III-A, IV-E (d) I-B, II-E, III-D, IV-C

30. A concave mirror gives an image three times as large as the object placed at a distance of $20cm$ from it. For the image to be real, the focal length should be [SCRA 1998; JIPMER 2000]

(a) $10cm$ (b) $15cm$

(c) $20cm$ (d) $30cm$

31. The minimum distance between the object and its real image for concave mirror is [RPMT 1999]

(a) f (b) $2f$

(c) $4f$ (d) Zero

32. An object is placed at $20 cm$ from a convex mirror of focal length $10 cm$. The image formed by the mirror is

[JIPMER 1999]

(a) Real and at $20 cm$ from the mirror

(b) Virtual and at $20 cm$ from the mirror

(c) Virtual and at $20/3 cm$ from the mirror

(d) Real and at $20/3 cm$ from the mirror

33. A point object is placed at a distance of $10 cm$ and its real image is formed at a distance of $20 cm$ from a concave mirror. If the object is moved by $0.1 cm$ towards the mirror, the image will shift by about [MP PMT 2000]

(a) $0.4 cm$ away from the mirror

(b) $0.4 cm$ towards the mirror

(c) $0.8 cm$ away from the mirror

(d) $0.8 cm$ towards the mirror

34. Under which of the following conditions will a convex mirror of focal length f produce an image that is erect, diminished and virtual [AMU (Engg.) 2001]

(a) Only when $2f > u > f$ (b) Only when $u = f$

(c) Only when $u < f$ (d) Always

35. The focal length of a convex mirror is 20 *cm* its radius of curvature will be [MP PMT 2001]

(a) 10 *cm* (b) 20 *cm*

(c) 30 *cm* (d) 40 *cm*

36. A concave mirror of focal length 15 *cm* forms an image having twice the linear dimensions of the object. The position of the object when the image is virtual will be

(a) 22.5 *cm* (b) 7.5 *cm*

(c) 30 *cm* (d) 45 *cm*

37. A point object is placed at a distance of 30 *cm* from a convex mirror of focal length 30*cm*. The image will form at

[JIPMER 2002]

(a) Infinity

(b) Focus

(c) Pole

(d) 15 *cm* behind the mirror

38. An object 2.5 *cm* high is placed at a distance of 10 *cm* from a concave mirror of radius of curvature 30 *cm* The size of the image is [BVP 2003]

(a) 9.2 *cm* (b) 10.5 *cm*

(c) 5.6 *cm* (d) 7.5 *cm*

39. For a real object, which of the following can produced a real image

(a) Plane mirror (b) Concave lens

(c) Convex mirror (d) Concave mirror

40. An object of length 6 *cm* is placed on the principle axis of a concave mirror of focal length f at a distance of $4f$. The length of the image will be [MP PET 2003]

(a) 2 *cm* (b) 12 *cm*

(c) 4 *cm* (d) 1.2 *cm*

41. Convergence of concave mirror can be decreased by dipping in

(a) Water (b) Oil

(c) Both (d) None of these

42. What will be the height of image when an object of 2 *mm* is placed on the axis of a convex mirror at a distance 20 *cm* of radius of curvature 40 *cm* [Orissa PMT 2004]

(a) 20 *mm* (b) 10 *mm*

(c) 6 *mm* (d) 1 *mm*

43. Image formed by a concave mirror of focal length 6 *cm*, is 3 times of the object, then the distance of object from mirror is

[RPMT 2000]

(a) – 4 *cm* (b) 8 *cm*

(c) 6 *cm* (d) 12 *cm*

44. A concave mirror of focal length f (in air) is immersed in water ($\mu = 4/3$). The focal length of the mirror in water will be

(a) f (b) $\frac{4}{3}f$

(c) $\frac{3}{4}f$ (d) $\frac{7}{3}f$

Refraction of Light at Plane Surfaces

1. To an observer on the earth the stars appear to twinkle. This can be ascribed to

[CPMT 1972, 74; AFMC 1995]

(a) The fact that stars do not emit light continuously

(b) Frequent absorption of star light by their own atmosphere

(c) Frequent absorption of star light by the earth's atmosphere

(d) The refractive index fluctuations in the earth's atmosphere

2. The ratio of the refractive index of red light to blue light in air is

(a) Less than unity

(b) Equal to unity

(c) Greater than unity

(d) Less as well as greater than unity depending upon the experimental arrangement

3. The refractive index of a piece of transparent quartz is the greatest for [MP PET 1985, 94]

(a) Red light (b) Violet light

(c) Green light (d) Yellow light

4. The refractive index of a certain glass is 1.5 for light whose wavelength in vacuum is 6000 Å. The wavelength of this light when it passes through glass is

[NCERT 1979; CBSE PMT 1993;

MP PET 1985, 89] [Orissa JEE 2003]

(a) 4000 Å (b) 6000 Å

(c) 9000 Å (d) 15000 Å

5. When light travels from one medium to the other of which the refractive index is different, then which of the following will change

[MP PMT 1986; AMU 2001; BVP 2003]

(a) Frequency, wavelength and velocity

(b) Frequency and wavelength

(c) Frequency and velocity

(d) Wavelength and velocity

6. A light wave has a frequency of 4×10^{14} Hz and a wavelength of 5×10^{-7} meters in a medium. The refractive index of the medium is [MP PMT 1989]

(a) 1.5 (b) 1.33

(c) 1.0 (d) 0.66

7. How much water should be filled in a container 21 *cm* in height, so that it appears half filled when viewed from the top of the container (given that ${}_a\mu_\omega = 4/3$) [MP PMT 1989]

(a) 8.0 *cm* (b) 10.5 *cm*

(c) 12.0 *cm* (d) None of the above

8. Light of different colours propagates through air

(a) With the velocity of air

(b) With different velocities

(c) With the velocity of sound

(d) Having the equal velocities

9. Monochromatic light is refracted from air into the glass of refractive index μ. The ratio of the wavelength of incident and refracted waves is [JIPMER 2000; MP PMT 1996, 2003]

(a) $1:\mu$ (b) $1:\mu^2$

(c) $\mu:1$ (d) 1 : 1

10. A monochromatic beam of light passes from a denser medium into a rarer medium. As a result [CPMT 1972]

(a) Its velocity increases (b) Its velocity decreases

(c) Its frequency decreases (d) Its wavelength decreases

11. Refractive index for a material for infrared light is [CPMT 1984]

(a) Equal to that of ultraviolet light

(b) Less than for ultraviolet light

(c) Equal to that for red colour of light

(d) Greater than that for ultraviolet light

12. The index of refraction of diamond is 2.0, velocity of light in diamond in *cm/second* is approximately [CPMT 1975; MNR 1987; UPSEAT 2000]

(a) 6×10^{10} (b) 3.0×10^{10}

(c) 2×10^{10} (d) 1.5×10^{10}

13. A beam of light propagating in medium *A* with index of refraction *n* (*A*) passes across an interface into medium *B* with index of refraction *n*(*B*). The angle of incidence is greater than the angle of refraction; *v*(*A*) and *v*(*B*) denotes the speed of light in *A* and *B*. Then which of the following is true

(a) $v(A) > v(B)$ and $n(A) > n(B)$

(b) $v(A) > v(B)$ and $n(A) < n(B)$

(c) $v(A) < v(B)$ and $n(A) > n(B)$

(d) $v(A) < v(B)$ and $n(A) < n(B)$

14. A rectangular tank of depth 8 meter is full of water ($\mu = 4/3$), the bottom is seen at the depth [MP PMT 1987]

(a) 6 *m* (b) 8/3 *m*

(c) 8 *cm* (d) 10 *cm*

15. A vessel of depth 2d *cm* is half filled with a liquid of refractive index μ_1 and the upper half with a liquid of refractive index μ_2. The apparent depth of the vessel seen perpendicularly is

(a) $d\left(\frac{\mu_1\mu_2}{\mu_1+\mu_2}\right)$ (b) $d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

(c) $2d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$ (d) $2d\left(\frac{1}{\mu_1\mu_2}\right)$

16. A beam of light is converging towards a point I on a screen. A plane glass plate whose thickness in the direction of the beam = t, refractive index = μ, is introduced in the path of the beam. The convergence point is shifted by [MNR 1987]

(a) $t\left(1-\frac{1}{\mu}\right)$ away (b) $t\left(1+\frac{1}{\mu}\right)$ away

(c) $t\left(1-\frac{1}{\mu}\right)$ nearer (d) $t\left(1+\frac{1}{\mu}\right)$ nearer

17. Light travels through a glass plate of thickness *t* and having refractive index *n*. If *c* is the velocity of light in vacuum, the time taken by the light to travel this thickness of glass is [NCERT 1976; MP PET 1994; CBSE PMT 1996; KCET 1994; MP PMT 1999, 2001]

(a) $\frac{t}{nc}$ (b) tnc

(c) $\frac{nt}{c}$ (d) $\frac{tc}{n}$

18. When a light wave goes from air into water, the quality that remains unchanged is its [AMU 1995; MNR 1985, 95; KCET 1993; CPMT 1990, 97; MP PET 1991, 2000, 02; UPSEAT 1999, 2000; AFMC 1993, 98, 2003; RPET 1996, 2000, 03; RPMT 1999, 2000; DCE 2001; BHU 2001]

(a) Speed (b) Amplitude

(c) Frequency (d) Wavelength

19. Light takes 8 *min* 20 *sec* to reach from sun on the earth. If the whole atmosphere is filled with water, the light will take the time (${}_a\mu_w = 4/3$)

(a) 8 *min* 20 *sec* (b) 8 *min*

(c) 6 *min* 11 *sec* (d) 11 *min* 6 *sec*

20. The length of the optical path of two media in contact of length d_1 and d_2 of refractive indices μ_1 and μ_2 respectively, is

(a) $\mu_1 d_1 + \mu_2 d_2$ (b) $\mu_1 d_2 + \mu_2 d_1$

(c) $\frac{d_1 d_2}{\mu_1\mu_2}$ (d) $\frac{d_1 + d_2}{\mu_1\mu_2}$

21. Immiscible transparent liquids A, B, C, D and E are placed in a rectangular container of glass with the liquids making layers according to their densities. The refractive index of the liquids are shown in the adjoining diagram. The container is illuminated from the side and a small piece of glass having refractive index 1.61 is

gently dropped into the liquid layer. The glass piece as it descends downwards will not be visible in [CPMT 1986]

A	1.51
B	1.53
C	1.61
D	1.52
E	1.65

(a) Liquid *A* and *B* only

(b) Liquid *C* only

(c) Liquid *D* and *E* only

(d) Liquid *A, B, D* and *E*

22. The refractive indices of glass and water *w.r.t.* air are 3/2 and 4/3 respectively. The refractive index of glass *w.r.t.* water will be

[MNR 1990; JIPMER 1997, 2000; MP PET 2000]

(a) 8/9 (b) 9/8

(c) 7/6 (d) None of these

23. If ${}_i\mu_j$ represents refractive index when a light ray goes from medium *i* to medium *j*, then the product ${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3$ is equal to [CBSE PMT 1990]

(a) ${}_3\mu_1$ (b) ${}_3\mu_2$

(c) $\frac{1}{{}_1\mu_4}$ (d) ${}_4\mu_2$

24. The wavelength of light diminishes μ times ($\mu = 1.33$ for water) in a medium. A diver from inside water looks at an object whose natural colour is green. He sees the object as

[CPMT 1990; MNR 1998]

(a) Green (b) Blue

(c) Yellow (d) Red

25. Ray optics fails when

(a) The size of the obstacle is 5 *cm*

(b) The size of the obstacle is 3 *cm*

(c) The size of the obstacle is less than the wavelength of light

(d) (a) and (b) both

26. When light travels from air to water and from water to glass, again from glass to CO_2 gas and finally through air. The relation between their refractive indices will be given by

(a) ${}_a n_w \times {}_w n_{gl} \times {}_{gl} n_{gas} \times {}_{gas} n_a = 1$

(b) ${}_a n_w \times {}_w n_{gl} \times {}_{gas} n_{gl} \times {}_{gl} n_a = 1$

(c) ${}_a n_w \times {}_w n_{gl} \times {}_{gl} n_{gas} = 1$

(d) There is no such relation

27. For a colour of light the wavelength for air is 6000 Å and in water the wavelength is 4500 Å. Then the speed of light in water will be

(a) $5.\times 10^{14}\ m/s$ (b) 2.25×10^{8} *m/s*

(c) 4.0×10^{8} *m/s* (d) Zero

28. A ray of light travelling inside a rectangular glass block of refractive index $\sqrt{2}$ is incident on the glass–air surface at an angle of incidence of 45°. The refractive index of air is 1. Under these conditions the ray [CPMT 1972]

(a) Will emerge into the air without any deviation

(b) Will be reflected back into the glass

(c) Will be absorbed

(d) Will emerge into the air with an angle of refraction equal to 90°

29. If ε_0 and μ_0 are respectively, the electric permittivity and the magnetic permeability of free space, ε and μ the corresponding quantities in a medium, the refractive index of the medium is

[IIT-JEE 1982; MP PET 1995; CBSE PMT 1997]

(a) $\sqrt{\frac{\mu\varepsilon}{\mu_0\varepsilon_0}}$ (b) $\frac{\mu\varepsilon}{\mu_0\varepsilon_0}$

(c) $\sqrt{\frac{\mu_0\varepsilon_0}{\mu\varepsilon}}$ (d) $\sqrt{\frac{\mu\mu_0}{\varepsilon\varepsilon_0}}$

30. A beam of monochromatic blue light of wavelength 4200Å in air travels in water ($\mu = 4/3$). Its wavelength in water will be

(a) 2800 Å (b) 5600 Å

(c) 3150 Å (d) 4000 Å

31. If μ_0 be the relative permeability and K_0 the dielectric constant of a medium, its refractive index is given by

[MNR 1995]

(a) $\frac{1}{\sqrt{\mu_0 K_0}}$ (b) $\frac{1}{\mu_0 K_0}$

(c) $\sqrt{\mu_0 K_0}$ (d) $\mu_0 K_0$

32. If the speed of light in vacuum is C $m/\sec$, then the velocity of light in a medium of refractive index 1.5

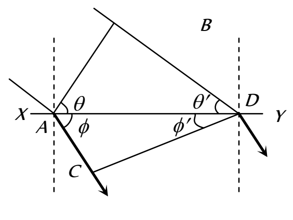
[NCERT 1977; MP PMT 1984; CPMT 2002]

(a) Is 1.5 × *C* (b) Is *C*

(c) Is $\frac{C}{1.5}$ (d) Can have any velocity

33. In the adjoining diagram, a wavefront *AB*, moving in air is incident on a plane glass surface *XY*. Its position *CD* after refraction through a glass slab is shown also along with the normals drawn at *A* and *D*. The refractive index of glass with respect to air ($\mu = 1$) will be equal to

[CPMT 1988; DPMT 1999]



(a) $\frac{\sin\theta}{\sin\theta'}$

(b) $\frac{\sin\theta}{\sin\phi'}$

(c) $\frac{\sin\phi'}{\sin\theta}$

(d) $\frac{AB}{CD}$

34. When light enters from air to water, then its

[MP PMT 1994; MP PET 1996]

(a) Frequency increases and speed decreases

(b) Frequency is same but the wavelength is smaller in water than in air

(c) Frequency is same but the wavelength in water is greater than in air

(d) Frequency decreases and wavelength is smaller in water than in air

35. On a glass plate a light wave is incident at an angle of 60°. If the reflected and the refracted waves are mutually perpendicular, the refractive index of material is

[MP PMT 1994; Haryana CEE 1996; KCET 1994; 2000]

(a) $\frac{\sqrt{3}}{2}$ (b) $\sqrt{3}$

(c) $\frac{3}{2}$ (d) $\frac{1}{\sqrt{3}}$

36. Refractive index of glass is $\frac{3}{2}$ and refractive index of water is $\frac{4}{3}$. If the speed of light in glass is 2.00×10^{8} m/s, the speed in water will be **[MP PMT 1994; RPMT 1997]**

(a) 2.67×10^{8} *m/s* (b) 2.25×10^{8} *m/s*

(c) 1.78×10^{8} *m/s* (d) 1.50×10^{8} *m/s*

37. Monochromatic light of frequency 5×10^{14} *Hz* travelling in vacuum enters a medium of refractive index 1.5. Its wavelength in the medium is

[MP PET/ PMT 1995; Pb. PET 2003]

(a) 4000 *Å* (b) 5000 *Å*

(c) 6000 *Å* (d) 5500 *Å*

38. Light of wavelength is 7200 Å in air. It has a wavelength in glass ($\mu = 1.5$) equal to **[DCE 1999]**

(a) 7200 *Å* (b) 4800 *Å*

(c) 10800 *Å* (d) 7201.5 *Å*

39. Which of the following is *not* a correct statement

[MP PET 1997]

(a) The wavelength of red light is greater than the wavelength of green light

(b) The wavelength of blue light is smaller than the wavelength of orange light

(c) The frequency of green light is greater than the frequency of blue light

(d) The frequency of violet light is greater than the frequency of blue light

40. Which of the following is a *correct* relation **[MP PET 1997]**

(a) ${}_a\mu_r = {}_a\mu_w \times {}_r\mu_\omega$ (b) ${}_a\mu_r \times {}_r\mu_w = {}_w\mu_a$

(c) ${}_a\mu_r \times {}_r\mu_a = 0$ (d) ${}_a\mu_r / {}_w\mu_r = {}_a\mu_w$

41. The time taken by sunlight to cross a 5 *mm* thick glass plate $(\mu = 3/2)$ is **[MP PMT/PET 1998; BHU 2005]**

(a) 0.25×10^{-10} *s* (b) 0.167×10^{-7} *s*

(c) 2.5×10^{-10} *s* (d) 1.0×10^{-10} *s*

42. The distance travelled by light in glass (refractive index =1.5) in a nanosecond will be **[MP PET 1999]**

(a) 45 *cm* (b) 40 *cm*

(c) 30 *cm* (d) 20 *cm*

43. When light is refracted from air into glass

[IIT 1980; CBSE PMT 1992; MP PET 1999; MP PMT 1999; RPMT 1997, 2000, 03; MH CET 2004]

(a) Its wavelength and frequency both increase

(b) Its wavelength increases but frequency remains unchanged

(c) Its wavelength decreases but frequency remains unchanged

(d) Its wavelength and frequency both decrease

44. A mark at the bottom of a liquid appears to rise by 0.1 *m*. The depth of the liquid is 1 *m*. The refractive index of the liquid is

(a) 1.33 (b) $\frac{9}{10}$

(c) $\frac{10}{9}$ (b) 1.5

45. A man standing in a swimming pool looks at a stone lying at the bottom. The depth of the swimming pool is *h*. At what distance from the surface of water is the image of the stone formed (Line of vision is normal; Refractive index of water is *n*)

(a) h/n (b) n/h

(c) h (d) hn

46. On heating a liquid, the refractive index generally

[KCET 1994]

(a) Decreases

(b) Increases or decreases depending on the rate of heating

(c) Does not change

(d) Increases

47. If $\hat{i}$ denotes a unit vector along incident light ray, $\hat{r}$ a unit vector along refracted ray into a medium of refractive index μ and $\hat{n}$ unit vector normal to boundary of medium directed towards incident medium, then law of refraction is

[EAMCET (Engg.) 1995]

(a) $\hat{i}\,.\,\hat{n} = \mu(\hat{r}\,.\,\hat{n})$ (b) $\hat{i}\times\hat{n} = \mu(\hat{n}\times\hat{r})$

(c) $\hat{i}\times\hat{n} = \mu(\hat{r}\times\hat{n})$ (d) $\mu(\hat{i}\times\hat{n}) = \hat{r}\times\hat{n}$

48. The bottom of a container filled with liquid appear slightly raised because of **[RPMT 1997]**

(a) Refraction (b) Interference

(c) Diffraction (d) Reflection

49. The speed of light in air is 3×10^{8} m/s. What will be its speed in diamond whose refractive index is 2.4

[KCET 1993]

(a) 3×10^{8} m/s (b) 332 m/s

(c) 1.25×10^{8} *m/s* (d) 7.2×10^{8} m/s

50. Time taken by the sunlight to pass through a window of thickness 4 mm whose refractive index is 1.5 is

[CBSE PMT 1993]

(a) 2×10^{-8} *sec* (b) 2×10^{8} *sec*

(c) 2×10^{-11} *sec* (d) 2×10^{11} *sec*

51. Ray optics is valid, when characteristic dimensions are

[CBSE PMT 1994; CPMT 2001]

(a) Of the same order as the wavelength of light

(b) Much smaller than the wavelength of light

(c) Of the order of one millimetre

(d) Much larger than the wavelength of light

52. The refractive index of water is 1.33. What will be the speed of light in water **[CBSE PMT 1996; KCET 1998]**

(a) $3\times10^{8}\ m/s$ (b) $2.25\times10^{8}\ m/s$

(c) $4\times10^{8}\ m/s$ (d) 1.33×10^{8} *m/s*

53. The time required to pass the light through a glass slab of 2 *mm* thick is ($\mu_{glass}=1.5$) **[AFMC 1997; MH CET 2002, 04]**

(a) $10^{-5}\ s$ (b) $10^{-11}\ s$

(c) $10^{-9}\ s$ (d) $10^{-13}\ s$

54. The refractive index of water with respect to air is $4/3$ and the refractive index of glass with respect to air is 3/2. The refractive index of water with respect to glass is

[BHU 1997; JIPMER 2000]

(a) $\frac{9}{8}$ (b) $\frac{8}{9}$

(c) $\frac{1}{2}$ (d) 2

55. Electromagnetic radiation of frequency *n*, wavelength λ, travelling with velocity *v* in air, enters a glass slab of refractive index μ. The frequency, wavelength and velocity of light in the glass slab will be respectively

[CBSE PMT 1997]

(a) $\frac{n}{\mu},\frac{\lambda}{\mu},\frac{v}{\mu}$ (b) $n,\frac{\lambda}{\mu},\frac{v}{\mu}$

(c) $n,\lambda,\frac{v}{\mu}$ (d) $\frac{n}{\mu},\ \frac{\lambda}{\mu},v$

56. What is the time taken (in *seconds*) to cross a glass of thickness 4 *mm* and μ = 3 by light **[BHU 1998; Pb. PMT 1999, 2001; MH CET 2000; MP PET 2001]**

(a) 4×10^{-11} (b) 2×10^{-11}

(c) 16×10^{-11} (d) 8×10^{-10}

57. A plane glass slab is kept over various coloured letters, the letter which appears least raised is

[J & K CET 2004; BHU 1998, 05]

(a) Blue (b) Violet

(c) Green (d) Red

58. A ray of light is incident on the surface of separation of a medium at an angle 45° and is refracted in the medium at an angle 30°. What will be the velocity of light in the medium**[AFMC 1998; MH CET (Med.) 1999]**

(a) 1.96×10^{8} *m/s* (b) $2.12\times10^{8}\ m/s$

(c) $3.18\times10^{8}\ m/s$ (d) $3.33\times18^{8}\ m/s$

59. Absolute refractive indices of glass and water are $\frac{3}{2}$ and $\frac{4}{3}$. The ratio of velocity of light in glass and water will be

[UPSEAT 1999]

(a) 4 : 3 (b) 8 : 7

(c) 8 : 9 (d) 3 : 4

60. The ratio of thickness of plates of two transparent mediums *A* and *B* is 6 : 4. If light takes equal time in passing through them, then refractive index of *B* with respect to *A* will be

[UPSEAT 1999]

(a) 1.4 (b) 1.5

(c) 1.75 (d) 1.33

61. The refractive index of water and glass with respect to air is 1.3 and 1.5 respectively. Then the refractive index of glass with respect to water is **[MH CET (Med.) 1999]**

(a) $\frac{2.6}{1.5}$ (b) $\frac{1.5}{2.6}$

(c) $\frac{1.3}{1.5}$ (d) $\frac{1.5}{1.3}$

62. A tank is filled with benzene to a height of 120 *mm*. The apparent depth of a needle lying at a bottom of the tank is measured by a microscope to be 80 *mm*. The refractive index of benzene is

(a) 1.5 (b) 2.5

(c) 3.5 (d) 4.5

63. Each quarter of a vessel of depth *H* is filled with liquids of the refractive indices n_1, n_2, n_3 and n_4 from the bottom respectively. The apparent depth of the vessel when looked normally is

(a) $\frac{H(n_1+n_2+n_3+n_4)}{4}$ (b) $\frac{H\left(\frac{1}{n_1}+\frac{1}{n_2}+\frac{1}{n_3}+\frac{1}{n_4}\right)}{4}$

(c) $\frac{(n_1+n_2+n_3+n_4)}{4H}$ (d) $\frac{H\left(\frac{1}{n_1}+\frac{1}{n_2}+\frac{1}{n_3}+\frac{1}{n_4}\right)}{2}$

64. A ray of light passes through four transparent media with refractive indices $\mu_1.\mu_2\mu_3$, and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray *CD* is parallel to the incident ray *AB*, we must have

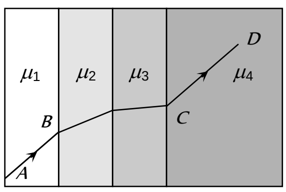
[IIT-JEE (Screening) 2001]

(a) $\mu_1=\mu_2$

(b) $\mu_2=\mu_3$

(c) $\mu_3=\mu_4$

(d) $\mu_4=\mu_1$



65. The reason of seeing the Sun a little before the sunrise is

[MP PMT 2001; Orissa JEE 2003]

(a) Reflection of the light (b) Refraction of the light

(c) Scattering of the light (d) Dispersion of the light

66. An under water swimmer is at a depth of 12 *m* below the surface of water. A bird is at a height of 18 *m* from the surface of water, directly above his eyes. For the swimmer the bird appears to be at a distance from the surface of water equal to (Refractive Index of water is 4/3) **[KCET (Engg.) 2001]**

(a) 24 *m* (b) 12 *m*

(c) 18 *m* (d) 9 *m*

67. The optical path of a monochromatic light is same if it goes through 4.0 *cm* of glass or 4.5 *cm* of water. If the refractive index of glass is 1.53, the refractive index of the water is **[UPSEAT 2002]**

(a) 1.30 (b) 1.36

(c) 1.42 (d) 1.46

68. Which of the following statement is true **[Orissa JEE 2002]**

(a) Velocity of light is constant in all media

(b) Velocity of light in vacuum is maximum

(c) Velocity of light is same in all reference frames

(d) Laws of nature have identical form in all reference frames

69. A ray of light is incident on a transparent glass slab of refractive index 1.62. The reflected and the refracted rays are mutually perpendicular. The angle of incidence is **[MP PET 2002]**

(a) 58.3° (b) 50°

(c) 35° (d) 30°

70. A microscope is focussed on a coin lying at the bottom of a beaker. The microscope is now raised up by 1 *cm*. To what depth should the water be poured into the beaker so that coin is again in focus ? (Refractive index of water is $\frac{4}{3}$) **[BHU 2003]**

(a) 1 *cm* (b) $\frac{4}{3}$ *cm*

(c) 3 *cm* (d) 4 *cm*

71. Velocity of light in glass whose refractive index with respect to air is 1.5 is 2×10^8 *m/s* and in certain liquid the velocity of light found to be 2.5×10^8 *m/s*. The refractive index of the liquid with respect to air is **[CPMT 1978; MP PET/PMT 1988]**

(a) 0.64 (b) 0.80

(c) 1.20 (d) 1.44

72. Stars are twinkling due to **[CPMT 1997]**

(a) Diffraction (b) Reflection

(c) Refraction (d) Scattering

73. A thin oil layer floats on water. A ray of light making an angle of incidence of 40° shines on oil layer. The angle of refraction of light ray in water is ($\mu_{oil} = 1.45, \mu_{water} = 1.33$) **[MP PMT 1993]**

(a) 36 .1° (b) 44.5°

(c) 26. 8° (d) 28.9°

74. An object is immersed in a fluid. In order that the object becomes invisible, it should **[AIIMS 2004]**

(a) Behave as a perfect reflector

(b) Absorb all light falling on it

(c) Have refractive index one

(d) Have refractive index exactly matching with that of the surrounding fluid

75. When light travels from glass to air, the incident angle is θ_1 and the refracted angle is θ_2. The true relation is **[Orissa PMT 2004]**

(a) $\theta_1 = \theta_2$ (b) $\theta_1 < \theta_2$

(c) $\theta_1 > \theta_2$ (d) Not predictable

76. Velocity of light in a medium is $1.5 \times 10^8 \, m/s$. Its refractive index will be **[Pb. PET 2000]**

(a) 8 (b) 6

(c) 4 (d) 2

77. The frequency of a light ray is $6 \times 10^{14} \, Hz$. Its frequency when it propagates in a medium of refractive index 1.5, will be **[MP PMT 2000; DPMT 2003; Pb PMT 2003; MH CET 2004]**

(a) $1.67 \times 10^{14} \, Hz$ (b) $9.10 \times 10^{14} \, Hz$

(c) $6 \times 10^{14} \, Hz$ (d) $4 \times 10^{14} \, Hz$

78. The refractive indices of water and glass with respect to air are 1.2 and 1.5 respectively. The refractive index of glass with respect to water is **[Pb. PET 2002]**

(a) 0.6 (b) 0.8

(c) 1.25 (d) 1.75

79. The wavelength of sodium light in air is 5890 *Å*. The velocity of light in air is $3 \times 10^8 ms^{-1}$. The wavelength of light in a glass of refractive index 1.6 would be close to **[DCE 2003]**

(a) 5890 *Å* (b) 3681 *Å*

(c) 9424 *Å* (d) 15078 *Å*

80. The mean distance of sun from the earth is $1.5 \times 10^8 \, Km$ (nearly). The time taken by the light to reach earth from the sun is

(a) 0.12 *min* (b) 8.33 *min*

(c) 12.5 *min* (d) 6.25 *min*

81. Refractive index of air is 1.0003. The correct thickness of air column which will have one more wavelength of yellow light (6000 Å) than in the same thickness in vacuum is **[RPMT 1995]**

(a) 2 *mm* (b) 2 *cm*

(c) 2 *m* (d) 2 *km*

82. The wavelength of light in air and some other medium are respectively λ_a and λ_m. The refractive index of medium is **[RPMT 2003]**

(a) λ_a / λ_m (b) λ_m / λ_a

(c) $\lambda_a \times \lambda_m$ (d) None of these

83. An astronaut in a spaceship see the outer space as **[CPMT 1990, MP PMT 1991; JIPMER 1997]**

(a) White (b) Black

(c) Blue (d) Red

84. Speed of light is maximum in

[CPMT 1990; MP PMT 1994; AFMC 1996]

(a) Water (b) Air

(c) Glass (d) Diamond

85. Which one of the following statements is correct

[KCET 1994]

(a) In vacuum, the speed of light depends upon frequency

(b) In vacuum, the speed of light does not depend upon frequency

(c) In vacuum, the speed of light is independent of frequency and wavelength

(d) In vacuum, the speed of light depends upon wavelength

86. If the wavelength of light in vacuum be λ, the wavelength in a medium of refractive index n will be

[UPSEAT 2001; MP PET 2001]

(a) $n\lambda$ (b) $\frac{\lambda}{n}$

(c) $\frac{\lambda}{n^2}$ (d) $n\lambda$

87. In vacuum the speed of light depends upon [MP PMT 2001]

(a) Frequency

(b) Wave length

(c) Velocity of the source of light

(d) None of these

88. 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 the cube is

[CPMT 2004; MP PMT 2005]

(a) 2.0 (b) 2.5

(c) 1.6 (d) 1.5

89. A glass slab of thickness 3 *cm* and refractive index 3/2 is placed on ink mark on a piece of paper. For a person looking at the mark at a distance 5.0 *cm* above it, the distance of the mark will appear to be [Kerala PMT 2005]

(a) 3.0 *cm* (b) 4.0 *cm*

(c) 4.5 *cm* (d) 5.0 *cm*

90. A fish at a depth of 12 *cm* in water is viewed by an observer on the bank of a lake. To what height the image of the fish is raised.

(a) 9 *cm* (b) 12 *cm*

(c) 3.8 *cm* (d) 3 *cm*

Total Internal Reflection

1. A cut diamond sparkles because of its

[NCERT 1974; RPET 1996; AFMC 2005]

(a) Hardness

(b) High refractive index

(c) Emission of light by the diamond

(d) Absorption of light by the diamond

2. A diver in a swimming pool wants to signal his distress to a person lying on the edge of the pool by flashing his water proof flash light

[NCERT 1972]

(a) He must direct the beam vertically upwards

(b) He has to direct the beam horizontally

(c) He has to direct the beam at an angle to the vertical which is slightly less than the critical angle of incidence for total internal reflection

(d) He has to direct the beam at an angle to the vertical which is slightly more than the critical angle of incidence for the total internal reflection

3. Finger prints on a piece of paper may be detected by sprinkling fluorescent powder on the paper and then looking it into

(a) Mercury light (b) Sunlight

(c) Infrared light (d) Ultraviolet light

4. Critical angle of light passing from glass to air is minimum for

(a) Red (b) Green

(c) Yellow (d) Violet

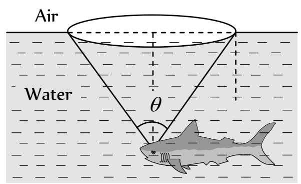
5. The wavelength of light in two liquids '*x*' and '*y*' is 3500 Å and 7000 Å, then the critical angle of *x* relative to y will be

(a) 60° (b) 45°

(c) 30° (d) 15°

6. A fish is a little away below the surface of a lake. If the critical angle is 49°, then the fish could see things above the water surface within an angular range of θ^o where

[MP PMT 1986]



(a) $\theta = 49^o$

(b) $\theta = 90^o$

(c) $\theta = 98^o$

(d) $\theta = 24\frac{1^o}{2}$

7. If the critical angle for total internal reflection from a medium to vacuum is 30°, the velocity of light in the medium is

KCET 2000; BCECE 2003; RPMT 2003]

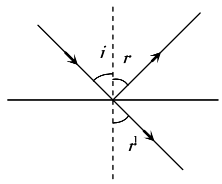
(a) 3×10^8 *m/s* (b) 1.5×10^8 *m/s*

(c) 6×10^8 *m/s* (d) $\sqrt{3}\times10^8$ *m/s*

8. A ray of light is incident at an angle *i* from denser to rare medium. The reflected and the refracted rays are mutually perpendicular. The angle of reflection and the angle of refraction are respectively *r* and *r'*, then the critical angle will be

CBSE PMT 1996; MP PMT 1985, 99; Pb. PET 2002]

[MP PET 2005]



(a) $\sin^{-1}(\sin r)$

(b) $\sin^{-1}(\tan r')$

(c) $\sin^{-1}(\tan i)$

(d) $\tan^{-1}(\sin i)$

9. For total internal reflection to take place, the angle of incidence i and the refractive index μ of the medium must satisfy the inequality [MP PET 1994]

(a) $\frac{1}{\sin i} < \mu$ (b) $\frac{1}{\sin i} > \mu$

(c) $\sin i < \mu$ (d) $\sin i > \mu$

10. Total internal reflection of light is possible when light enters from

(a) Air to glass (b) Vacuum to air

(c) Air to water (d) Water to air

11. Total internal reflection of a ray of light is possible when the (i_c = critical angle, i = angle of incidence)

[NCERT 1977; MP PMT 1994]

(a) Ray goes from denser medium to rarer medium and $i < i_c$

(b) Ray goes from denser medium to rarer medium and $i > i_c$

(c) Ray goes from rarer medium to denser medium and $i > i_c$

(d) Ray goes from rarer medium to denser medium and $i < i_c$

12. A diver at a depth of $12m$ in water ($\mu = 4/3$) sees the sky in a cone of semi-vertical angle

[KCET 1999; Pb. PMT 2002; MP PMT 1995, 2003]

(a) $\sin^{-1}(4/3)$ (b) $\tan^{-1}(4/3)$

(c) $\sin^{-1}(3/4)$ (d) $90°$

13. Critical angle is that angle of incidence in the denser medium for which the angle of refraction in rarer medium is

[MP PMT 1996]

(a) $0°$ (b) $57°$

(c) $90°$ (d) $180°$

14. The critical angle for diamond (refractive index = 2) is

[MP PET 2003]

(a) About $20°$ (b) $60°$

(c) $45°$ (d) $30°$

15. The reason for shining of air bubble in water is

[MP PET 1997; KCET 1999]

(a) Diffraction of light

(b) Dispersion of light

(c) Scattering of light

(d) Total internal reflection of light

16. With respect to air critical angle in a medium for light of red colour $[\lambda_1]$ is θ. Other facts remaining same, critical angle for light of yellow colour $[\lambda_2]$ will be [MP PET 1999]

(a) θ (b) More than θ

(c) Less than θ (d) $\frac{\theta\lambda_1}{\lambda_2}$

17. 'Mirage' is a phenomenon due to

[AIIMS 1998; MP PET 2002; AFMC 2003]

(a) Reflection of light

(b) Refraction of light

(c) Total internal reflection of light

(d) Diffraction of light

18. A ray of light travelling in a transparent medium falls on a surface separating the medium from air at an angle of incidence of 45°. The ray undergoes total internal reflection. If n is the refractive index of the medium with respect to air, select the possible value (s) of n from the following

[IIT-JEE 1998]

[CPMT 1973; MP PMT 1994]

(a) 1.3 (b) 1.4

(c) 1.5 (d) 1.6

19. When a ray of light emerges from a block of glass, the critical angle is [KCET 1994]

(a) Equal to the angle of reflection

(b) The angle between the refracted ray and the normal

(c) The angle of incidence for which the refracted ray travels along the glass-air boundary

(d) The angle of incidence

20. The phenomenon utilised in an optical fibre is

[KCET 1994; AMU 1995;

CBSE PMT 2001; DCE 1999, 2000, 01, 02; AIEEE 2002]

(a) Refraction (b) Interference

(c) Polarization (d) Total internal reflection

21. The refractive index of water is $4/3$ and that of glass is 5/3. What will be the critical angle for the ray of light entering water from the glass [RPMT 1996]

(a) $\sin^{-1}\frac{4}{5}$ (b) $\sin^{-1}\frac{5}{4}$

(c) $\sin^{-1}\frac{1}{2}$ (d) $\sin^{-1}\frac{2}{1}$

22. Total internal reflection is possible when light rays travel

[RPMT 1999]

(a) Air to water (b) Air to glass

(c) Glass to water (d) Water to glass

23. The velocity of light in a medium is half its velocity in air. If ray of light emerges from such a medium into air, the angle of incidence, at which it will be totally internally reflected, is

[Roorkee 1999]

(a) $15°$ (b $30°$

(c) $45°$ (d) $60°$

24. A ray of light propagates from glass (refractive index = 3/2) to water (refractive index = 4/3). The value of the critical angle [JIPMER 1999; UPSEAT 20

(a) $\sin^{-1}(1/2)$ (b) $\sin^{-1}\left(\frac{\sqrt{8}}{9}\right)$

(c) $\sin^{-1}(8/9)$ (d) $\sin^{-1}(5/7)$

25. Relation between critical angles of water and glass is

[CBSE PMT 2000; Pb. PET 2000; CPMT 2001]

(a) $C_w > C_g$ (b) $C_w < C_g$

(c) $C_w = C_g$ (d) $C_w = C_g = 0$

26. If critical angle for a material to air is $30°$, the refractive index of the material will be [MP PET 2001]

(a) 1.0 (b) 1.5

(c) 2.0 (d) 2.5

27. The refractive index of water is 1.33. The direction in which a man under water should look to see the setting sun is

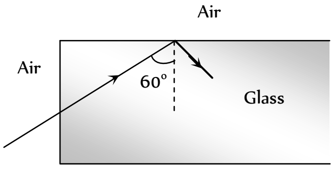
[MP PET 1991; Kerala PET 2002; Pb. PET 2003]

(a) 49° to the horizontal (b) 90° with the vertical
(c) 49° to the vertical (d) Along the horizontal

28. Optical fibres are related with [AFMC 2002]
(a) Communication (b) Light
(c) Computer (d) None of these

29. Brilliance of diamond is due to
[AIIMS 2002; MP PMT 2003]
(a) Shape (b) Cutting
(c) Reflection (d) Total internal reflection

30. A light ray from air is incident (as shown in figure) at one end of a glass fiber (refractive index $\mu = 1.5$) making an incidence angle of 60° on the lateral surface, so that it undergoes a total internal reflection. How much time would it take to traverse the straight fiber of length 1 *km*
[Orissa JEE 2002]
(a) 3.33 μ *sec*
(b) 6.67 μ *sec*
(c) 5.77 μ *sec*
(d) 3.85 μ *sec*



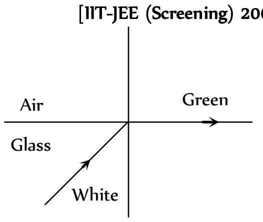
31. Light wave enters from medium 1 to medium 2. Its velocity in 2nd medium is double from 1st. For total internal reflection the angle of incidence must be greater than [CPMT 2002]
(a) 30° (b) 60°
(c) 45° (d) 90°

32. Consider telecommunication through optical fibres. Which of the following statements is not true
[AIEEE 2003]
(a) Optical fibres may have homogeneous core with a suitable cladding
(b) Optical fibres can be of graded refractive index
(c) Optical fibres are subject to electromagnetic interference from outside
(d) Optical fibres have extremely low transmission loss

33. The critical angle for a medium is 60^o. The refractive index of the medium is [MP PMT 2004]
(a) $\frac{2}{\sqrt{3}}$ (b) $\frac{\sqrt{2}}{3}$
(c) $\sqrt{3}$ (d) $\frac{\sqrt{3}}{2}$

34. Glass has refractive index μ with respect to air and the critical angle for a ray of light going from glass to air is θ. If a ray of light is incident from air on the glass with angle of incidence θ, the corresponding angle of refraction is
[MP PMT 2004]
(a) $\sin^{-1}\left(\frac{1}{\sqrt{\mu}}\right)$ (b) 90^o
(c) $\sin^{-1}\left(\frac{1}{\mu^2}\right)$ (d) $\sin^{-1}\left(\frac{1}{\mu}\right)$

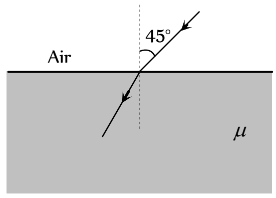
35. White light is incident on the interface of glass and air as shown in the figure. If green light is just totally internally reflected then the emerging ray in air contains
[IIT-JEE (Screening) 2004]



(a) Yellow, orange, red
(b) Violet, indigo, blue
(c) All colours
(d) All colours except green

36. Material *A* has critical angle i_A, and material *B* has critical angle $i_B (i_B > i_A)$. Then which of the following is true
(i) Light can be totally internally reflected when it passes from *B* to *A*
(ii) Light can be totally internally reflected when it passes from *A* to *B*
(iii) Critical angle for total internal reflection is $i_B - i_A$
(iv) Critical angle between *A* and *B* is $\sin^{-1}\left(\frac{\sin i_A}{\sin i_B}\right)$
[UPSEAT 2004]
(a) (i) and (iii) (b) (i) and (iv)
(c) (ii) and (iii) (d) (ii) and (iv)

37. In the figure shown, for an angle of incidence 45^o, at the top surface, what is the minimum refractive index needed for total internal reflection at vertical face [DCE 2002]
(a) $\frac{\sqrt{2}+1}{2}$
(b $\sqrt{\frac{3}{2}}$
(c) $\sqrt{\frac{1}{2}}$
(d) $\sqrt{2}+1$



38. Critical angle for light going from medium (i) to (ii) is θ. The speed of light in medium (i) is *v* then speed in medium (ii) is
[DCE 2002]
(a) $v(1-\cos\theta)$ (b $v/\sin\theta$
(c) $v/\cos\theta$ (d) $v(1-\sin\theta)$

39. If light travels a distance *x* in t_1 *sec* in air and 10 *x* distance in t_2 *sec* in a medium, the critical angle of the medium will be
(a) $\tan^{-1}\left(\frac{t_1}{t_2}\right)$ (b) $\sin^{-1}\left(\frac{t_1}{t_2}\right)$
(c) $\sin^{-1}\left(\frac{10t_1}{t_2}\right)$ (d) $\tan^{-1}\left(\frac{10t_1}{t_2}\right)$

40. The critical angle of a medium with respect to air is 45^o. The refractive index of medium is [MH CET 2003]
(a) 1.41 (b) 1.2
(c) 1.5 (d) 2

41. An endoscope is employed by a physician to view the internal parts of a body organ. It is based on the principle of
[AIIMS 2004]
(a) Refraction (b) Reflection
(c) Total internal reflection (d) Dispersion

42. A normally incident ray reflected at an angle of 90^o. The value of critical angle is [RPMT 1996]

(a) 45^o (b 90^o

(c) 65^o (d) 43.2^o

43. The phenomena of total internal reflection is seen when angle of incidence is [RPMT 2001]

(a) 90^o (b Greater than critical angle

(c) Equal to critical angle (d) 0^o

44. A fish looking up through the water sees the outside world contained in a circular horizon. If the refractive index of water is $\frac{4}{3}$ and the fish is 12 *cm* below the surface, the radius of this circle in *cm* is

[NCERT 1980; KCET 2002; AIEEE 2005; CPMT 2005]

(a) $36\sqrt{5}$ (b) $4\sqrt{5}$

(c) $36\sqrt{7}$ (d) $36/\sqrt{7}$

45. 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

[CBSE PMT 1994; JIPMER 2001, 02]

(a) 2 *m* (b 6 *m*

(c) 4 *m* (d) 3 *m*

46. A fist looking from within water sees the outside world through a circular horizon. If the fish $\sqrt{7}$ *cm* below the surface of water, what will be the radius of the circular horizon

(a) 3.0 *cm* (b) 4.0 *cm*

(c) 4.5 *cm* (d) 5.0 *cm*

Refraction at Curved Surface

1. The radius of curvature for a convex lens is 40 *cm*, for each surface. Its refractive index is 1.5. The focal length will be

[MP PMT 1989]

(a) 40 *cm* (b) 20 *cm*

(c) 80 *cm* (d) 30 *cm*

2. A convex lens of focal length f is placed somewhere in between an object and a screen. The distance between the object and the screen is x. If the numerical value of the magnification produced by the lens is m, , then the focal length of the lens is

(a) $\frac{mx}{(m+1)^2}$ (b) $\frac{mx}{(m-1)^2}$

(c) $\frac{(m+1)^2}{m}x$ (d) $\frac{(m-1)^2}{m}x$

3. A thin lens focal length f_1 and its aperture has diameter *d*. It forms an image of intensity *I*. Now the central part of the aperture upto diameter $\frac{d}{2}$ is blocked by an opaque paper. The focal length and image intensity will change to

[CPMT 1989; MP PET 1997; KCET 1998]

(a) $\frac{f}{2}$ and $\frac{I}{2}$ (b) f and $\frac{I}{4}$

(c) $\frac{3f}{4}$ and $\frac{I}{2}$ (d) f and $\frac{3I}{4}$

4. A lens of power + 2 diopters is placed in contact with a lens of power – 1 diopter. The combination will behave like

(a) A convergent lens of focal length 50 *cm*

(b) A divergent lens of focal length 100 *cm*

(c) A convergent lens of focal length 100 *cm*

(d) A convergent lens of focal length 200 *cm*

5. A convex lens of focal length 40 cm is in contact with a concave lens of focal length 25 cm. The power of combination is

[IIT-JEE 1982; AFMC 1997; CBSE PMT 2000; RPMT 2003]

(a) – 1.5 *D* (b) – 6.5 *D*

(c) + 6.5 *D* (d) + 6.67 *D*

6. Two lenses are placed in contact with each other and the focal length of combination is 80 *cm*. If the focal length of one is 20 *cm*, then the power of the other will be

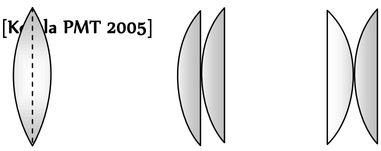
[NCERT 1981]

(a) 1.66 *D* (b) 4.00 *D*

(c) –1.00 *D* (d) – 3.75 *D*

7. Two similar plano-convex lenses are combined together in three different ways as shown in the adjoining figure. The ratio of the focal lengths in three cases will be

[Kerala PMT 2005]



(a) 2 : 2 : 1 (b 1 : 1 : 1

(c) 1 : 2 : 2 (d) 2 : 1 : 1

8. Two lenses of power +12 and – 2 diopters are placed in contact. What will the focal length of combination

[MP PET 1990; MNR 1987;

MH CET (Med.) 2001; UPSEAT 2000; Pb. PMT 2003]

(a) 10 *cm* (b) 12.5 *cm*

(c) 16.6 *cm* (d) 8.33 *cm*

9. A concave and convex lens have the same focal length of 20 cm and are put into contact to form a lens combination. The combination is used to view an object of 5 *cm* length kept at 20 cm from the lens combination. As compared to the object, the image will be

(a) Magnified and inverted

(b) Reduced and erect

(c) Of the same size as the object and erect

(d) Of the same size as the object but inverted

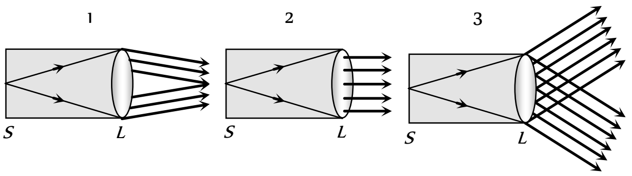
10. If in a plano-convex lens, the radius of curvature of the convex surface is 10 *cm* and the focal length of the lens is 30 *cm*, then the refractive index of the material of lens will be

[CPMT 1986; MNR 1988; MP PMT 2002; UPSEAT 2000]

(a) 1.5 (b) 1.66

(c) 1.33 (d) 3

11. The slit of a collimator is illuminated by a source as shown in the adjoining figures. The distance between the slit *S* and the collimating lens *L* is equal to the focal length of the lens. The correct direction of the emergent beam will be as shown in figure



(a) 1 (b) 3

(c) 2 (d) None of the figures

12. A converging lens is used to form an image on a screen. When upper half of the lens is covered by an opaque screen

[IIT-JEE 1986; SCRA 1994; MP PET 1996; MP PMT 2004; BHU 1998, 05]

(a) Half the image will disappear

(b) Complete image will be formed of same intensity

(c) Half image will be formed of same intensity

(d) Complete image will be formed of decreased intensity

13. A thin convex lens of focal length 10 *cm* is placed in contact with a concave lens of same material and of same focal length. The focal length of combination will be

[CPMT 1972; 1988]

(a) Zero (b) Infinity

(c) 10 *cm* (d) 20 *cm*

14. A convex lens of focal length 84 *cm* is in contact with a concave lens of focal length 12 *cm*. The power of combination (in diopters) is

(a) 25/24 (b) 25/18

(c) – 50/7 (d) + 50/7

15. A convex lens makes a real image 4 *cm* long on a screen. When the lens is shifted to a new position without disturbing the object, we again get a real image on the screen which is 16 *cm* tall. The length of the object must be [MP PET 1991]

(a) 1/4 *cm* (b) 8 *cm*

(c) 12 *cm* (d) 20 *cm*

16. A glass convex lens $(\mu_g = 1.5)$ has a focal length of $8\,cm$ when placed in air. What would be the focal length of the lens when it is immersed in water ($\mu_w = 1.33$)

[BHU 1994; MP PMT 1996]

(a) 2 *m* (b) 4 *cm*

(c) 16 *cm* (d) 32 *cm*

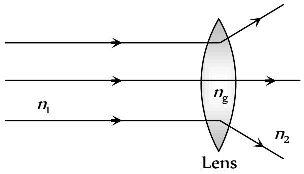
17. The ray diagram could be correct [CPMT 1988]

(a) If $n_1 = n_2 = n_g$

(b) If $n_1 = n_2$ and $n_1 < n_g$

(c) If $n_1 = n_2$ and $n_1 > n_g$

(d) Under no circumstances



18. A thin convex lens of refractive index 1.5 has a focal length of 15 *cm* in air. When the lens is placed in liquid of refractive index 4/3 , its focal length will be

[CPMT 1974, 77; MP PMT 1992]

(a) 15 *cm* (b) 10 *cm*

(c) 30 *cm* (d) 60 *cm*

19. A glass lens is placed in a medium in which it is found to behave like a glass plate. Refractive index of the medium will be

(a) Greater than the refractive index of glass

(b) Smaller than the refractive index of glass

(c) Equal to refractive index of glass [CPMT 1986]

(d) No case will be possible from above

20. If I_1 and I_2 be the size of the images respectively for the two positions of lens in the displacement method, then the size of the object is given by [CPMT 1988]

(a) I_1 / I_2 (b) $I_1 \times I_2$

(c) $\sqrt{I_1 \times I_2}$ (d) $\sqrt{I_1 / I_2}$

21. A convex lens of crown glass (n =1.525) will behave as a divergent lens if immersed in [CPMT 1984]

(a) Water (n =1.33)

(b) In a medium of n = 1.525

(c) Carbon disulphide n =1.66

(d) It cannot act as a divergent lens

22. A divergent lens will produce [CPMT 1984]

(a) Always a virtual image

(b) Always real image

(c) Sometimes real and sometimes virtual

(d) None of the above

23. The minimum distance between an object and its real image formed by a convex lens is [CPMT 1973; JIPMER 1997]

(a) 1.5 f (b) 2 f

(c) 2.5 f (d) 4 f

[MP PET 1991]

24. An object is placed at a distance of 20 *cm* from a convex lens of focal length 10 *cm*. The image is formed on the other side of the lens at a distance [CPMT 1971; RPET 2003]

(a) 20 *cm* (b) 10 *cm*

(c) 40 *cm* (d) 30 *cm*

25. Two thin lenses, one of focal length + 60 *cm* and the other of focal length – 20 *cm* are put in contact. The combined focal length is [CPMT 1973, 8

(a) + 15 *cm* (b) – 15 *cm*

(c) + 30 *cm* (d) –30 *cm*

26. A double convex lens of focal length 20 *cm* is made of glass of refractive index 3 / 2. When placed completely in water $({}_a\mu_w = 4/3)$, its focal length will be

[CBSE PMT 1990; MP PMT/PET 1998]

(a) 80 *cm* (b) 15 *cm*

(c) 17.7 *cm* (d) 22.5 *cm*

27. Two thin lenses of focal lengths 20 *cm* and 25 *cm* are placed in contact convex. The effective power of the combination is

[CBSE PMT 1990; RPMT 2001]

(a) 45 *dioptres* (b) 9 *dioptres*

(c) 1/9 *dioptre* (d) 6 *dioptres*

28. An object is placed at a distance of $f/2$ from a convex lens. The image will be [CPMT 1974, 89]

(a) At one of the foci, virtual and double its size

(b) At $3f/2$, real and inverted

(c) At $2f$, virtual and erect

(d) None of these

29. A double convex thin lens made of glass (refractive index $\mu = 1.5$) has both radii of curvature of magnitude 20 *cm*. Incident light rays parallel to the axis of the lens will converge at a distance L such that

[MNR 1991; MP PET 1996; UPSEAT 2000; Pb PET 2004]

(a) $L = 20$ *cm* (b) $L = 10$ *cm*

(c) $L = 40$ *cm* (d) $L = 20/3$ *cm*

30. A lens behaves as a converging lens in air and a diverging lens in water. The refractive index of the material is

[CPMT 1991; NCERT 1979; BHU 2005]

(a) Equal to unity (b) Equal to 1.33

(c) Between unity and 1.33 (d) Greater than 1.33

31. A biconvex lens forms a real image of an object placed perpendicular to its principal axis. Suppose the radii of curvature of the lens tend to infinity. Then the image would

[MP PET 1994]

(a) Disappear

(b) Remain as real image still

(c) Be virtual and of the same size as the object

(d) Suffer from aberrations

32. The radius of curvature of convex surface of a thin plano-convex lens is 15 *cm* and refractive index of its material is 1.6. The power of the lens will be [MP PMT 1994]

(a) $+1\,D$ (b) $-2\,D$

(c) $+3\,D$ (d) $+4\,D$

33. Focal length of a convex lens will be maximum for

[MP PMT 1994]

(a) Blue light (b) Yellow light

(c) Green light (d) Red light

34. A lens is placed between a source of light and a wall. It forms images of area A_1 and A_2 on the wall for its two different positions. The area of the source or light is

[CBSE PMT 1995]

(a) $\dfrac{A_1 + A_2}{2}$ (b) $\left[\dfrac{1}{A_1} + \dfrac{1}{A_2}\right]^{-1}$

(c) $\sqrt{A_1 A_2}$ (d) $\left[\dfrac{\sqrt{A_1} + \sqrt{A_2}}{2}\right]^2$

35. Two lenses of power $6D$ and $-2D$ are combined to form a single lens. The focal length of this lens will be

[MP PET 2003]

(a) $\dfrac{3}{2}\,m$ (b $\dfrac{1}{4}\,m$

(c) $4\,m$ (d) $\dfrac{1}{8}\,m$

36. A combination of two thin lenses with focal lengths f_1 and f_2 respectively forms an image of distant object at distance 60 *cm* when lenses are in contact. The position of this image shifts by 30 *cm* towards the combination when two lenses are separated by 10 *cm*. The corresponding values of f_1 and f_2 are

(a) $30\ cm, -60\ cm$ (b) $20\ cm, -30\ cm$

(c) $15\ cm, -20\ cm$ (d) $12\ cm, -15\ cm$

37. An achromatic combination of lenses is formed by joining

[BHU 1995; Pb. PMT 2000, 04]

(a) 2 convex lenses

(b) 2 concave lenses

(c) 1 convex lens and 1 concave lens

(d) Convex lens and plane mirror

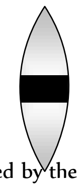
38. A plano convex lens $(f = 20cm)$ is silvered at plane surface. Now f will be [BHU 1995; DPMT 2001; MP PMT 2005]

(a) 20 *cm* (b) 40 *cm*

(c) 30 cm (d) 10 *cm*

39. If the central portion of a convex lens is wrapped in black paper as shown in the figure

[Manipal MEE 1995; KCET 2001]



(a) No image will be formed by the remaining portion of the lens

(b) The full image will be formed but it will be less bright

(c) The central portion of the image will be missing

(d) There will be two images each produced by one of the exposed portions of the lens

40. A diminished image of an object is to be obtained on a screen 1.0 *m* from it. This can be achieved by appropriately placing

(a) A convex mirror of suitable focal length

(b) A concave mirror of suitable focal length

(c) A concave lens of suitable focal length

(d) A convex lens of suitable focal length less than 0.25 *m*

41. The focal length of convex lens is 30 *cm* and the size of image is quarter of the object, then the object distance is

[AFMC 1995]

(a) 150 *cm* (b) 60 *cm*

(c) 30 *cm* (d) 40 *cm*

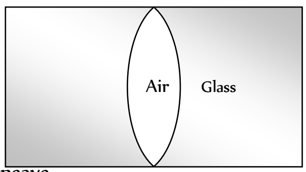
42. A convex lens forms a real image of a point object placed on its principal axis. If the upper half of the lens is painted black, the image will [MP PET 1995]

(a) Be shifted downwards (b) Be shifted upwards

(c) Not be shifted (d) Shift on the principal axis

43. In the figure, an air lens of radii of curvature 10 *cm* ($R_1 = R_2 =$ 10 *cm*) is cut in a cylinder of glass $(\mu = 1.5)$. The focal length and the nature of the lens is

[MP PET 1995; Pb. PET 2000]



(a) 15 *cm*, concave

(b) 15 *cm*, convex

(c) ∞, neither concave nor convex

(d) 0, concave

44. A lens (focal length 50 *cm*) forms the image of a distant object which subtends an angle of 1 *milliradian* at the lens. What is the size of the image [MP PMT 1995]

(a) 5 *mm* (b) 1 *mm*

(c) 0.5 *mm* [AIIMS 1995] (d) 0.1 *mm*

45. A convex lens of focal length 12 *cm* is made of glass of $\mu = \dfrac{3}{2}$. What will be its focal length when immersed in liquid of $\mu = \dfrac{5}{4}$

(a) 6 *cm* (b) 12 *cm*

(c) 24 *cm* (d) 30 *cm*

46. Two thin lenses of focal lengths f_1 and f_2 are in contact and coaxial. The combination is equivalent to a single lens of power [MP PET 1996, 98; MP PMT 1998; DCE 2000; UP SEAT 2005]

(a) $f_1 + f_2$ (b) $\frac{f_1 f_2}{f_1 + f_2}$

(c) $\frac{1}{2}(f_1 + f_2)$ (d) $\frac{f_1 + f_2}{f_1 f_2}$

47. A plano convex lens is made of glass of refractive index 1.5. The radius of curvature of its convex surface is *R*. Its focal length is

(a) *R*/ 2 (b) *R*

(c) 2*R* (d) 1.5 *R*

48. Two lenses have focal lengths f_1 and f_2 and their dispersive powers are ω_1 and ω_2 respectively. They will together form an achromatic combination if

(a) $\omega_1 f_1 = \omega_2 f_2$ (b) $\omega_1 f_2 + \omega_2 f_1 = 0$

(c) $\omega_1 + f_1 = \omega_2 + f_2$ (d) $\omega_1 - f_1 = \omega_2 - f_2$

49. The dispersive powers of glasses of lenses used in an achromatic pair are in the ratio 5 : 3. If the focal length of the concave lens is 15 *cm*, then the nature and focal length of the other lens would be

(a) Convex, 9 *cm* (b) Concave, 9 *cm*

(c) Convex, 25 *cm* (d) Concave, 25 *cm*

50. A thin double convex lens has radii of curvature each of magnitude 40 *cm* and is made of glass with refractive index 1.65. Its focal length is nearly [MP PMT 1997]

(a) 20 *cm* (b) 31 *cm*

(c) 35 *cm* (d) 50 *cm*

51. The plane surface of a plano-convex lens of focal length *f* is silvered. It will behave as [MP PMT/PET 1998]

(a) Plane mirror

(b) Convex mirror of focal length 2 f

(c) Concave mirror of focal length $f/2$

(d) None of the above

52. An equiconvex lens of glass of focal length 0.1 metre is cut along a plane perpendicular to principle axis into two equal parts. The ratio of focal length of new lenses formed is [MP PET 1999; DPMT 2000]

(a) 1 : 1 (b) 1 : 2

(c) 2 : 1 (d) $2 : \frac{1}{2}$

53. A lens of refractive index n is put in a liquid of refractive index n' of focal length of lens in air is f, its focal length in liquid will be

(a) $-\frac{fn'(n-1)}{n'-n}$ (b) $-\frac{f(n'-n)}{n'(n-1)}$

(c) $-\frac{n'(n-1)}{f(n'-n)}$ (d) $\frac{fn'n}{n-n'}$

54. An object of height 1.5 *cm* is placed on the axis of a convex lens of focal length 25 *cm*. A real image is formed at a distance of 75 *cm* from the lens. The size of the image will be

(a) 4.5 *cm* (b) 3.0 *cm*

(c) 0.75 *cm* (d) 0.5 *cm*

55. A symmetric double convex lens is cut in two equal parts by a plane perpendicular to the principal axis. If the power of the original lens was 4 *D*, the power of a cut lens will be [MP PMT 1999]

(a) 2 *D* (b) 3 *D*

(c) 4 *D* (d) 5 *D*

56. A plane convex lens is made of refractive index 1.6. The radius of curvature of the curved surface is 60 *cm*. The focal length of the lens is [CBSE PMT 1999; Pb. PMT 1999; BHU 2001; Very Similar to BHU 2003]

(a) 50 [RPET 2003] (b) 100 *cm*

(c) 200 *cm* (d) 400 *cm*

57. A concave lens of glass, refractive index 1.5, has both surfaces of same radius of curvature *R*. On immersion in a medium of refractive index 1.75, it will behave as a [IIT-JEE 1999]

(a) Convergent lens of focal length 3.5 *R*

(b) Convergent lens of focal length 3.0 *R*

(c) Divergent lens of focal length 3.5 *R*

(d) Divergent lens of focal length 3.0 *R*

58. A convex lens of focal length 0.5 *m* and concave lens of focal length 1 *m* are combined. The power of the resulting lens will be

(a) 1 *D* [MP PET 1997] (b) – 1 *D*

(c) 0.5 *D* (d) – 0.5 *D*

59. A double convex lens is made of glass of refractive index 1.5. If its focal length is 30 cm, then radius of curvature of each of its curved surface is [Bihar CEET 1995]

(a) 10 *cm* (b) 15 *cm*

(c) 18 *cm* (d) None of these

60. A thin lens made of glass of refractive index 1.5 has a front surface + 11 *D* power and back surface – 6 *D*. If this lens is submerged in a liquid of refractive index 1.6, the resulting power of the lens is

(a) – 0.5 *D* (b) + 0.5 *D*

(c) – 0.625 *D* (d) + 0.625 *D*

61. An object is placed first at infinity and then at 20 *cm* from the object side focal plane of the convex lens. The two images thus formed are 5 *cm* apart. The focal length of the lens is

(a) 5 *cm* (b 10 *cm*

(c) 15 *cm* (d) 20 *cm*

62. 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 [SCRA 1994]

(a) ≈ 3 *dioptres* (b) ≈ 5 *dioptres*

(c) ≈ 7 *diopters* (d) ≈ 9 *diopters*

63. The image distance of an object placed 10 *cm* in front of a thin lens of focal length 5 *cm* is [MP PET 1999] [SCRA 1994]

(a) 6.5 *cm* (b) 8.0 *cm*

(c) 9.5 *cm* (d) 10.0 *cm*

64. A achromatic combination is made with a lens of focal length f and dispersive power ω with a lens having dispersive power of 2ω. The focal length of second will be [RPET 1997]

(a) 2 f [MP PET 1999] (b) $f/2$

(c) $-f/2$ (d) – 2 f

65. A biconvex lens with equal radii curvature has refractive index 1.6 and focal length 10 *cm*. Its radius of curvature will be
(a) 20 *cm* (b) 16 *cm*
(c) 10 *cm* (d) 12 *cm*

66. A convex lens [RPMT 1997]
(a) Converges light rays
(b) Diverges light rays
(c) Form real images always
(d) Always forms virtual images

67. The focal length of a combination of lenses formed with lenses having powers of + 2.50 *D* and – 3.75 *D* will be [RPMT 1997]
(a) – 20 *cm* (b) – 40 *cm*
(c) – 60 *cm* (d) – 80 *cm*

68. Focal length of a converging lens in air is *R*. If it is dipped in water of refractive index 1.33, then its focal length will be around (Refractive index of lens material is 1.5) [RPMT 1997; EAMCET (Med.) 1995]
(a) *R* (b) 2*R*
(c) 4*R* (d) *R* / 2

69. Focal length of a convex lens of refractive index 1.5 is 2 *cm*. Focal length of lens when immersed in a liquid of refractive index of 1.25 will be [CBSE PMT 1993]
(a) 10 *cm* (b) 2.5 *cm*
(c) 5 *cm* (d) 7.5 *cm*

70. The focal length of a convex lens depends upon [AFMC 1994]
(a) Frequency of the light ray
(b) Wavelength of the light ray
(c) Both (a) and (b)
(d) None of these

71. If a convex lens of focal length 80 *cm* and a concave lens of focal length 50 *cm* are combined together, what will be their resulting power [CBSE PMT 1996; AFMC 2002]
(a) + 6.5*D* (b) – 6.5 *D*
(c) + 7.5 *D* (d) – 0.75 *D*

72. f_v and f_r are the focal lengths of a convex lens for violet and red light respectively and F_v and F_r are the focal lengths of a concave lens for violet and red light respectively, then
(a) $f_v < f_r$ and $F_v > F_r$ (b $f_v < f_R$ and $F_v < F_r$
(c) $f_c > f_r$ and $F_v > F_r$ (d) $f_v > f_r$ and $F_v < F_r$

73. If a lens is cut into two pieces perpendicular to the principal axis and only one part is used, the intensity of the image [CPMT 1996]
(a) Remains same (b) $\frac{1}{2}$ times
(c) 2 times (d) Infinite

74. A convex lens of focal length f produces an image $\frac{1}{n}$ times than that of the size of the object. The distance of the object from the lens is [BHU 1997; JIPMER 2001, 02]
(a) nf [MP PET 2003] (b) $\frac{f}{n}$
(c) $(n+1)f$ (d) $(n-1)f$

75. Two thin lenses whose powers are +2*D* and –4*D* respectively combine, then the power of combination is [AFMC 1998; CPMT 1996; Very Similar to BHU 2004]
(a) – 2*D* (b) + 2*D*
(c) – 4*D* (d) + 4*D*

76. A substance is behaving as convex lens in air and concave in water, then its refractive index is [BHU 1998]
(a) Smaller than air
(b) Greater than both air and water
(c) Greater than air but less than water
(d) Almost equal to water

77. A concave lens of focal length 20 *cm* placed in contact with a plane mirror acts as a [SCRA 1998]
(a) Convex mirror of focal length 10 *cm*
(b) Concave mirror of focal length 40 *cm*
(c) Concave mirror of focal length 60 *cm*
(d) Concave mirror of focal length 10 *cm*

78. A convex lens is used to form real image of an object on a screen. It is observed that even when the positions of the object and that screen are fixed there are two positions of the lens to form real images. If the heights of the images are 4 *cm* and 9 *cm* respectively, the height of the object is [AMU (Med.) 1999]
(a) 2.25 *cm* (b 6.00 *cm*
(c) 6.50 *cm* (d) 36.00 *cm*

79. A convex lens of power + 6*D* is placed in contact with a concave lens of power – 4*D*. What is the nature and focal length of the combination [AMU (Engg.) 1999]
(a) Concave, 25 *cm* (b) Convex, 50 *cm*
(c) Concave, 20 *cm* (d) Convex, 100 *cm*

80. A double convex lens of glass of μ = 1.5 has radius of curvature of each of its surface is 0.2 *m*. The power of the lens is [CBSE PMT 1996]
(a) + 10 *dioptres* (b) – 10 *dioptres*
(c) – 5 *dioptres* (d) +5 *dioptres*

81. A lens of focal power 0.5 *D* is [JIPMER 1999]
(a) A convex lens of focal length 0.5 *m*
(b) A concave lens of focal length 0.5 *m*
(c) A convex lens of focal length 2 *m*
(d) A concave lens of focal length 2 *m*

82. A lens which has focal length of 4 *cm* and refractive index of 1.4 is immersed in a liquid of refractive index 1.6, then the focal length will be [RPMT 1999]
(a) – 12.8 *cm* (b) 32 *cm*
(c) 12.8 *cm* (d) – 32 *cm*

83. A convex lens has 9 *cm* focal length and a concave lens has – 18 *cm* focal length. The focal length of the combination in contact will be

(a) 9 *cm* (b) – 18 *cm*

(c) – 9 *cm* (d) 18 *cm*

84. A double convex thin lens made of glass of refractive index 1.6 has radii of curvature 15 *cm* each. The focal length of this lens when immersed in a liquid of refractive index 1.63 is

(a) – 407 *cm* (b) 250 *cm*

(c) 125 *cm* (d) 25 *cm*

85. A lens of power + 2 *diopters* is placed in contact with a lens of power – 1 *diopoter*. The combination will behave like

[UPSEAT 2000]

(a) A divergent lens of focal length 50 *cm*

(b) A convergent lens of focal length 50 *cm*

(c) A convergent lens of focal length 100 *cm*

(d) A divergent lens of focal length 100 *cm*

86. Chromatic aberration of lens can be corrected by

[AFMC 2000]

(a) Reducing its aperature

(b) Proper polishing of its two surfaces

(c) Suitably combining it with another lens

(d) Providing different suitable curvature to its two surfaces

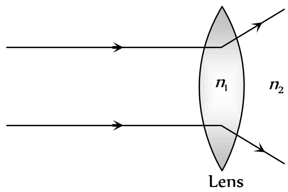
87. The relation between n_1 and n_2, if behaviour of light rays is as shown in figure is [KCET 2000]

(a) $n_1 >> n_2$

(b $n_2 > n_1$

(c) $n_1 > n_2$

(d) $n_1 = n_2$



88. A candle placed 25 *cm* from a lens, forms an image on a screen placed 75 *cm* on the other end of the lens. The focal length and type of the lens should be [KCET 2000]

(a) + 18.75 *cm* and convex lens

(b) – 18.75 *cm* and concave lens

(c) + 20.25 *cm* and convex lens

(d) – 20.25 *cm* and concave lens

89. We combined a convex lens of focal length f_1 and concave lens of focal lengths f_2 and their combined focal length was *F*. The combination of these lenses will behave like a concave lens, if

(a) $f_1 > f_2$ (b) $f_1 < f_2$

(c) $f_1 = f_2$ (d) $f_1 \leq f_2$

90. In a plano-convex lens the radius of curvature of the convex lens is 10 *cm*. If the plane side is polished, then the focal length will be (Refractive index = 1.5)

[CBSE PMT 2000; BHU 2004]

(a) 10.5 *cm* (b 10 *cm*

(c) 5.5 *cm* (d) 5 *cm*

91. The focal length of a convex lens is 10 *cm* and its refractive index is 1.5. If the radius of curvature of one surface is 7.5 *cm*, the radius of curvature of the second surface will be [RPMT 1999]

[MP PMT 2000]

(a) 7.5 *cm* (b) 15.0 *cm*

(c) 75 *cm* (d) 5.0 *cm*

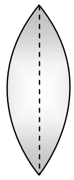
92. A convex lens has a focal length *f*. It is cut into two parts along the dotted line as shown in the figure. The focal length of each part will be [UPSEAT 2000; Pb. PET 2004] [MP PET 2000]

(a) $\frac{f}{2}$

(b) *f*

(c) $\frac{3}{2}f$

(d) $2f$



93. An object has image thrice of its original size when kept at 8 *cm* and 16 *cm* from a convex lens. Focal length of the lens is

(a) 8 *cm*

(b) 16 *cm*

(c) Between 8 *cm* and 16 *cm*

(d) Less than 8 *cm*

94. The combination of a convex lens (*f* = 18 *cm*) and a thin concave lens (*f* = 9 *cm*) is [AMU (Engg.) 2001]

(a) A concave lens (*f* = 18 *cm*)

(b) A convex lens (*f* = 18 *cm*)

(c) A convex lens (*f* = 6 *cm*)

(d) A concave lens (*f* = 6 *cm*)

95. A convex lens forms a real image of an object for its two different positions on a screen. If height of the image in both the cases be 8 *cm* and 2 *cm*, then height of the object is

[KCET 2000, 01]

(a) 16 *cm* (b) 8 *cm*

(c) 4 *cm* (d) 2 *cm*

96. A convex lens of focal length 25 *cm* and a concave lens of focal length 10 *cm* are joined together. The power of the combination will be [MP PMT 2001]

(a) – 16 *D* (b) + 16 *D*

(c) – 6 *D* (d) + 6 *D*

97. The unit of focal power of a lens is [KCET 2001]

(a) Watt (b) Horse power

(c) Dioptre (d) Lux

98. A thin lens made of glass of refractive index μ = 1.5 has a focal length equal to 12 *cm* in air. It is now immersed in water $\left(\mu = \frac{4}{3}\right)$. Its new focal length is [UPSEAT 2002]

(a) 48 *cm* [KCET 2000] (b) 36 *cm*

(c) 24 *cm* (d) 12 *cm*

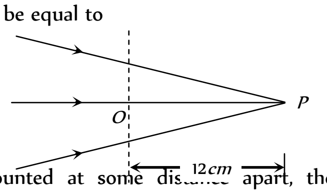
99. Figure given below shows a beam of light converging at point *P*. When a convex lens of focal length 16 *cm* is introduced in the path of the beam at a place *O* shown by dotted line such that *OP* becomes the axis of the lens, the beam converges at a distance *x* from the lens. The value *x* will be equal to

(a) 12 *cm*

(b) 24 *cm*

(c) 36 *cm*

(d) 48 *cm*



100. If two + 5 *D* lenses are mounted at some distance apart, the equivalent power will always be negative if the distance is

[UPSEAT 2002]

(a) Greater than 40 *cm* (b) Equal to 40 *cm*

(c) Equal to 10 *cm* (d) Less than 10 *cm*

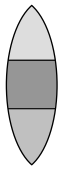
101. A convex lens produces a real image *m* times the size of the object. What will be the distance of the object from the lens

[JIPMER 2002]

(a) $\left(\frac{m+1}{m}\right)f$ (b) $(m-1)f$

(c) $\left(\frac{m-1}{m}\right)f$ (d) $\frac{m+1}{f}$

102. A convex lens is made up of three different materials as shown in the figure. For a point object placed on its axis, the number of images formed are [KCET 2002]



(a) 1

(b) 5

(c) 4

(d) 3

103. An object is placed 12 *cm* to the left of a converging lens of focal length 8 *cm*. Another converging lens of 6 *cm* focal length is placed at a distance of 30 *cm* to the right of the first lens. The second lens will produce [KCET 2002]

(a) No image (b) A virtual enlarged image

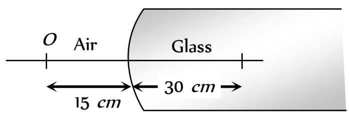
(c) A real enlarged image (d) A real smaller image

104. If convex lens of focal length 80*cm* and a concave lens of focal length 50 *cm* are combined together, what will be their resulting power [AFMC 2002]

(a) + 6.5 *D* (b) – 6.5 *D*

(c) + 7.5 *D* (d) – 0.75 *D*

105. A point object *O* is placed in front of a glass rod having spherical end of radius of curvature 30 *cm*. The image would be formed at



(a) 30 *cm* left

(b) Infinity

(c) 1 *cm* to the right

(d) 18 *cm* to the left

106. The focal length of lens of refractive index 1.5 in air is 30 *cm*. When it is immersed in a liquid of refractive index $\frac{4}{3}$, then its focal length in liquid will be [BHU 2002]

(a) 30 *cm* (b) 60 *cm*

(c) 120 *cm* (d) 240 *cm*

107. Two thin lenses of focal lengths f_1 and f_2 are in contact. The focal length of this combination is [MP PET 2002]

(a) $\frac{f_1 f_2}{f_1 - f_2}$ (b) $\frac{f_1 f_2}{f_1 + f_2}$

(c) $\frac{2 f_1 f_2}{f_1 - f_2}$ (d) $\frac{2 f_1 f_2}{f_1 + f_2}$

108. A convex lens is dipped in a liquid whose refractive index is equal to the refractive index of the lens. Then its focal length will

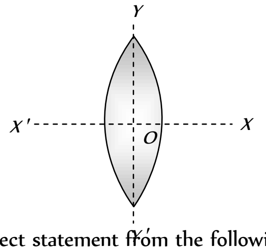
(a) Become infinite

(b) Become small, but non–zero

(c) Remain unchanged

(d) Become zero

109. An equiconvex lens is cut into two halves along (i) XOX' and (ii) YOY' as shown in the figure. Let f, f', f'' be the focal lengths of the complete lens, of each half in case (i), and of each half in case (ii), respectively



Choose the correct statement from the following

[CBSE PMT 2003]

(a) $f' = 2f, f'' = f$ (b) $f' = f, f'' = f$

(c) $f' = 2f, f'' = 2f$ (d) $f' = f, f'' = 2f$

110. The sun makes 0.5° angle on earth surface. Its image is made by convex lens of 50 *cm* focal length. The diameter of the image will be [CPMT 2003]

(a) 5 *mm* (b) 4.36 *mm*

(c) 7 *mm* (d) None of these

111. The chromatic Aberration in lenses becomes due to

[CPMT 2003]

(a) Disimilarity of main axis of rays

(b) Disimilarity of radii of curvature

(c) Variation of focal length of lenses with wavelength

(d) None of these

112. If aperture of lens is halved then image will be [AFMC 2003]

[Orissa JEE 2002]

(a) No effect on size

(b) Intensity of image decreases

(c) Both (a) and (b)

(d) None of these

113. When the convergent nature of a convex lens will be less as compared with air [AFMC 2003]

(a) In water (b) In oil

(c) In both (a) and (b) (d) None of these

114. An achromatic combination of lenses produces

[KCET 1993; JIPMER 1997]

(a) Coloured images

(b) Highly enlarged image

(c) Images in black and white

(d) Images unaffected by variation of refractive index with wavelength

115. In a parallel beam of white light is incident on a converging lens, the colour which is brought to focus nearest to the lens is

(a) Violet (b) Red

(c) The mean colour (d) All the colours together

116. A magnifying glass is to be used at the fixed object distance of 1 *inch*. If it is to produce an erect image magnified 5 *times* its focal length should be [MP PMT 1990]

(a) 0.2 *inch* (b) 0.8 *inch*
(c) 1.25 *inch* (d) 5 *inch*

117. A film projector magnifies a 100 *cm* film strip on a screen. If the linear magnification is 4, the area of magnified film on the screen is CPMT 1977, 91; MP PET 1985, 89; RPMT 2001; BCEC 2005]

(a) 1600 *cm* (b) 400 *cm*
(c) 800 *cm* (d) 200 *cm*

118. An object placed 10 *cm* in front of a lens has an image 20 *cm* behind the lens. What is the power of the lens (in *dioptres*) [MP PMT 1995]

(a) 1.5 (b) 3.0
(c) – 15.0 (d) + 15.0

119. A beam of parallel rays is brought to a focus by a plano-convex lens. A thin concave lens of the same focal length is joined to the first lens. The effect of this is [KCET 2004]

(a) The focal point shifts away from the lens by a small distance
(b) The focus remains undisturbed
(c) The focus shifts to infinity
(d) The focal point shifts towards the lens by a small distance

120. A thin plano-convex lens acts like a concave mirror of focal length 0.2 *m* when silvered from its plane surface. The refractive index of the material of the lens is 1.5. The radius of curvature of the convex surface of the lens will be [KCET 2004]

(a) 0.4 *m* (b 0.2 *m*
(c) 0.1 *m* (d) 0.75 *m*

121. A point object is placed at the center of a glass sphere of radius 6 *cm* and refractive index 1.5. The distance of the virtual image from the surface of the sphere is [IIT-JEE (Screening) 2004]

(a) 2 *cm* (b) 4 *cm*
(c) 6 *cm* (d) 12 *cm*

122. In order to obtain a real image of magnification 2 using a converging lens of focal length 20 *cm*, where should an object be placed [AFMC 2004]

(a) 50 *cm* (b) 30 *cm*
(c) – 50 *cm* (d) – 30 *cm*

123. A plano-convex lens of refractive index 1.5 and radius of curvature 30 *cm* is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object be placed in order to have a real image of the size of the object [AIEEE 2004]

(a) 20 *cm* (b) 30 *cm*
(c) 60 *cm* (d) 80 *cm*

124. A double convex lens $(R_1 = R_2 = 10\,cm)$ $(\mu = 1.5)$ having focal length equal to the focal length of a concave mirror. The radius of curvature of the concave mirror is [Orssia PMT 2004]

(a) 10 *cm* (b 20 *cm*
(c) 40 *cm* (d) 15 *cm*

125. At what distance from a convex lens of focal length 30 *cm*, an object should be placed so that the size of the image be 1/2 of the object

(a) 30 *cm* (b) 60 *cm*
(c) 15 *cm* (d) 90 *cm*

126. A plano-convex lens is made of refractive index of 1.6. The radius of curvature of the curved surface is 60 *cm*. The focal length of the lens is [NCERT 1980; Pb. PET 2000]

(a) 400 *cm* (b) 200 *cm*
(c) 100 *cm* (d) 50 *cm*

127. The radius of the convex surface of plano-convex lens is 20 *cm* and the refractive index of the material of the lens is 1.5. The focal length of the lens is [CPMT 2004]

(a) 30 *cm* (b) 50 *cm*
(c) 20 *cm* (d) 40 *cm*

128. A combination of two thin convex lenses of focal length 0.3 *m* and 0.1 *m* will have minimum spherical and chromatic aberrations if the distance between them is [UPSEE 2004]

(a) 0.1 *m* (b 0.2 *m*
(c) 0.3 *m* (d) 0.4 *m*

129. A bi-convex lens made of glass (refractive index 1.5) is put in a liquid of refractive index 1.7. Its focal length will [UPSEAT 2004]

(a) Decrease and change sign
(b Increase and change sign
(c) Decrease and remain of the same sign
(d) Increase and remain of the same sign

130. Spherical aberration in a lens [UPSEAT 2004]

(a) Is minimum when most of the deviation is at the first surface
(b) Is minimum when most of the deviation is at the second surface
(c) Is minimum when the total deviation is equally distributed over the two surface
(d) Does not depend on the above consideration

131. The focal lengths of convex lens for red and blue light are 100 *cm* and 96.8 *cm* respectively. The dispersive power of material of lens is [Pb. PET 2003]

(a) 0.325 (b 0.0325
(c) 0.98 (d) 0.968

132. The power of an achromatic convergent lens of two lenses is + 2*D*. The power of convex lens is + 5*D*. The ratio of dispersive power of convex and concave lens will be [Pb. PET 2003]

(a) 5 : 3 (b 3 : 5
(c) 2 : 5 (d) 5 : 2

133. The focal lengths for violet, green and red light rays are f_V, f_G and f_R respectively. Which of the following is the true relationship [BHU 2004; CBS

(a) $f_R < f_G < f_V$ (b $f_V < f_G < f_R$
(c) $f_G < f_R < f_V$ (d) $f_G < f_V < f_R$

134. Two lenses of power + 12 and – 2 diopters are placed in contact. The combined focal length of the combination will be

(a) 8.33 *cm* (b) 1.66 *cm*

(c) 12.5 *cm* (d) 10 *cm*

135. When light rays from the sun fall on a convex lens along a direction parallel to its axis [MP PMT 2004]

(a) Focal length for all colours is the same

(b Focal length for violet colour is the shortest

(c) Focal length for yellow colour is the longest

(d) Focal length for red colour is the shortest

136. A convex lens is in contact with concave lens. The magnitude of the ratio of their focal length is 2/3. Their equivalent focal length is 30 *cm*. What are their individual focal lengths

(a) – 75, 50 (b) – 10, 15

(c) 75, 50 (d) – 15, 10

137. A thin glass (refractive index 1.5) lens has optical power of $-5D$ in air. It's optical power in a liquid medium with refractive index 1.6 will be [AIEEE 2005]

(a) 25 *D* (b) – 25 *D*

(c) 1 *D* (d) None of these

138. The plane faces of two identical plano-convex lenses each having focal length of 40 *cm* are pressed against each other to form a usual convex lens. The distance from this lens, at which an object must be placed to obtain a real, inverted image with magnification one is [NCERT 1980; CPMT 1981; MP PMT 1999; UPSEAT 1999]

(a) 80 *cm* (b 40 *cm*

(c) 20 *cm* (d) 162 *cm*

139. If two lenses of +5 diopters are mounted at some distance apart, the equivalent power will always be negative if the distance is

(a) Greater than 40 *cm* (b) Equal to 40 *cm*

(c) Equal to 10 *cm* (d) Less than 10 *cm*

140. A concave lens and a convex lens have same focal length of 20 *cm* and both put in contact this combination is used to view an object 5 *cm* long kept at 20 *cm* from the lens combination. As compared to object the image will be [CPMT 2005]

(a) Magnified and inverted

(b Reduced and erect

(c) Of the same size and erect

(d) Of the same size and inverted

141. The focal length of the field lens (which is an achromatic combination of two lenses) of telescope is 90 *cm*. The dispersive powers of the two lenses in the combination are 0.024 and 0.036. The focal lengths of two lenses are [CPMT 2005]

(a) 30 *cm* and 60 *cm* (b 30 *cm* and – 45 *cm*

(c) 45 *cm* and 90 *cm* (d) 15 *cm* and 45 *cm*

142. A combination of two thin lenses of the same material with focal lengths f_1 and f_2, arranged on a common axis minimizes chromatic aberration, if the distance between them is

(a) $\frac{(f_1+f_2)}{4}$ (b) $\frac{(f_1+f_2)}{2}$

(c) (f_1+f_2) (d) $2(f_1+f_2)$

143. If the focal length of a double convex lens for red light is f_R, its focal length for the violet light is [EAMCET 2005]

(a) f_R (b) Greater than f_R

(c) Less than f_R (d) $2f_R$

144. A thin equiconvex lens is made of glass of refractive index 1.5 and its focal length is 0.2 *m*, if it acts as a concave lens of 0.5 *m* focal length when dipped in a liquid, the refractive index of the liquid is

(a) $\frac{17}{8}$ (b) $\frac{15}{8}$

(c) $\frac{13}{8}$ (d) $\frac{9}{8}$

145. The dispersive power of the material of lens of focal length 20 *cm* is 0.08. The longitudinal chromatic aberration of the lens is

(a) 0.08 *cm* (b) 0.08/20 *cm*

(c) 1.6 *cm* (d) 0.16 *cm*

[IIT-JEE (Screening) 2005]

Prism Theory & Dispersion of Light

1. Which source is associated with a line emission spectrum [MP PET/PMT 1988; CBSE PMT 1993]

(a) Electric fire (b) Neon street sign

(c) Red traffic light (d) Sun

2. Formula for dispersive power is (where symbols have their usual meanings) [MP PMT/PET 1988]

or

If the refractive indices of crown glass for red, yellow and violet colours are respectively μ_r, μ_y and μ_v, then the dispersive power of this glass would be [MP PMT 1996]

(a) $\frac{\mu_v-\mu_y}{\mu_r-1}$ (b) $\frac{\mu_v-\mu_r}{\mu_y-1}$

(c) $\frac{\mu_v-\mu_r}{\mu_y-\mu_r}$ [BCECE 2005] (d) $\frac{\mu_v-\mu_r}{\mu_y}-1$

3. The critical angle between an equilateral prism and air is 45°. If the incident ray is perpendicular to the refracting surface, then

(a) After deviation it will emerge from the second refracting surface

(b) It is totally reflected on the second surface and emerges out perpendicularly from third surface in air

(c) It is totally reflected from the second and third refracting surfaces and finally emerges out from the first surface

(d) It is totally reflected from all the three sides of prism and never emerges out

4. When white light passes through a glass prism, one gets spectrum on the other side of the prism. In the emergent beam, the ray which is deviating least is or

Deviation by a prism is lowest for [MP PMT 1997]

(a) Violet ray (b) Green ray

(c) Red ray (d) Yellow ray

5. We use flint glass prism to disperse polychromatic light because light of different colours [EAMCET 2005] [MP PET 1993]

(a) Travel with same speed

(b) Travel with same speed but deviate differently due to the shape of the prism

(c) Have different anisotropic properties while travelling through the prism

(d) Travel with different speeds

6. A prism $(\mu = 1.5)$ has the refracting angle of 30°. The deviation of a monochromatic ray incident normally on its one surface will be (sin 48° 36' = 0.75)

[MP PMT/PET 1988]

(a) 18° 36' (b) 20° 30'
(c) 18° (d) 22°1'

7. Fraunhofer lines are obtained in

[CPMT 1973; MP PMT 1989; MP PMT 2004]

(a) Solar spectrum
(b) The spectrum obtained from neon lamp
(c) Spectrum from a discharge tube
(d) None of the above

8. When light rays are incident on a prism at an angle of 45°, the minimum deviation is obtained. If refractive index of the material of prism is $\sqrt{2}$, then the angle of prism will be

[MP PMT 1986]

(a) 30° (b) 40°
(c) 50° (d) 60°

9. A spectrum is formed by a prism of dispersive power 'ω'. If the angle of deviation is 'δ', then the angular dispersion is

[MP PMT 1989]

(a) ω / δ (b) δ / ω
(c) $1/\omega\delta$ (d) $\omega\delta$

10. Light from sodium lamp is passed through cold sodium vapours, the spectrum of transmitted light consists of

[MP PET 1989; RPMT 2001]

(a) A line at 5890 Å (b) A line at 5896 Å
(c) Sodium doublet lines (d) No spectral features

11. Angle of minimum deviation for a prism of refractive index 1.5 is equal to the angle of prism. The angle of prism is (cos 41° = 0.75)

(a) 62° (b) 41°
(c) 82° (d) 31°

12. In the formation of primary rainbow, the sunlight rays emerge at minimum deviation from rain-drop after

[MP PET 1989]

(a) One internal reflection and one refraction
(b) One internal reflection and two refractions
(c) Two internal reflections and one refraction
(d) Two internal reflections and two refractions

13. Dispersive power depends upon [RPMT 1997]

(a) The shape of prism (b) Material of prism
(c) Angle of prism (d) Height of the prism

14. When white light passes through the achromatic combination of prisms, then what is observed

[MP PMT 1989]

(a) Only deviation (b) Only dispersion
(c) Deviation and dispersion (d) None of the above

15. The dispersion for a medium of wavelength λ is *D*, then the dispersion for the wavelength 2λ will be

[MP PET 1989]

(a) *D*/8 (b) *D*/4
(c) *D*/2 (d) *D*

16. The refractive index of a prism for a monochromatic wave is $\sqrt{2}$ and its refracting angle is 60°. For minimum deviation, the angle of incidence will be

[MNR 1998; MP PMT 1989, 92, 2002; CPMT 1993, 2004]

(a) 30° (b) 45°
(c) 60° (d) 75°

17. The ratio of angle of minimum deviation of a prism in air and when dipped in water will be (${}_a\mu_g = 3/2$ and ${}_a\mu_w = 4/3$)

(a) 1/8 (b) 1/2
(c) 3/4 (d) 1/4

18. The respective angles of the flint and crown glass prisms are *A*' and *A*. They are to be used for dispersion without deviation, then the ratio of their angles *A*' /*A* will be

[MP PMT 1989]

(a) $-\dfrac{(\mu_y - 1)}{(\mu_y' - 1)}$ (b) $\dfrac{(\mu_y' - 1)}{(\mu_y - 1)}$
(c) $(\mu_y' - 1)$ (d) $(\mu_y - 1)$

19. The number of wavelengths in the visible spectrum

[MP PMT 1989]

(a) 4000 (b) 6000
(c) 2000 (d) Infinite

20. The black lines in the solar spectrum during solar eclipse can be explained by [MP PMT 1989]

(a) Planck's law (b) Kirchoff's law
(c) Boltzmann's law (d) Solar disturbances

21. The dispersive power is maximum for the material

(a) Flint glass (b) Crown glass
(c) Mixture of both [MP PET/PMT 1988] (d) None of the above

22. A light ray is incident by grazing one of the face of a prism and after refraction ray does not emerge out, what should be the angle of prism while critical angle is *C*

(a) Equal to 2*C* (b) Less than 2*C*
(c) More than 2*C* (d) None of the above

23. A parallel beam of monochromatic light is incident at one surface of a equilateral prism. Angle of incidence is 55° and angle of emergence is 46°. The angle of minimum deviation will be

(a) Less than 41° (b) Equal to 41°
(c) More than 41° (d) None of the above

24. The spectrum of light emitted by a glowing solid is

(a) Continuous spectrum (b) Line spectrum
(c) Band spectrum (d) Absorption spectrum

25. Light rays from a source are incident on a glass prism of index of refraction μ and angle of prism α. At near normal incidence, the angle of deviation of the emerging rays is

[MP PMT 1993]

(a) $(\mu - 2)\alpha$ (b) $(\mu - 1)\alpha$
(c) $(\mu + 1)\alpha$ (d) $(\mu + 2)\alpha$

26. Which of the following element was discovered by study of Fraunhofer lines

(a) Hydrogen (b) Oxygen

(c) Helium (d) Ozone

27. By placing the prism in minimum deviation position, images of the spectrum

(a) Becomes inverted (b) Becomes broader

(c) Becomes distinct (d) Becomes intensive

28. Our eye is most sensitive for which of the following wavelength

(a) 4500 Å

(b) 5500 Å

(c) 6500 Å

(d) Equally sensitive for all wave lengths of visible spectrum

29. Three prisms of crown glass, each have angle of prism 9° and two prisms of flint glass are used to make direct vision spectroscope. What will be the angle of flint glass prisms if μ for flint is 1.60 and μ for crown glass is 1.53

(a) 11.9° (b) 16.0°

(c) 15.3° (d) 9.11°

30. If the refractive indices of crown glass for red, yellow and violet colours are 1.5140, 1.5170 and 1.5318 respectively and for flint glass these are 1.6434, 1.6499 and 1.6852 respectively, then the dispersive powers for crown and flint glass are respectively

(a) 0.034 and 0.064 (b) 0.064 and 0.034

(c) 1.00 and 0.064 (d) 0.034 and 1.0

31. The minimum temperature of a body at which it emits light is

(a) 1200°C (b) 1000°C

(c) 500°C (d) 200°C

32. Band spectrum is obtained when the source emitting light is in the form of **or**

Band spectrum is characteristic of

[CPMT 1988; MP PET 1994; DCE 2004; MP PET 2005]

(a) Atoms (b Molecules

(c) Plasma (d) None of the above

33. Flint glass prism is joined by a crown glass prism to produce dispersion without deviation. The refractive indices of these for mean rays are 1.602 and 1.500 respectively. Angle of prism of flint prism is 10°, then the angle of prism for crown prism will be

(a) 12°2.4' (b) 12°4'

(c) 1.24° (d) 12°

34. The angle of minimum deviation for a prism is 40° and the angle of the prism is 60°. The angle of incidence in this position will be

[EAMCET (Engg.) 1995; MH CET 1999; CPMT 2000]

(a) 30° (b) 60°

(c) 50° (d) 100°

35. In the position of minimum deviation when a ray of yellow light passes through the prism, then its angle of incidence is

[MP PMT 1989; RPMT 1997]

(a) Less than the emergent angle

(b) Greater than the emergent angle

(c) Sum of angle of incidence and emergent angle is 90°

(d) Equal to the emergent angle

36. A circular disc of which 2/3 part is coated with yellow and 1/3 part is with blue. It is rotated about its central axis with high velocity, then it will be seen as

(a) Green (b) Brown

(c) White (d) Violet

37. The fine powder of a coloured glass is seen as

(a) Coloured (b) White

(c) That of the glass colour (d) Black

38. When a white light passes through a hollow prism, then

[MP PMT 1987]

(a) There is no dispersion and no deviation

(b) Dispersion but no deviation

(c) Deviation but no dispersion

(d) There is dispersion and deviation both

39. The light ray is incidence at angle of 60° on a prism of angle 45°. When the light ray falls on the other surface at 90°, the refractive index of the material of prism [MP PET/PMT 1988] μ and the angle of deviation δ are given by [DPMT 2001]

(a) $\mu = \sqrt{2}\,,\delta = 30^o$ (b) $\mu = 1.5\,,\delta = 15^o$

(c) $\mu = \frac{\sqrt{3}}{2},\delta = 30^o$ (d) $\mu = \sqrt{\frac{3}{2}},\delta = 15^o$

40. In dispersion without deviation

(a) The emergent rays of all the colours are parallel to the incident ray

(b) Yellow coloured ray is parallel to the incident ray

(c) Only red coloured ray is parallel to the incident ray

(d) All the rays are parallel, but not parallel to the incident ray

41. Deviation of 5° is observed from a prism whose angle is small and whose refractive index is 1.5. The angle of prism is

[DPMT 2001]

(a) 7.5° (b) 10°

(c) 5° (d) 3.3°

42. The refractive indices of violet and red light are 1.54 and 1.52 respectively. If the angle of prism is 10°, then the angular dispersion is [MP PMT 1990]

(a) 0.02 (b) 0.2

(c) 3.06 (d) 30.6

43. The angle of minimum deviation measured with a prism is 30° and the angle of prism is 60°. The refractive index of prism material is

(a) $\sqrt{2}$ (b) 2

(c) 3/2 (d) 4/3

44. If the refractive indices of a prism for red, yellow and violet colours be 1.61, 1.63 and 1.65 respectively, then the dispersive power of the prism will be

[MP PET 1991; DPMT 1999]

(a) $\frac{1.65-1.62}{1.61-1}$ (b) $\frac{1.62-1.61}{1.65-1}$

(c) $\frac{1.65-1.61}{1.63-1}$ (d) $\frac{1.65-1.63}{1.61-1}$

45. The minimum deviation produced by a hollow prism filled with a certain liquid is found to be 30°. The light ray is also found to be refracted at angle of 30°. The refractive index of the liquid is

(a) $\sqrt{2}$ (b) $\sqrt{3}$

(c) $\sqrt{\frac{3}{2}}$ (d) $\frac{3}{2}$

46. Minimum deviation is observed with a prism having angle of prism *A*, angle of deviation δ, angle of incidence *i* and angle of emergence *e*. We then have generally

[MP PET 1991]

(a) $i > e$ (b) $i < e$

(c) $i = e$ (d) $i = e = \delta$

47. A thin prism P_1 with angle 4° and made from glass of refractive index 1.54 is combined with another thin prism P_2 made from glass of refractive index 1.72 to produce dispersion without deviation. The angle of prism P_2 is

[MP PMT 1991, 92; IIT-JEE 1990; MP PET 1995, 99; UPSEAT 2001; RPMT 2004]

(a) 2.6° (b) 3°

(c) 4° (d) 5.33°

48. An achromatic prism is made by combining two prisms $P_1(\mu_v = 1.523, \mu_r = 1.515)$ and $P_2(\mu_v = 1.666, \mu_r = 1.650)$; where μ represents the refractive index. If the angle of the prism P_1 is 10°, then the angle of the prism P_2 will be

[MP PMT 1991]

(a) 5° (b) 7.8°

(c) 10.6° (d) 20°

49. Angle of a prism is 30° and its refractive index is $\sqrt{2}$ and one of the surface is silvered. At what angle of incidence, a ray should be incident on one surface so that after reflection from the silvered surface, it retraces its path

[MP PMT 1991; UPSEAT 2001; CBSE PMT 2004]

(a) 30° (b) 60°

(c) 45° (d) $\sin^{-1}\sqrt{1.5}$

50. For a material, the refractive indices for red, violet and yellow colour light are respectively 1.52, 1.64 and 1.60. The dispersive power of the material is [MP PMT 1991]

(a) 2 (b) 0.45

(c) 0.2 (d) 0.045

51. Band spectrum is produced by [CPMT 1978]

(a) *H* (b) *He*

(c) H_2 (d) *Na*

52. The band spectra (characteristic of molecular species) is due to emission of radiation [CPMT 1982, 90]

(a) Gaseous state (b) Liquid state

(c) Solid state (d) All of three states

53. Line spectrum was first of all theoretically explained by

(a) Swan (b) Fraunhofer

(c) Kirchoff (d) Bohr

54. The spectrum of iodine gas under white light will be

[MP PET 1991]

(a) Only violet

(b) Bright lines

(c) Only red lines

(d) Some black bands in continuous spectrum

55. Continuous spectrum is not due to

(a) Hydrogen flame (b) Electric bulb

(c) Kerosene oil lamp flame (d) Candle flame

56. Fraunhofer lines are produced by

(a) The element present in the photosphere of sun

(b) The elements present in the chromosphere of the sun

(c) The vapour of the element present in the chromosphere of the sun

(d) The carbon dioxide present in the atmosphere

57. A medium is said to be dispersive, if [MP PMT 1990]

(a) Light of different wavelengths propagate at different speeds

(b) Light of different wavelengths propagate at same speed but has different frequencies

(c) Light is gradually bent rather than sharply refracted at an interface between the medium and air

(d) Light is never totally internally reflected

58. A ray of light is incident at an angle of 60° on one face of a prism of angle 30°. The ray emerging out of the prism makes an angle of 30° with the incident ray. The emergent ray is

[EAMCET 1990; MP PMT 1990]

(a) Normal to the face through which it emerges

(b) Inclined at 30° to the face through which it emerges

(c) Inclined at 60° to the face through which it emerges

(d) None of these

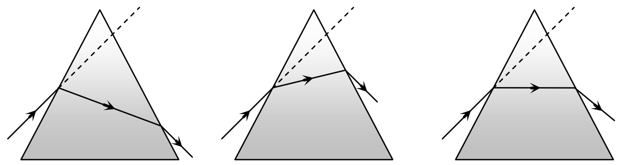
59. In a thin prism of glass (refractive index 1.5), which of the following relations between the angle of minimum deviations δ_m and angle of refraction r will be correct

[MP PMT 1990]

(a) $\delta_m = r$ (b) $\delta_m = 1.5\,r$

(c) $\delta_m = 2r$ (d) $\delta_m = \frac{r}{2}$

60. The figures represent three cases of a ray passing through a prism of angle *A*. The case corresponding to minimum deviation is



(1) (2) (3)

(a) 1 (b) 2

(c) 3 (d) None of these

61. Dispersion can take place for [MP PET 1992]

(a) Transverse waves only but not for longitudinal waves

(b) Longitudinal waves only but not for transverse waves

(c) Both transverse and longitudinal waves

(d) Neither transverse nor longitudinal waves

62. Emission spectrum of CO_2 gas [MP PET 1992]

(a) Is a line spectrum

(b Is a band spectrum

(c) Is a continuous spectrum

(d) Does not fall in the visible region

63. A ray of light passes through an equilateral glass prism 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 the prism. The angle of deviation is

[MNR 1988; MP PMT 1999; Roorkee 2000; UPSEAT 2000; MP PET 2005]

(a) 45° (b) 39°

(c) 20° (d) 30°

64. The true statement is

(a) The order of colours in the primary and the secondary rainbows is the same

(b) The intensity of colours in the primary and the secondary rainbows is the same

(c) The intensity of light in the primary rainbow is greater and the order of colours is the same than the secondary rainbow

(d) The intensity of light for different colours in primary rainbow is greater and the order of colours is reverse than the secondary rainbow

65. What will be the colour of sky as seen from the earth, if there were no atmosphere [MP PMT 1992]

(a) Black (b) Blue

(c) Orange (d) Red

66. When light emitted by a white hot solid is passed through a sodium flame, the spectrum of the emergent light will show

[MP PMT 1992]

(a) The D_1 and D_2 bright yellow lines of sodium

(b) Two dark lines in the yellow region

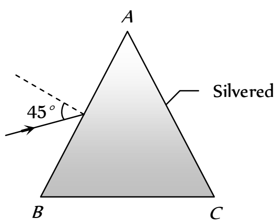
(c) All colours from violet to red

(d) No colours at all

67. A prism ABC of angle 30° has its face AC silvered. A ray of light incident at an angle of 45° at the face AB retraces its path after refraction at face AB and reflection at face AC. The refractive index of the material of the prism is

[MP PMT 1992; EAMCET 2001]

(a) 1.5



(b) $\frac{3}{\sqrt{2}}$

(c) $\sqrt{2}$

(d) $\frac{4}{3}$

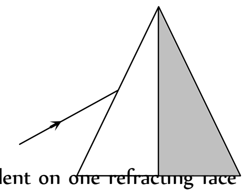
68. A light ray is incident upon a prism in minimum deviation position and suffers a deviation of 34°. If the shaded half of the prism is knocked off, the ray will [MP PMT 1992]

(a) Suffer a deviation of 34°

(b) Suffer a deviation of 68°

(c) Suffer a deviation of 17°

(d) Not come out of the prism



69. A ray of monochromatic light is incident on one refracting face of a prism of angle 75°. It passes through the prism and is incident on the other face at the critical angle. If the refractive index of the material of the prism is $\sqrt{2}$, the angle of incidence on the first face of the prism is

[EAMCET 1983]

(a) 30° (b) 45°

(c) 60° (d) 0°

70. Three glass prisms A, B and C of same refractive index are placed in contact with each other as shown in figure, with no air gap between the prisms. Monochromatic ray of light OP passes through the prism assembly and emerges as QR. The conditions of minimum deviation is satisfied in the prisms

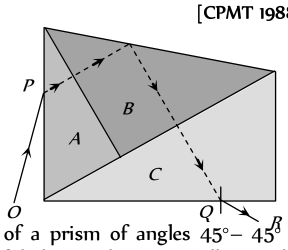
[CPMT 1988]

(a) A and C

(b) B and C

(c) A and B

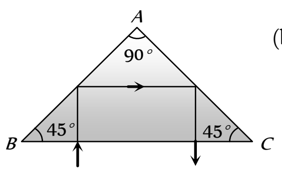
(d) In all prisms A, B and C



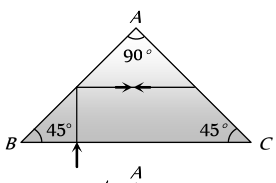
71. The refractive index of a material of a prism of angles 45°– 45° – 90° is 1.5. The path of the ray of light incident normally on the hypotenuse side is shown in

[EAMCET 1985]

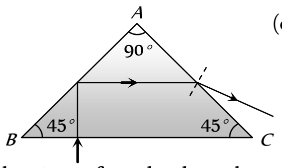
(a)



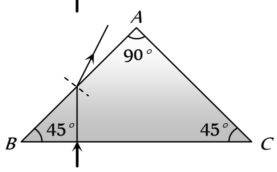
(b)



(c)



(d)



72. At the time of total solar eclipse, the spectrum of solar radiation would be [MP PMT 1990; RPMT 2004]

(a) A large number of dark Fraunhofer lines

(b) A less number of dark Fraunhofer lines

(c) No lines at all

(d) All Fraunhofer lines changed into brilliant colours

73. Angle of deviation (δ) by a prism (refractive index = μ and supposing the angle of prism A to be small) can be given by

(a) $\delta = (\mu - 1)A$ (b) $\delta = (\mu + 1)A$

(c) $\delta = \dfrac{\sin\frac{A+\delta}{2}}{\sin\frac{A}{2}}$ (d) $\delta = \dfrac{\mu - 1}{\mu + 1}A$

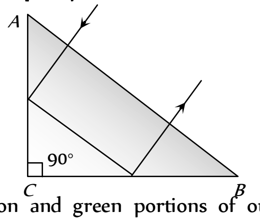
74. Angle of prism is A and its one surface is silvered. Light rays falling at an angle of incidence 2A on first surface return back through the same path after suffering reflection at second silvered surface. Refractive index of the material of prism is

(a) 2 sin A (b) 2 cos A

(c) $\frac{1}{2}\cos A$ (d) $\tan A$

75. A ray of light incident normally on an isosceles right angled prism travels as shown in the figure. The least value of the refractive index of the prism must be

[Manipal MEE 1995; BHU 2003]



(a) $\sqrt{2}$

(b) $\sqrt{3}$

(c) 1.5

(d) 2.0

76. When seen in green light, the saffron and green portions of our National Flag will appear to be [Manipal MEE 1995]

(a) Black

(b) Black and green respectively

(c) Green

(d) Green and yellow respectively

77. At sun rise or sunset, the sun looks more red than at mid-day because [AFMC 1995; Similar to DCE 2003]

(a) The sun is hottest at these times

(b) Of the scattering of light

(c) Of the effects of refraction

(d) Of the effects of diffraction

78. Line spectrum contains information about [MP PET 1995]

(a) The atoms of the prism

(b) The atoms of the source

(c) The molecules of the source

(d) The atoms as well as molecules of the source

79. Missing lines in a continuous spectrum reveal

[MP PET 1995]

(a) Defects of the observing instrument

(b) Absence of some elements in the light source

(c) Presence in the light source of hot vapours of some elements

(d) Presence of cool vapours of some elements around the light source

80. A source emits light of wavelength 4700Å, 5400 Å and 6500 Å. The light passes through red glass before being tested by a spectrometer. Which wavelength is seen in the spectrum

[MP PMT 1995]

(a) 6500 Å (b) 5400 Å

(c) 4700 Å (d) All the above

81. A ray passes through a prism of angle 60° in minimum deviation position and suffers a deviation of 30°. What is the angle of incidence on the prism [MP PMT 1994]

[MP PMT 1995; Pb. PMT 2001; RPMT 2003]

(a) 30° (b) 45°

(c) 60° (d) 90°

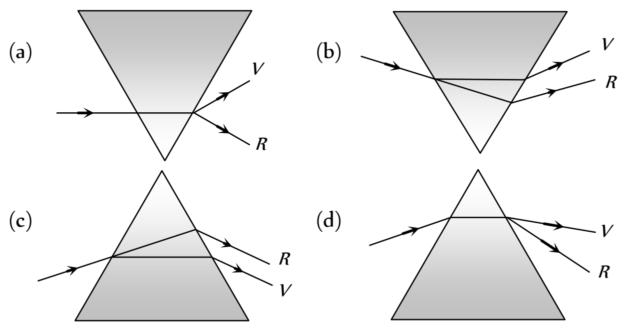
82. When light of wavelength λ is incident on an equilateral prism kept in its minimum deviation position, it is found that the angle of deviation equals the angle of the prism itself. The refractive index of the material of the prism for the wavelength λ is, then [AIIMS 1995]

(a) $\sqrt{3}$ (b) $\frac{\sqrt{3}}{2}$

(c) 2 (d) $\sqrt{2}$

83. Which of the following diagrams, shows correctly the dispersion of white light by a prism

[NSEP 1994; MP PET 1996]



84. A neon sign does not produce

[MP PET 1996; UPSEAT 2004]

(a) Line spectrum

(b) An emission spectrum

(c) An absorption spectrum

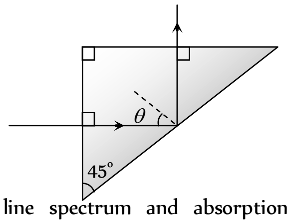
(d) Photons

85. The refractive index of flint glass for blue F line is 1.6333 and red C line is 1.6161. If the refractive index for yellow D line is 1.622, the dispersive power of the glass is

(a) 0.0276 (b) 0.276

(c) 2.76 (d) 0.106

86. A triangular prism of glass is shown in the figure. A ray incident normally to one face is totally reflected, if $\theta = 45^o$. The index of refraction of glass is [AIEEE 2004]



(a) Less than 1.41

(b) Equal to 1.41

(c) Greater than 1.41

(d) None of the above

87. The wavelength of emission line spectrum and absorption line spectrum of a substance are related as

(a) Absorption has larger value

(b) Absorption has smaller value

(c) They are equal

(d) No relation

88. White light is passed through a prism whose angle is 5°. If the refractive indices for rays of red and blue colour are respectively 1.64 and 1.66, the angle of deviation between the two colours will be

(a) 0.1 *degree* (b) 0.2 *degree*

(c) 0.3 *degree* (d) 0.4 *degree*

89. From which source a continuous emission spectrum and a line absorption spectrum are simultaneously obtained

[MP PMT 1997]

(a) Bunsen burner flame

(b) The sun

(c) Tube light

(d) Hot filament of an electric bulb

90. A thin prism P_1 with angle 6° and made from glass of refractive index 1.54 is combined with another thin prism P of refractive index 1.72 to produce dispersion without deviation. The angle of prism P_2 will be [MP PMT 1999]

(a) 5° 24′ (b) 4° 30′

(c) 6° (d) 8°

91. If the refractive index of a material of equilateral prism is $\sqrt{3}$, then angle of minimum deviation of the prism is

[CBSE PMT 1999; Pb. PMT 2004; MH CET 2004]

(a) 30° (b) 45°

(c) 60° (d) 75°

92. The splitting of white light into several colours on passing through a glass prism is due to [CPMT 1999]

(a) Refraction (b) Reflection

(c) Interference (d) Diffraction

93. A white screen illuminated by green and red light appears to be

(a) Green (b) Red

(c) Yellow (d) White

94. Dark lines on solar spectrum are due to

[EAMCET (Engg.) 1995]

(a) Lack of certain elements

(b) Black body radiation

(c) Absorption of certain wavelengths by outer layers

(d) Scattering

95. Line spectra are due to [EAMCET (Med.) 1995]

(a) Hot solids

(b) Atoms in gaseous state

(c) Molecules in gaseous state

(d) Liquid at low temperature

96. The path of a refracted ray of light in a prism is parallel to the base of the prism only when the [SCRA 1994]

(a) Light is of a particular wavelength

(b) Ray is incident normally at one face

(c) Ray undergoes minimum deviation

(d) Prism is made of a particular type of glass

97. For a medium, refractive indices for violet, red and yellow are 1.62, 1.52 and 1.55 respectively, then dispersive power of medium will be

[RPET 1997]

(a) 0.65 (b) 0.22

(c) 0.18 [MP PET 1997] (d) 0.02

98. Two lenses having $f_1 : f_2 = 2 : 3$ has combination to make no dispersion. Find the ratio of dispersive power of glasses used

(a) 2 : 3 (b) 3 : 2

(c) 4 : 9 (d) 9 : 4

99. If refractive index of red, violet and yellow lights are 1.42, 1.62 and 1.50 respectively for a medium. Its dispersive power will be

(a) 0.4 (b) 0.3

(c) 0.2 (d) 0.1

100. A ray is incident at an angle of incidence i on one surface 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

[CBSE PMT 1992]

(a) A / μ (b) $A / 2\mu$

(c) μA (d) $\mu A / 2$

101. Fraunhofer spectrum is a [KCET 1993, 94; RPET 1997; MP PET 1997, 2001; JIPMER 2000; AIIMS 2001]

(a) Line absorption spectrum

(b) Band absorption spectrum

(c) Line emission spectrum

(d) Band emission spectrum

102. The angle of a prism is 60° and its refractive index is $\sqrt{2}$. The angle of minimum deviation suffered by a ray of light in passing through it is [MP PET 2003]

(a) About 20° [KCET 1994; RPMT 1997] (b) 30°

(c) 60° (d) 45°

103. Colour of the sky is blue due to

[CPMT 1996, 99; AFMC 1993; AIIMS 1999; AIEEE 2002; BCECE 2003; BHU 2004]

(a) Scattering of light (b) Total internal reflection

(c) Total emission (d) None of the above

104. Which of the following spectrum have all the frequencies from high to low frequency range [CPMT 1996]

(a) Band spectrum (b) Continuous spectrum

(c) Line spectrum (d) Discontinuous spectrum

105. Stars are not visible in the day time because

[JIPMER 1997]

(a) Stars hide behind the sun

(b) Stars do not reflect sun rays during day

(c) Stars vanish during the day

(d) Atmosphere scatters sunlight into a blanket of extreme brightness through which faint stars cannot be visible

106. Which of the following colours suffers maximum deviation in a prism [KCET 1998; DPMT 2000]

(a) Yellow (b) Blue
(c) Green (d) Orange

107. If a thin prism of glass is dipped into water then minimum deviation (with respect to air) of light produced by prism will be left $\left({}_a\mu_g = \frac{3}{2} \text{ and } {}_a\mu_w = \frac{4}{3}\right)$ [UPSEAT 1999]

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$
(c) 2 (d) $\frac{1}{5}$

108. The refractive indices for the light of violet and red colours of any material are 1.66 and 1.64 respectively. If the angle of prism made of this material is 10°, then angular dispersion will be

(a) 0.20° (b) 0.10°
(c) 0.40° (d) 1°

109. The refractive index of the material of the prism for violet colour is 1.69 and that for red is 1.65. If the refractive index for mean colour is 1.66, the dispersive power of the material of the prism

(a) 0.66 (b) 0.06
(c) 0.65 (d) 0.69

110. The deviation caused in red, yellow and violet colours for crown glass prism are 2.84°, 3.28° and 3.72° respectively. The dispersive power of prism material is [KCET (Engg.) 1999]

(a) 0.268 (b) 0.368
(c) 0.468 (d) 0.568

111. Dispersion of light is due to [DCE 1999]

(a) Wavelength (b) Intensity of light
(c) Density of medium (d) None of these

112. A prism of refracting angle 60° is made with a material of refractive index μ. For a certain wavelength of light, the angle of minimum deviation is 30°. For this, wavelength the value of refractive index of the material is [CPMT 1999, MH CET 2000]

(a) 1.231 (b) 1.820
(c) 1.503 (d) 1.414

113. Which of the prism is used to see infrared spectrum of light [RPMT 2000]

(a) Rock Salt (b) Nicol
(c) Flint (d) Crown

114. When white light enters a prism, it gets split into its constituent colours. This is due to [DCE 2000]

(a) High density of prism material
(b) Because μ is different for different λ
(c) Diffraction of light
(d) Velocity changes for different frequencies

115. The dispersive powers of crown and flint glasses are 0.02 and 0.04 respectively. In an achromatic combination of lenses the focal length of flint glass lens is 40 *cm*. The focal length of crown glass lens will be [DCE 2000]

(a) – 20 *cm* (b) + 20 *cm*
(c) – 10 *cm* (d) + 10 *cm*

116. When a ray of light is incident normally on one refracting surface of an equilateral prism (Refractive index of the material of the prism = 1.5 [EAMCET (Med.) 2000]

(a) Emerging ray is deviated by 30°
(b) Emerging ray is deviated by 45°
(c) Emerging ray just grazes the second refracting surface
(d) The ray undergoes total internal reflection at the second refracting surface

117. Consider the following two statements A and B and identify the correct choice in the given answers [EAMCET (Engg.) 2000]

A : Line spectra is due to atoms in gaseous state
B : Band spectra is due to molecules

(a) Both A and B are false
(b) A is true and B is false [UPSEAT 1999]
(c) A is false and B is true
(d) Both A and B are true

118. Under minimum deviation condition in a prism, if a ray is incident at an angle 30°, the angle between the emergent ray and the second refracting surface of the prism is [UPMEAT 1999] [EAMCET (Engg.) 2000]

(a) 0° (b) 30°
(c) 45° (d) 60°

119. The angle of prism is 5° and its refractive indices for red and violet colours are 1.5 and 1.6 respectively. The angular dispersion produced by the prism is [MP PMT 2000]

(a) 7.75° (b) 5°
(c) 0.5° (d) 0.17°

120. If the refractive angles of two prisms made of crown glass are 10° and 20° respectively, then the ratio of their colour deviation powers will be [KCET 1999; AFMC 2001]

(a) 1 : 1 (b) 2 : 1
(c) 4 : 1 (d) 1 : 2

121. The nature of sun's spectrum is [MP PET 2000; MP PMT 2001]

(a) Continuous spectrum with absorption lines
(b) Line spectrum
(c) The spectrum of the helium atom
(d) Band spectrum

122. A ray of light is incident normally on one of the face of a prism of angle 30° and refractive index $\sqrt{2}$. The angle of deviation will be [KCET 2001]

(a) 26° (b) 0°
(c) 23° (d) 15°

123. For a prism of refractive index 1.732, the angle of minimum deviation is equal to the angle of the prism. The angle of the prism is [CBSE PMT 2001]

(a) 80° (b) 70°

(c) 60° (d) 50°

124. The spectrum obtained from an electric lamp or red hot heater is

(a) Line spectrum (b) Band spectrum

(c) Absorption spectrum (d) Continuous spectrum

125. When a glass prism of refracting angle 60° is immersed in a liquid its angle of minimum deviation is 30°. The critical angle of glass with respect to the liquid medium is [EAMCET 2001]

(a) 42° (b) 45°

(c) 50° (d) 52°

126. Three prisms 1, 2 and 3 have the prism angle A = 60°, but their refractive indices are respectively 1.4, 1.5 and 1.6. If δ_1, δ_2, δ_3 be their respective angles of deviation then

[MP PMT 2001]

(a) $\delta_3 > \delta_2 > \delta_1$ (b) $\delta_1 > \delta_2 > \delta_3$

(c) $\delta_1 = \delta_2 = \delta_3$ (d) $\delta_2 > \delta_1 > \delta_3$

127. Which one of the following alternative is FALSE for a prism placed in a position of minimum deviation [MP PET 2001]

(a) $i_1 = i_2$ (b) $r_1 = r_2$

(c) $i_1 = r_1$ (d) All of these

128. In the visible region the dispersive powers and the mean angular deviations for crown and flint glass prisms are ω, ω' and d, d' respectively. The condition for getting deviation without dispersion when the two prisms are combined is

[EAMCET 2001]

(a) $\sqrt{\omega d} + \sqrt{\omega' d'} = 0$ (b) $\omega' d + \omega d' = 0$

(c) $\omega d + \omega' d' = 0$ (d) $(\omega d)^2 + (\omega' d')^2 = 0$

129. A ray of light passes through the equilateral prism such that angle of incidence is equal to the angle of emergence if the angle of incidence is 45°. The angle of deviation will be

[Pb. PMT 2002]

(a) 15° (b) 75°

(c) 60° (d) 30°

130. The solar spectrum during a complete solar eclipse is

[Kerala PET 2002]

(a) Continuous (b) Emission line

(c) Dark line (d) Dark band

131. Why sun has elliptical shape on the time when rising and sun setting ? It is due to [AFMC 2002]

(a) Refraction (b) Reflection

(c) Scattering (d) Dispersion

132. In the formation of a rainbow light from the sun on water droplets undergoes [CBSE PMT 2000; Orissa JEE 2002; MP PET 2003; KCET 2004]

(a) Dispersion only

(b) Only total internal reflection

(c) Dispersion and total internal reflection

(d) None of these

[BHU 2001; Pb. PET 2003]

133. The Cauchy's dispersion formula is [AIIMS 2002]

(a) $n = A + B\lambda^{-2} + C\lambda^{-4}$ (b) $n = A + B\lambda^{2} + C\lambda^{-4}$

(c) $n = A + B\lambda^{-2} + C\lambda^{4}$ (d) $n = A + B\lambda^{2} + C\lambda^{4}$

134. A prism of refractive index μ and angle A is placed in the minimum deviation position. If the angle of minimum deviation is A, then the value of A in terms of μ is

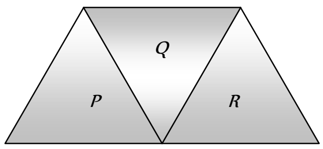
[EAMCET 2003]

(a) $\sin^{-1}\left(\frac{\mu}{2}\right)$ (b) $\sin^{-1}\sqrt{\frac{\mu-1}{2}}$

(c) $2\cos^{-1}\left(\frac{\mu}{2}\right)$ (d) $\cos^{-1}\left(\frac{\mu}{2}\right)$

135. A given ray of light suffers minimum deviation in an equilateral prism P. Additional prisms Q and R of identical shape and material are now added to P as shown in the figure. The ray will suffer

[IIT-JEE (Screening) 2001; KCET 2003]



(a) Greater deviation

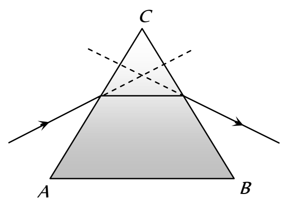
(b) Same deviation

(c) No deviation

(d) Total internal reflection

136. In the given figure, what is the angle of prism

[Orissa JEE 2003]



(a) A

(b) B

(c) C

(d) D

137. A prism of refractive index $\sqrt{2}$ has a refracting angle of 60°. At what angle a ray must be incident on it so that it suffers a minimum deviation [BHU 2003; MP PMT 2005]

(a) 45° (b) 60°

(c) 90° (d) 180°

138. A convex lens, a glass slab, a glass prism and a solid sphere all are made of the same glass, the dispersive power will be

[CPMT 1986]

(a) In the glass slab and prism

(b) In the lens and solid sphere

(c) Only in prism

(d) In all the four

139. A parallel beam of white light falls on a convex lens. Images of blue, yellow and red light are formed on other side of the lens at a distance of 0.20 m, 0.205 m and 0.214 m respectively. The dispersive power of the material of the lens will be

(a) 619/1000 (b) 9/200

(c) 14/205 (d) 5/214

140. The refractive index of the material of the prism for violet colour is 1.69 and that for red is 1.65. If the refractive index for mean colour is 1.66, the dispersive power of the material of the prism [JIPMER 1999]

(a) 0.66 (b 0.06

(c) 0.65 (d) 0.69

141. If the angle of prism is 60^o and the angle of minimum deviation is 40^o, the angle of refraction will be [MP PMT 2004]

(a) 30^o (b) 60^o

(c) 100^o (d) 120^o

142. The refractive index of a particular material is 1.67 for blue light, 1.65 for yellow light and 1.63 for red light. The dispersive power of the material is .... [KCET 2004]

(a) 0.0615 (b) 0.024

(c) 0.031 (d) 1.60

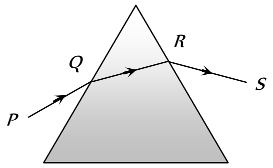
143. A ray of light is incident on an equilateral glass prism placed on a horizontal table. For minimum deviation which of the following is true [IIT-JEE (Screening) 2004]

(a) *PQ* is horizontal

(b) *QR* is horizontal

(c) *RS* is horizontal

(d) Either *PQ* or *RS* is horizontal



144. A beam of light composed of red and green ray is incident obliquely at a point on the face of rectangular glass slab. When coming out on the opposite parallel face, the red and green ray emerge from [CBSE PMT 2004]

(a) Two points propagating in two different directions

(b) Two points propagating in two parallel directions

(c) One point propagating in two different directions

(d) One point propagating in the same directions

145. White light is passed through a prism .... colour shows minimum deviation [Orissa PMT 2004]

(a) Red (b) Violet

(c) Yellow (d) Green

146. A ray of monochromatic light suffers minimum deviation of 38^o while passing through a prism of refracting angle 60^o. Refractive index of the prism material is [Pb. PET 2001]

(a) 1.5 (b) 1.3

(c) 0.8 (d) 2.4

147. A ray incident a 15^o on one refracting surface of a prism of angle 60^o, suffers a deviation of 55^o. What is the angle of emergence [DCE 2002]

(a) 95^o (b) 45^o

(c) 30^o (d) None of these

148. The spectrum obtained from a sodium vapour lamp is an example of [MH CET 2003]

(a) Absorption spectrum (b) Emission spectrum
(c) Continuous spectrum (d) Band spectrum

149. The sky would appear red instead of blue if [DCE 2004]

(a) Atmospheric particles scatter blue light more than red light
(b) Atmospheric particles scatter all colours equally
(c) Atmospheric particles scatter red light more than the blue light
(d) The sun was much hotter

150. Sir C.V. Raman was awarded Nobel Prize for his work connected with which of the following phenomenon of radiation

(a) Scattering (b) Diffraction
(c) Interference (d) Polarisation

151. In absorption spectrum of *Na* the missing wavelength (*s*) are [BCECE 2005]

(a) 589 *nm* (b) 589.6 *nm*
(c) Both (d) None of these

Human Eye and Lens Camera

1. A far sighted man who has lost his spectacles, reads a book by looking through a small hole (3-4 *mm*) in a sheet of paper. The reason will be [CPMT 1977]

(a) Because the hole produces an image of the letters at a longer distance
(b) Because in doing so, the focal length of the eye lens is effectively increased
(c) Because in doing so, the focal length of the eye lens is effectively decreased
(d) None of these

2. For a normal eye, the least distance of distinct vision is [CPMT 1984]

(a) 0.25 *m* (b) 0.50 *m*
(c) 25 *m* (d) Infinite

3. For the myopic eye, the defect is cured by [CPMT 1990; KCET (Engg.) 2000]

(a) Convex lens (b) Concave lens
(c) Cylindrical lens (d) Toric lens

4. Lens used to remove long sightedness (hypermetropia) is

or

A person suffering from hypermetropia requires which type of spectacle lenses [MP PMT 1995]

(a) Concave lens (b) Plano-concave lens
(c) Convexo-concave lens (d) Convex lens

5. Substance on the choroid is

(a) Japan black (b) Nigrim pigment
(c) Carbon black (d) Platinum black

6. Astigmatism (for a human eye) can be removed by using [CPMT 1972; MP PET/PMT 1988; CBSE PMT 1990]

(a) Concave lens (b) Convex lens
(c) Cylindrical lens (d) Prismatic lens

7. Circular part in the centre of retina is called [MP PET/PMT 1988]

(a) Blind spot (b) Yellow spot
(c) Red spot (d) None of the above

8. Image formed on the retina is

(a) Real and inverted (b) Virtual and erect
(c) Real and erect (d) Virtual and inverted

9. If there had been one eye of the man, then

(a) Image of the object would have been inverted
(b) Visible region would have decreased
(c) Image would have not been seen three dimensional
(d) (b) and (c) both

10. A person cannot see distinctly at the distance less than one metre. Calculate the power of the lens that he should use to read a book at a distance of 25 *cm* [CPMT 1983; AFMC 2005] [CPMT 1977; MP PET 1985, 88; MP PMT 1990]

(a) + 3.0 *D* (b) + 0.125 *D*
(c) – 3.0 *D* (d) + 4.0 *D*

11. How should people wearing spectacles work with a microscope

(a) They cannot use the microscope at all
(b) They should keep on wearing their spectacles
(c) They should take off spectacles
(d) (b) and (c) is both way

12. A man who cannot see clearly beyond 5 *m* wants to see stars clearly. He should use a lens of focal length [MP PET/PMT 1988; Pb. PET 2003]

(a) – 100 *m* (b) + 5 *m*
(c) – 5 *m* (d) Very large

13. A man can see only between 75 *cm* and 200 *cm*. The power of lens to correct the near point will be

(a) + 8/3 *D* (b) + 3 *D*
(c) – 3 *D* (d) – 8/3 *D*

14. Image is formed for the short sighted person at [AFMC 1988]

(a) Retina (b) Before retina
(c) Behind the retina (d) Image is not formed at all

15. A man can see the objects upto a distance of one metre from his eyes. For correcting his eye sight so that he can see an object at infinity, he requires a lens whose power is

or

A man can see upto 100 *cm* of the distant object. The power of the lens required to see far objects will be [MP PMT 1993, 2003]

(a) + 0.5 *D* (b) + 1.0 *D*
(c) + 2.0 *D* (d) – 1.0 *D*

16. A man can see the object between 15 *cm* and 30 *cm*. He uses the lens to see the far objects. Then due to the lens used, the near point will be at

(a) $\frac{10}{3}$ *cm* (b) 30 *cm*
(c) 15 *cm* (d) $\frac{100}{3}$ *cm*

17. The far point of a myopia eye is at 40 *cm*. For removing this defect, the power of lens required will be [MP PMT 1987]

(a) 40 *D* (b) – 4 *D*
(c) – 2.5 *D* (d) 0.25 *D*

18. A man suffering from myopia can read a book placed at 10 *cm* distance. For reading the book at a distance of 60 *cm* with relaxed vision, focal length of the lens required will be [MP PMT 1989]

(a) 45 *cm* (b) – 20 *cm*

(c) – 12 *cm* (d) 30 *cm*

19. If the distance of the far point for a myopia patient is doubled, the focal length of the lens required to cure it will become

(a) Half

(b) Double

(c) The same but a convex lens

(d) The same but a concave lens

20. 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 *D* (b) 4 *D*

(c) – 2.5 *D* (d) 0.25 *D*

21. An imaginary line joining the optical centre of the eye lens and the yellow point is called as

(a) Principal axis (b) Vision axis

(c) Neutral axis (d) Optical axis

22. The light when enters the human eye experiences most of the refraction while passing through

(a) Cornea (b) Aqueous humour

(c) Vitrous humour (d) Crystalline lens

23. The impact of an image on the retina remains for

(a) 0.1 *sec* (b) 0.5 *sec*

(c) 10 *sec* (d) 15 *sec*

24. A person is suffering from myopic defect. He is able to see clear objects placed at 15 *cm*. What type and of what focal length of lens he should use to see clearly the object placed 60 *cm* away

(a) Concave lens of 20 *cm* focal length

(b) Convex lens of 20 *cm* focal length

(c) Concave lens of 12 *cm* focal length

(d) Convex lens of 12 *cm* focal length

25. The sensation of vision in the retina is carried to the brain by

(a) Ciliary muscles (b) Blind spot

(c) Cylindrical lens (d) Optic nerve

26. When the power of eye lens increases, the defect of vision is produced. The defect is known as

(a) Shortsightedness (b) Longsightedness

(c) Colourblindness (d) None of the above

27. A man is suffering from colour blindness for green colour. To remove this defect, he should use goggles of

(a) Green colour glasses (b) Red colour glasses

(c) Smoky colour glasses (d) None of the above

28. In human eye the focussing is done by [CPMT 1983]

(a) To and fro movement of eye lens

(b) To and fro movement of the retina

(c) Change in the convexity of the lens surface

(d) Change in the refractive index of the eye fluids

29. A short sighted person can see distinctly only those objects which lie between 10 *cm* and 100 *cm* from him. The power of the spectacle lens required to see a distant object is

[MP PET 1992]

(a) + 0.5 *D* (b) – 1.0 *D*

(c) – 10 *D* (d) + 4.0 *D*

30. A person can see clearly only upto a distance of 25 *cm*. He wants to read a [MP PET 1989] at a distance of 50 *cm*. What kind of lens does he require for his spectacles and what must be its power

(a) Concave, – 1.0 *D* (b) Convex, + 1.5 *D*

(c) Concave, – 2.0 *D* (d) Convex, + 2.0 *D*

31. The human eye has a lens which has a [MP PET 1994]

(a) Soft portion at its centre

(b) Hard surface

(c) Varying refractive index

(d) Constant refractive index

32. A man with defective eyes cannot see distinctly object at the distance more than 60 *cm* from his eyes. The power of the lens to be used will be [MP PMT 1994]

(a) + 60 *D* (b) – 60 *D*

(c) – 1.66 *D* (d) $\frac{1}{1.66}D$

33. A person's near point is 50 *cm* and his far point is 3 *m*. Power of the lenses he requires for

(i) reading and

(ii) for seeing distant stars are [MP PMT 1994]

(a) – 2 *D* and 0.33 *D* (b) 2 *D* and – 0.33 *D*

(c) – 2 *D* and 3 *D* (d) 2 *D* and – 3 *D*

34. A person wears glasses of power – 2.5 *D*. The defect of the eye and the far point of the person without the glasses are respectively [MP PMT 1991]

(a) Farsightedness, 40 *cm* (b) Nearsightedness, 40 *cm*

(c) Astigmatism, 40 *cm* (d) Nearsightedness, 250 *cm*

35. Myopia is due to [AFMC 1996]

(a) Elongation of eye ball

(b) Irregular change in focal length

(c) Shortening of eye ball

(d) Older age

36. A person is suffering from the defect astigmatism. Its main reason is

(a) Distance of the eye lens from retina is increased

(b) Distance of the eye lens from retina is decreased

(c) The cornea is not spherical

(d) Power of accommodation of the eye is decreased

37. A person cannot see objects clearly beyond 2.0 *m*. The power of lens required to correct his vision will be

[MP PMT/PET 1998; JIPMER 2000; KCET 2000; Pb. PET 2001]

(a) + 2.0 *D* (b) – 1.0 *D*

(c) + 1.0 *D* (d) – 0.5 *D*

38. The resolving limit of healthy eye is about

[MP PET 1999; RPMT 1999; AIIMS 2001]

(a) $1'$ or $\left(\frac{1}{60}\right)^{\circ}$ (b) $1''$

(c) 1^{o} (d) $\frac{1}{60}''$

39. When objects at different distances are seen by the eye, which of the following remains constant [MP PMT 1999]

(a) The focal length of the eye lens
(b) The object distance from the eye lens
(c) The radii of curvature of the eye lens
(d) The image distance from the eye lens

40. A person wears glasses of power – 2.0 *D*. The defect of the eye and the far point of the person without the glasses will be

(a) Nearsighted, 50 *cm* (b) Farsighted, 50 *cm*
(c) Nearsighted, 250 *cm* (d) Astigmatism, 50 *cm*

41. An eye specialist prescribes spectacles having a combination of convex lens of focal length 40 *cm* in contact with a concave lens of focal length 25 *cm*. The power of this lens combination in diopters is

[IIT 1997 Cancelled; DPMT 2000]

(a) + 1.5 (b) – 1.5
(c) + 6.67 (d) – 6.67

42. Match the List *I* with the List *II* from the combinations shown

(I)	Presbiopia	(A)	Sphero-cylindrical lens
(II)	Hypermetropia	(B)	Convex lens of proper power may be used close to the eye
(III)	Astigmatism	(C)	Concave lens of suitable focal length
(IV)	Myopia	(D)	Bifocal lens of suitable focal length

(a) I-A; II-C; III-B; IV-D (b) I-B; II-D; III-C; IV-A
(c) I-D; II-B; III-A; IV-C (d) I-D; II-A; III-C; IV-B

43. Near and far points of a human eye are

[EAMCET (Med.) 1995; MP PET 2001; BCECE 2004]

(a) 0 and 25 *cm* (b) 0 and ∞
(c) 25 *cm* and 100 *cm* (d) 25 *cm* and ∞

44. Two parallel pillars are 11 *km* away from an observer. The minimum distance between the pillars so that they can be seen separately will be [RPET 1997; RPMT 2000]

(a) 3.2 *m* (b) 20.8 *m*
(c) 91.5 *m* (d) 183 *m*

45. Retina of eye acts like .... of camera [AFMC 2003]

(a) Shutter (b) Film
(c) Lens (d) None of these

46. The hyper-metropia is a [CBSE PMT 2000]

(a) Short-side defect (b) Long- side defect
(c) Bad vision due to old age (d) None of these

47. Amount of light entering into the camera depends upon

[DCE 2000]

(a) Focal length of the objective lens
(b) Product of focal length and diameter of the objective lens
(c) Distance of the object from camera
(d) Aperture setting of the camera

48. A man cannot see clearly the objects beyond a distance of 20 *cm* from his eyes. To see distant objects clearly he must use which kind of lenses and of what focal length

[MP PMT 2000]

(a) 100 *cm* convex (b) 100 *cm* concave
(c) 20 *cm* convex (d) 20 *cm* concave

49. A person uses spectacles of power +2*D*. He is suffering from

[MP PMT 1999] [MP PET 2000]

(a) Short sightedness or myopia
(b) Long sightedness or hypermetropia
(c) Presbyopia
(d) Astigmatism

50. To remove myopia (short sightedness) a lens of power 0.66 *D* is required. The distant point of the eye is approximately

[MP PMT 2001]

(a) 100 *cm* (b) 150 *cm*
(c) 50 *cm* (d) 25 *cm*

51. A person suffering from 'presbyopia' (myopia and hyper metropia both defects) should use [ISM Dhanbad 1994] [MP PET 2001]

(a) A concave lens
(b) A convex lens
(c) A bifocal lens whose lower portion is convex
(d) A bifocal lens whose upper portion is convex

52. A person who can see things most clearly at a distance of 10 *cm*. Requires spectacles to enable to him to see clearly things at a distance of 30 *cm*. What should be the focal length of the spectacles

[BHU 2003; CPMT 2004; PM PMT 2005]

(a) 15 *cm* (Concave) (b) 15 *cm* (Convex)
(c) 10 *cm* (d) 0

53. Far points of myopic eye is 250 *cm*, then the focal length of the lens to be used will be [DPMT 2002]

(a) – 250 *cm* (b) – 250/9 *cm*
(c) + 250 *cm* (d) + 250/9 *cm*

54. A man can see clearly up to 3 *metres*. Prescribe a lens for his spectacles so that he can see clearly up to 12 *metres*

[DPMT 2002]

(a) – 3/4 *D* (b) 3 *D*
(c) – 1/4 *D* (d) – 4 *D*

55. A satisfactory photographic print is obtained when the exposure time is 10 *sec* at a distance of 2 *m* from a 60 *cd* lamp. The time of exposure required for the same quality print at a distance of 4 *m* from a 120 *cd* lamp is

[Kerala PMT 2002]

(a) 5 *sec* (b) 10 *sec*
(c) 15 *sec* (d) 20 *sec*

56. A person can not see the objects clearly placed at a distance more than 40 *cm*. He is advised to use a lens of power

[DCE 2002; MP PMT 2002, 03]

(a) – 2.5 *D* (b) + 2.5 *D*
(c) – 6.25 *D* (d) + 1.5 *D*

57. A person uses a lens of power + 3*D* to normalise vision. Near point of hypermetropic eye is [CPMT 2002]

(a) 1 *m* (b) 1.66 *m*
(c) 2 *m* (d) 0.66 *m*

58. A defective eye cannot see close objects clearly because their image is formed [MP PET 2003]

(a) On the eye lens
(b) Between eye lens and retina
(c) On the retina
(d) Beyond retina

59. Image formed on retina of eye is proportional to [RPMT 2001]

(a) Size of object (b) Area of object
(c) $\frac{\text{Size of object}}{\text{Size of image}}$ (d) $\frac{\text{size of image}}{\text{size of object}}$

60. A student can distinctly see the object upto a distance 15 *cm*. He wants to see the black board at a distance of 3 *m*. Focal length and power of lens used respectively will be [Pb. PMT 2003]

(a) $-4.8\,cm, -3.3\,D$ (b) $-5.8\,cm, -4.3\,D$
(c) $-7.5\,cm, -6.3\,D$ (d) $-15.8\,cm, -6.3\,D$

61. A camera objective has an aperture diameter *d*. If the aperture is reduced to diameter $d/2$, the exposure time under identical conditions of light should be made [Kerala PMT 2004]

(a) $\sqrt{2}$ fold (b) 2 fold
(c) $2\sqrt{2}$ fold (d) 4 fold

62. The light gathering power of a camera lens depends on [DCE 2003]

(a) Its diameter only
(b) Ratio of focal length and diameter
(c) Product of focal length and diameter
(d) Wavelength of light used

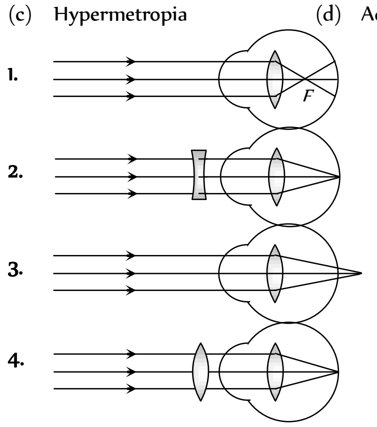
63. The exposure time of a camera lens at the $\frac{f}{2.8}$ setting is $\frac{1}{200}$ second. The correct time of exposure at $\frac{f}{5.6}$ is [DCE 2003]

(a) 0.4 *sec* (b) 0.02 *sec*
(c) 0.002 *sec* (d) 0.04 *sec*

64. Ability of the eye to see objects at all distances is called [AFMC 2005]

(a) Binocular vision (b) Myopia
(c) Hypermetropia (d) Accommodation

65. [KCET 2005]



Identify the wrong description of the above figures

(a) 1 represents far-sightedness
(b) 2 correction for short sightedness
(c) 3 represents far sightedness
(d) 4 correction for far-sightedness

Microscope and Telescope

1. The focal lengths of the objective and eye-lens of a microscope are 1 *cm* and 5 *cm* respectively. If the magnifying power for the relaxed eye is 45, then the length of the tube is

(a) 30 *cm* (b) 25 *cm*
(c) 15 *cm* (d) 12 *cm*

2. In a compound microscope magnification will be large, if the focal length of the eye piece is [CPMT 1984]

(a) Large (b) Smaller
(c) Equal to that of objective (d) Less than that of objective

3. The focal length of the objective lens of a compound microscope is [CPMT 198

(a) Equal to the focal length of its eye piece
(b) Less than the focal length of eye piece
(c) Greater than the focal length of eye piece
(d) Any of the above three

4. Microscope is an optical instrument which

(a) Enlarges the object
(b) Increases the visual angle formed by the object at the eye
(c) Decreases the visual angle formed by the object at the eye
(d) Brings the object nearer

5. Magnifying power of a simple microscope is (when final image is formed at $D = 25$ *cm* from eye) [MP PET 1996; BVP 2003]

(a) $\frac{D}{f}$ (b) $1+\frac{D}{f}$
(c) $1+\frac{f}{D}$ (d) $1-\frac{D}{f}$

6. If in compound microscope m_1 and m_2 be the linear magnification of the objective lens and eye lens respectively, then magnifying power of the compound microscope will be [CPMT 1985; KCET 1994]

(a) $m_1 - m_2$ (b) $\sqrt{m_1 + m_2}$
(c) $(m_1 + m_2)/2$ (d) $m_1 \times m_2$

7. For which of the following colour, the magnifying power of a microscope will be maximum

(a) White colour (b) Red colour
(c) Violet colour (d) Yellow colour

8. The length of the compound microscope is 14 *cm*. The magnifying power for relaxed eye is 25. If the focal length of eye lens is 5 *cm*, then the object distance for objective lens will be

(a) 1.8 *cm* (b) 1.5 *cm*
(c) 2.1 *cm* (d) 2.4 *cm*

9. If the focal length of objective and eye lens are 1.2 *cm* and 3 *cm* respectively and the object is put 1.25 *cm* away from the objective lens and the final image is formed at infinity. The magnifying power of the microscope is

(a) 150 (b) 200
(c) 250 (d) 400

10. The focal length of objective and eye lens of a microscope are 4 *cm* and 8 *cm* respectively. If the least distance of distinct vision is 24 *cm* and object distance is 4.5 *cm* from the objective lens, then the magnifying power of the microscope will be

(a) 18 (b) 32
(c) 64 (d) 20

11. When the length of a microscope tube increases, its magnifying power [MNR 1986]
(a) Decreases (b) Increases
(c) Does not change (d) May decrease or increase

12. In a compound microscope, if the objective produces an image I_o and the eye piece produces an image I_e, then [MP PET 1990]
(a) I_o is virtual but I_e is real
(b) I_o is real but I_e is virtual
(c) I_o and I_e are both real
(d) I_o and I_e are both virtual

13. The magnifying power of a simple microscope can be increased, if we use eye-piece of [MP PMT 1986]
(a) Higher focal length (b) Smaller focal length
(c) Higher diameter (d) Smaller diameter

14. An electron microscope is superior to an optical microscope in
(a) Having better resolving power
(b) Being easy to handle
(c) Low cost
(d) Quickness of observation

15. The magnifying power of a microscope with an objective of 5 *mm* focal length is 400. The length of its tube is 20 *cm*. Then the focal length of the eye-piece is [MP PMT 1991]
(a) 200 *cm* (b) 160 *cm*
(c) 2.5 *cm* (d) 0.1 *cm*

16. The maximum magnification that can be obtained with a convex lens of focal length 2.5 *cm* is (the least distance of distinct vision is 25 *cm*) [MP PET 2003]
(a) 10 (b) 0.1
(c) 62.5 (d) 11

17. When the object is self-luminous, the resolving power of a microscope is given by the expression
(a) $\dfrac{2\mu\sin\theta}{1.22\,\lambda}$ (b) $\dfrac{\mu\sin\theta}{\lambda}$
(c) $\dfrac{2\mu\cos\theta}{1.22\,\lambda}$ (d) $\dfrac{2\mu}{\lambda}$

18. The power of two convex lenses *A* and *B* are 8 *diopters* and 4 *diopters* respectively. If they are to be used as a simple microscope, the magnification of
(a) *B* will be greater than *A*
(b) *A* will be greater than *B*
(c) The information is incomplete
(d) None of the above

19. Finger prints are observed by the use of
(a) Telescope (b) Microscope
(c) Gallilean telescope (d) Concave lens

20. To produce magnified erect image of a far object, we will be required along with a convex lens, is [MNR 1983]
(a) Another convex lens (b) Concave lens
(c) A plane mirror (d) A concave mirror

21. In order to increase the magnifying power of a compound microscope [JIPMER 1986; MP PMT 1997]
(a) The focal lengths of the objective and the eye piece should be small
(b) Objective should have small focal length and the eye piece large
(c) Both should have large focal lengths
(d) The objective should have large focal length and eye piece should have small

22. If the focal length of the objective lens is increased then [MP PMT 1994]
(a) Magnifying power of microscope will increase but that of telescope will decrease
(b) Magnifying power of microscope and telescope both will increase
(c) Magnifying power of microscope and telescope both will decrease
(d) Magnifying power of microscope will decrease but that of telescope will increase

23. The magnification produced by the objective lens and the eye lens of a compound microscope are [CPMT 1984] 25 and 6 respectively. The magnifying power of this microscope is [Manipal MEE 1995; DPMT 2002]
(a) 19 (b) 31
(c) 150 (d) $\sqrt{150}$

24. The focal lengths of the objective and the eye-piece of a compound microscope are 2.0 *cm* and 3.0 *cm* respectively. The distance between the objective and the eye-piece is 15.0 *cm*. The final image formed by the eye-piece is at infinity. The two lenses are thin. The distances in *cm* of the object and the image produced by the objective measured from the objective lens are respectively [IIT 1995]
(a) 2.4 and 12.0 (b) 2.4 and 15.0
(c) 2.3 and 12.0 (d) 2.3 and 3.0

25. Resolving power of a microscope depends upon [MP PET 1995]
(a) The focal length and aperture of the eye lens
(b) The focal lengths of the objective and the eye lens
(c) The apertures of the objective and the eye lens
(d) The wavelength of light illuminating the object

26. The objective lens of a compound microscope produces magnification of 10. In order to get an overall magnification of 100 when image is formed at 25 *cm* from the eye, the focal length of the eye lens should be
(a) 4 *cm* (b) 10 *cm*
(c) $\dfrac{25}{9}$ *cm* (d) 9 *cm*

27. A person using a lens as a simple microscope sees an
(a) Inverted virtual image
(b) Inverted real magnified image
(c) Upright virtual image
(d) Upright real magnified image

28. Least distance of distinct vision is 25 *cm*. Magnifying power of simple microscope of focal length 5 *cm* is [EAMCET (Engg.) 1995; Pb. PMT 1999]
(a) 1 / 5 (b) 5
(c) 1 / 6 (d) 6

29. The objective of a compound microscope is essentially

[SCRA 1998]

(a) A concave lens of small focal length and small aperture

(b) Convex lens of small focal length and large aperture

(c) Convex lens of large focal length and large aperture

(d) Convex lens of small focal length and small aperture

30. Resolving power of a microscope depends upon [DCE 1999]

(a) Wavelength of light used, directly

(b) Wavelength of light used, inversely

(c) Frequency of light used

(d) Focal length of objective

31. In a compound microscope cross-wires are fixed at the point [EAMCET (Engg.) 2000]

(a) Where the image is formed by the objective

(b) Where the image is formed by the eye-piece

(c) Where the focal point of the objective lies

(d) Where the focal point of the eye-piece lies

32. In a compound microscope, the focal lengths of two lenses are 1.5 *cm* and 6.25 *cm* an object is placed at 2 *cm* form objective and the final image is formed at 25 *cm* from eye lens. The distance between the two lenses is [EAMCET (Med.) 2000]

(a) 6.00 *cm* (b) 7.75 *cm*

(c) 9.25 *cm* (d) 11.00 *cm*

33. The length of the tube of a microscope is 10 *cm*. The focal lengths of the objective and eye lenses are 0.5 *cm* and 1.0 *cm*. The magnifying power of the microscope is about [MP PMT 2000]

(a) 5 (b) 23

(c) 166 (d) 500

34. In a compound microscope, the intermediate image is [IIT-JEE (Screening) 2000; MP PET 2005]

(a) Virtual, erect and magnified

(b) Real, erect and magnified

(c) Real, inverted and magnified

(d) Virtual, erect and reduced

35. The magnifying power of a compound microscope increases when

(a) The focal length of objective lens is increased and that of eye lens is decreased

(b) The focal length of eye lens is increased and that of objective lens is decreased

(c) Focal lengths of both objective and eye-piece are increased

(d) Focal lengths of both objective and eye-piece are decreased

36. If the red light is replaced by blue light illuminating the object in a microscope the resolving power of the microscope

(a) Decreases (b) Increases

(c) Gets halved (d) Remains unchanged

37. The magnifying power of a simple microscope is 6. The focal length of its lens in *metres* will be, if least distance of distinct vision is 25 *cm* [MP PMT 2001]

(a) 0.05 (b) 0.06

(c) 0.25 (d) 0.12

38. Two points separated by a distance of 0.1 *mm* can just be resolved in a microscope when a light of wavelength 6000 Å is used. If the light of wavelength 4800Å is used this limit of resolution becomes

(a) 0.08 *mm* (b) 0.10 *mm*

(c) 0.12 *mm* (d) 0.06 *mm*

39. A compound microscope has two lenses. The magnifying power of one is 5 and the combined magnifying power is 100. The magnifying power of the other lens is [Kerala PMT 2002]

(a) 10 (b) 20

(c) 50 (d) 25

40. The angular magnification of a simple microscope can be increased by increasing [Orissa JEE 2002]

(a) Focal length of lens (b) Size of object

(c) Aperture of lens (d) Power of lens

41. Wavelength of light used in an optical instrument are $\lambda_1 = 4000\,Å$ and $\lambda_2 = 5000\,Å$, then ratio of their respective resolving power (corresponding to λ_1 and λ_2) is [AIEEE 2002]

(a) 16 : 25 (b) 9 : 1

(c) 4 : 5 (d) 5 : 4

42. The separation between two microscopic particles is measured P_A and P_B by two different lights of wavelength 2000 Å and 3000 Å respectively, then [AIEEE 2002]

(a) $P_A > P_B$ (b) $P_A < P_B$

(c) $P_A < 3/2 P_B$ (d) $P_A = P_B$

43. The image formed by an objective of a compound microscope is

(a) Virtual and enlarged (b) Virtual and diminished

(c) Real and diminished (d) Real and enlarged

44. An achromatic telescope objective is to be made by combining the lenses of flint and crown glasses. This proper choice is [MP PET 2000]

(a) Convergent of crown and divergent of flint

(b) Divergent of crown and convergent of flint

(c) Both divergent

(d) Both convergent

45. If F and F are the focal length of the objective and eye-piece respectively of a telescope, then its magnifying power will be [CPMT 1977, 82, 97; SCRA 1994; KCET 1999; Pb. PMT 2000; BHU 2001; DCE 2002; RPMT 2003; BCECE 2003, 04]

(a) $F_o + F_e$ (b) $F_o \times F_e$

[DCE 2001]

(c) F_o / F_e (d) $\frac{1}{2}(F_o + F_e)$

46. The magnifying power of a telescope can be increased by [CPMT 1979]

(a) Increasing focal length of the system

(b) Fitting eye piece of high power

(c) Fitting eye piece of low power

(d) Increasing the distance of objects

47. 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 is such a way that parallel rays comes out from the eye lens. If the object subtends an angle 2° at the objective, the angular width of the image

[CPMT 1979; NCERT 1980;
MP PET 1992; JIPMER 1997; UPSEAT 2001]

(a) 10° (b) 24°
(c) 50° (d) 1/6°

48. The diameter of the objective of the telescope is 0.1 *metre* and wavelength of light is 6000 Å. Its resolving power would be approximately [MP PET 1997]

(a) $7.32\times10^{-6} rad$ (b) $1.36\times10^{6} rad$
(c) $7.32\times10^{-5} rad$ (d) $1.36\times10^{5} rad$

49. A photograph of the moon was taken with telescope. Later on, it was found that a housefly was sitting on the objective lens of the telescope. In photograph

[NCERT 1970; MP PET 1999]

(a) The image of housefly will be reduced
(b) There is a reduction in the intensity of the image
(c) There is an increase in the intensity of the image
(d) The image of the housefly will be enlarged

50. For a telescope to have large resolving power the

[CPMT 1980, 81, 85; MP PET 1994;
DCE 2001; AFMC 2005]

(a) Focal length of its objective should be large
(b) Focal length of its eye piece should be large
(c) Focal length of its eye piece should be small
(d) Aperture of its objective should be large

51. An observer looks at a tree of height 15 *m* with a telescope of magnifying power 10. To him, the tree appears

[CPMT 1975]

(a) 10 times taller (b) 15 times taller
(c) 10 times nearer (d) 15 times nearer

52. The focal length of objective and eye lens of a astronomical telescope are respectively 2 *m* and 5 *cm*. Final image is formed at (i) least distance of distinct vision (ii) infinity. The magnifying power in both cases will be [MP PMT/PET 1988]

(a) – 48, – 40 (b) – 40, – 48
(c) – 40, 48 (d) – 48, 40

53. For observing a cricket match, a binocular is preferred to a terrestrial telescope because

(a) The binocular gives the proper three dimensional view
(b) The binocular has shorter length
(c) The telescope does not give erect image
(d) Telescope have chromatic aberrations

54. To increase the magnifying power of telescope (f_o = focal length of the objective and f_e = focal length of the eye lens)

[MP PET/PMT 1988; MP PMT 1992, 94]

(a) f_o should be large and f_e should be small
(b) f_o should be small and f_e should be large
(c) f_o and f_e both should be large
(d) f_o and f_e both should be small

55. Relative difference of focal lengths of objective and eye lens in the microscope and telescope is given as

[MH CET 2001]

(a) It is equal in both (b) It is more in telescope
(c) It is more in microscope (d) It may be more in any one

56. If the telescope is reversed *i.e.* seen from the objective side

(a) Object will appear very small
(b) Object will appear very large
(c) There will be no effect on the image formed by the telescope
(d) Image will be slightly greater than the earlier one

57. The focal length of the objective of a terrestrial telescope is 80 *cm* and it is adjusted for parallel rays, then its magnifying power is 20. If the focal length of erecting lens is 20 *cm*, then full length of telescope will be

(a) 84 *cm* (b) 100 *cm*
(c) 124 *cm* (d) 164 *cm*

58. An astronomical telescope has an angular magnification of magnitude 5 for distant objects. The separation between the objective and the eye piece is 36 *cm* and the final image is formed at infinity. The focal length f_o of the objective and the focal length f_e of the eye piece are

[IIT 1989; MP PET 1995; JIPMER 2000]

(a) f_o = 45 *cm* and f_e = – 9 *cm*
(b) f_o = 7.2 *cm* and f_e = 5 *cm*
(c) f_o = 50 *cm* and f_e = 10 *cm*
(d) f_o = 30 *cm* and f_e = 6 *cm*

59. In an astronomical telescope, the focal lengths of two lenses are 180 *cm* and 6 *cm* respectively. In normal adjustment, the magnifying power will be [MP PET 1990]

(a) 1080 (b) 200
(c) 30 (d) 186

60. The magnifying power of an astronomical telescope for relaxed vision is 16. On adjusting, the distance between the objective and eye lens is 34 *cm*. Then the focal length of objective and eye lens will be respectively [MP PMT 1989]

(a) 17 *cm*, 17 *cm* (b) 20 *cm*, 14 *cm*
(c) 32 *cm*, 2 *cm* (d) 30 *cm*, 4 *cm*

61. In Gallilean telescope, if the powers of an objective and eye lens are respectively +1.25 *D* and – 20 *D*, then for relaxed vision, the length and magnification will be

(a) 21.25 *cm* and 16 (b) 75 *cm* and 20
(c) 75 *cm* and 16 (d) 8.5 *cm* and 21.25

62. The aperture of a telescope is made large, because

[DPMT 1999]

(a) To increase the intensity of image
(b) To decrease the intensity of image
(c) To have greater magnification
(d) To have lesser resolution

63. In Gallilean telescope, the final image formed is

(a) Real, erect and enlarged
(b) Virtual, erect and enlarged
(c) Real, inverted and enlarged
(d) Virtual, inverted and enlarged

64. The magnifying power of a telescope is 9. When it is adjusted for parallel rays, the distance between the objective and the eye-piece is found to be 20 *cm*. The focal length of the two lenses are

(a) 18 *cm*, 2 *cm* (b) 11 *cm*, 9 *cm*

(c) 10 *cm*, 10 *cm* (d) 15 *cm*, 5 *cm*

65. The focal length of the objective and eye piece of a telescope are respectively 60 *cm* and 10 *cm*. The magnitude of the magnifying power when the image is formed at infinity is

(a) 50 (b) 6

(c) 70 (d) 5

66. The magnifying power of an astronomical telescope is 8 and the distance between the two lenses is 54 *cm*. The focal length of eye lens and objective lens will be respectively

[MP PMT 1991; CPMT 1991; Pb. PMT 2001]

(a) 6 *cm* and 48 *cm* (b) 48 *cm* and 6 *cm*

(c) 8 *cm* and 64 *cm* (d) 64 *cm* and 8 *cm*

67. An opera glass (Gallilean telescope) measures 9 *cm* from the objective to the eyepiece. The focal length of the objective is 15 *cm*. Its magnifying power is [DPMT 1988]

(a) 2.5 (b) 2/5

(c) 5/3 (d) 0.4

68. When a telescope is adjusted for parallel light, the distance of the objective from the eye piece is found to be 80 *cm*. The magnifying power of the telescope is 19. The focal lengths of the lenses are

[MP PMT 1992; Very similar to DPMT 2004]

(a) 61 *cm*, 19 *cm* (b) 40 *cm*, 40 *cm*

(c) 76 *cm*, 4 *cm* (d) 50 *cm*, 30 *cm*

69. A reflecting telescope utilizes [CPMT 1983]

(a) A concave mirror (b) A convex mirror

(c) A prism (d) A plano-convex lens

70. The aperture of the objective lens of a telescope is made large so as to [AIEEE 2003; KCET 2003]

(a) Increase the magnifying power of the telescope

(b) Increase the resolving power of the telescope

(c) Make image aberration less

(d) Focus on distant objects

71. On which of the following does the magnifying power of a telescope depends [MP PET 1992]

(a) The focal length of the objective only

(b) The diameter of aperture of the objective only

(c) The focal length of the objective and that of the eye piece

(d) The diameter of aperture of the objective and that of the eye piece

72. Large aperture of telescope are used for

[CPMT 1981; MP PMT 1995; AFMC 2000]

(a) Large image (b) Greater resolution

(c) Reducing lens aberration (d) Ease of manufacture

73. Two convex lenses of focal lengths 0.3 *m* and 0.05 *m* are used to make a telescope. The distance kept between the two is

(a) 0.35 *m* (b) 0.25 *m*

(c) 0.175 *m* (d) 0.15 *m*

74. The diameter of the objective lens of a telescope is 5.0 *m* and wavelength of light is 6000 Å. The limit of resolution of this telescope will be [MP PMT 1994]

(a) 0.03 *sec* (b) 3.03 *sec*

(c) 0.06 *sec* (d) 0.15 *sec*

75. All of the following statements are correct except

[Manipal MEE 1995]

(a) The total length of an astronomical telescope is the sum of the focal lengths of its two lenses

(b) The image formed by the astronomical telescope is always erect because the effect of the combination of the two lenses is divergent [MP PET 1991]

(c) The magnification of an astronomical telescope can be increased by decreasing the focal length of the eye-piece

(d) The magnifying power of the refracting type of astronomical telescope is the ratio of the focal length of the objective to that of the eye-piece

76. 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

[KCEE 1996]

(a) f (b) $2f$

(c) $3f$ (d) $4f$

77. The length of an astronomical telescope for normal vision (relaxed eye) (f_o = focal length of objective lens and f_e = focal length of eye lens) is

[EAMCET (Med.) 1995; CPMT 1999; BVP 2003]

(a) $f_o \times f_e$ (b) $\frac{f_o}{f_e}$

(c) $f_o + f_e$ (d) $f_o - f_e$

78. A Gallilean telescope has objective and eye-piece of focal lengths 200 *cm* and 2 *cm* respectively. The magnifying power of the telescope for normal vision is

[MP PMT 1996]

(a) 90 (b) 100

(c) 108 (d) 198

79. In an astronomical telescope, the focal length of the objective lens is 100 *cm* and of eye-piece is 2 *cm*. The magnifying power of the telescope for the normal eye is

[MP PET 1997]

(a) 50 (b) 10

(c) 100 (d) $\frac{1}{50}$

80. When diameter of the aperture of the objective of an astronomical telescope is increased, its [MP PMT 1997]

(a) Magnifying power is increased and resolving power is decreased

(b) Magnifying power and resolving power both are increased

(c) Magnifying power remains the same but resolving power is increased [MNR 1994]

(d) Magnifying power and resolving power both are decreased

81. The focal lengths of the objective and eye lenses of a telescope are respectively 200 *cm* and 5 *cm*. The maximum magnifying power of the telescope will be

[MP PMT/PET 1998; JIPMER 2001, 02]

(a) – 40 (b) – 48

(c) – 60 (d) – 100

82. The minimum magnifying power of a telescope is *M*, If the focal length of its eye lens is halved, the magnifying power will become

(a) *M* / 2 (b) 2 *M*

(c) 3 *M* (d) 4 *M*

83. The astronomical telescope consists of objective and eye-piece. The focal length of the objective is

[AIIMS 1998; BHU 2000]

(a) Equal to that of the eye-piece

(b) Greater than that of the eye-piece

(c) Shorter than that of the eye-piece

(d) Five times shorter than that of the eye-piece

84. Four convergent lenses have focal lengths 100 *cm*, 10 *cm*, 4 *cm* and 0.3 *cm*. For a telescope with maximum possible magnification, we choose the lenses of focal length

[KCET 1994]

(a) 100 *cm*, 0.3 *cm* (b) 10 *cm*, 0.3 *cm*

(c) 10 *cm*, 4 *cm* (d) 100 *cm*, 4 *cm*

85. The focal length of objective and eye-piece of a telescope are 100 *cm* and 5 *cm* respectively. Final image is formed at least distance of distinct vision. The magnification of telescope is

(a) 20 (b) 24

(c) 30 (d) 36

86. A planet is observed by an astronomical refracting telescope having an objective of focal length 16 *m* and an eye-piece of focal length 2 *cm* [IIT-JEE 1992; Roorkee 2000]

(a) The distance between the objective and the eye-piece is 16.02 *m*

(b) The angular magnification of the planet is 800

(c) The image of the planet is inverted

(d) The objective is larger than the eye-piece

87. If tube length of astronomical telescope is 105 *cm* and magnifying power is 20 for normal setting, calculate the focal length of objective

(a) 100 *cm* (b) 10 *cm*

(c) 20 *cm* (d) 25 *cm*

88. The length of a telescope is 36 *cm*. The focal lengths of its lenses can be [Bihar MEE 1995]

(a) 30 *cm*, 6 *cm* (b) – 30 *cm*, – 6 *cm*

(c) 30 *cm*, – 6 *cm* (d) – 30 *cm*, 6 *cm*

89. An astronomical telescope of ten-fold angular magnification has a length of 44 *cm*. The focal length of the objective is

[CBSE PMT 1997]

(a) 4 *cm* (b) 40 *cm*

(c) 44 *cm* (d) 440 *cm*

90. If both the object and image are at infinite distances form a refracting telescope its magnifying power will be equal to

[AMU (Engg.) 1999]

(a) The sum of the focal lengths of the objective and the eyepiece

(b) The difference of the focal lengths of the two lenses

(c) The ratio of the focal length of the objective and eyepiece

(d) The ratio of the focal length of the eyepiece and objective

91. The number of lenses in a terrestrial telescope is

[KCET 1999; MH CET 2003]

(a) Two (b) Three

(c) Four (d) Six

92. The focal lengths of the lenses of an astronomical telescope are 50 *cm* and 5 *cm*. The length of the telescope when the image is formed at the least distance of distinct vision is

[EAMCET (Engg.) 2000]

(a) $45\,cm$ (b) $55\,cm$

(c) $\frac{275}{6}cm$ (d) $\frac{325}{6}cm$

93. The focal lengths of the objective and eye-piece of a telescope are respectively 100 *cm* and 2 *cm*. The moon subtends an angle of 0.5^o at the eye. If it is looked through the telescope, the angle subtended by the moon's image will be

(a) 100^o (b) 50^o

(c) 25^o (d) 10^o

94. The diameter of the objective of a telescope is a, its magnifying power is *m* and wavelength of light is λ. The resolving power of the telescope is [MP PMT 2000]

(a) $(1.22\lambda)/a$ (b) $(1.22a)/\lambda$

(c) $\lambda m/(1.22a)$ [RPET 1997] (d) $a/(1.22\lambda)$

95. The sun's diameter is $1.4 \times 10^9 m$ and its distance from the earth is $10^{11} m$. The diameter of its image, formed by a convex lens of focal length $2m$ will be [MP PET 2000]

(a) 0.7 *cm* (b) 1.4 *cm*

(c) 2.8 *cm* (d) Zero (*i.e.* point image)

96. In a terrestrial telescope, the focal length of objective is 90 *cm*, of inverting lens is $5\,cm$ and of eye lens is $6\,cm$. If the final image is at 30 *cm*, then the magnification will be

[DPMT 2001]

(a) 21 (b) 12

(c) 18 [AFMC 1994] (d) 15

97. The resolving power of a telescope depends on

[MP PET 2000, 01; DCE 2003]

(a) Focal length of eye lens

(b) Focal length of objective lens

(c) Length of the telescope

(d) Diameter of the objective lens

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

[CPMT 2001; AIIMS 2001]

(a) + 15 *cm* (b) + 20 *cm*

(c) +150 *cm* (d) + 250 *cm*

99. In an astronomical telescope, the focal length of objective lens and eye-piece are 150 *cm* and 6 *cm* respectively. In case when final image is formed at least distance of distinct vision. the magnifying power is [KCET 2001]

(a) 20 (b) 30

(c) 60 (d) 15

100. In a laboratory four convex lenses L_1, L_2, L_3 and L_4 of focal lengths 2, 4, 6 and 8 *cm* respectively are available. Two of these lenses form a telescope of length 10 *cm* and magnifying power 4. The objective and eye lenses are

[MP PMT 2001]

(a) L_2, L_3 (b) L_1, L_4

(c) L_3, L_2 (d) L_4, L_1

101. A telescope has an objective of focal length 50 *cm* and an eye piece of focal length 5 *cm*. The least distance of distinct vision is 25 *cm*.

The telescope is focussed for distinct vision on a scale 200 *cm* away. The separation between the objective and the eye-piece is

(a) 75 *cm* (b) 60 *cm*

(c) 71 *cm* (d) 74 *cm*

102. The resolving power of a telescope whose lens has a diameter of 1.22 *m* for a wavelength of 5000 Å is [Kerala PMT 2002]

(a) 2×10^5 (b) 2×10^6

(c) 2×10^2 (d) 2×10^4

103. To increase both the resolving power and magnifying power of a telescope [Kerala PET 2002; KCET 2002]

(a) Both the focal length and aperture of the objective has to be increased

(b) The focal length of the objective has to be increased

(c) The aperture of the objective has to be increased

(d) The wavelength of light has to be decreased

104. A Galileo telescope has an objective of focal length $100 cm$ and magnifying power 50. The distance between the two lenses in normal adjustment will be [BHU 2002; Pb. PET 2002]

(a) 96 *cm* (b) 98 *cm*

(c) 102 *cm* (d) 104 *cm*

105. An astronomical telescope has a magnifying power 10. The focal length of eyepiece is 20 *cm*. The focal length of objective is [MP PMT 2002, 03; Pb. PET 2004]

(a) 2 *cm* (b) 200 *cm*

(c) $\frac{1}{2} cm$ (d) $\frac{1}{200} cm$

106. A telescope of diameter 2*m* uses light of wavelength 5000 Å for viewing stars. The minimum angular separation between two stars whose image is just resolved by this telescope is [MP PET 2003]

(a) 4×10^{-4} *rad* (b) 0.25×10^{-6} *rad*

(c) 0.31×10^{-6} *rad* (d) 5.0×10^{-3} *rad*

107. A simple magnifying lens is used in such a way that an image is formed at 25 *cm* away from the eye. In order to have 10 *times* magnification, the focal length of the lens should be

(a) 5 *cm* (b) 2 *cm*

(c) 25 *mm* (d) 0.1 *mm*

108. In a simple microscope, if the final image is located at infinity then its magnifying power is [MP PMT 2004]

(a) $\frac{25}{f}$ (b) $\frac{D}{26}$

(c) $\frac{f}{25}$ (d) $\frac{f}{D+1}$

109. In a compound microscope the objective of f_o and eyepiece of f_e are placed at distance L such that L equals [Kerala PMT 2004]

(a) $f_o + f_e$

(b) $f_o - f_e$

(c) Much greater than f_o or f_e

[Kerala PET 2002]

(d) Much less than f_o or f_e

(e) Need not depend either value of focal lengths

110. For a compound microscope, the focal lengths of object lens and eye lens are f_o and f_e respectively, then magnification will be done by microscope when [RPMT 2001]

(a) $f_o = f_e$ (b) $f_o > f_e$

(c) $f_o < f_e$ (d) None of these

111. The angular resolution of a 10 *cm* diameter telescope at a wavelength of 5000 Å is of the order [CBSE PMT 2005]

(a) $10^6 rad$ (b) $10^{-2} rad$

(c) $10^{-4} rad$ (d) $10^{-6} rad$

112. The resolving power of an astronomical telescope is 0.2 seconds. If the central half portion of the objective lens is covered, the resolving power will be [MP PMT 2004]

(a) 0.1 *sec* (b) 0.2 *sec*

(c) 1.0 *sec* (d) 0.6 *sec*

113. An astronomical telescope has objective and eye-piece lens of powers 0.5 *D* and 20 *D* respectively, its magnifying power will be

(a) 8 (b) 20

(c) 30 (d) 40

114. Which of the following is not correct regarding the radio telescope

(a) It can not work at night

(b) It can detect a very faint radio signal

(c) It can be operated even in cloudy weather

(d) It is much cheaper than optical telescope

115. The diameter of objective of a telescope is 1*m*. Its resolving limit for the light of wave length 4538 Å, will be [Pb. PET 2003]

(a) $5.54\times10^{-7} rad$ [MP PET 1990] (b) $2.54\times10^{-4} rad$

(c) $6.54\times10^{-7} rad$ (d) None of these

116. A telescope has an objective lens of focal length 200 *cm* and an eye piece with focal length 2 *cm*. If this telescope is used to see a 50 *meter* tall building at a distance of 2 *km*, what is the height of the image of the building formed by the objective lens

(a) 5 *cm* (b) 10 *cm*

(c) 1 *cm* (d) 2 *cm*

117. Magnification of a compound microscope is 30. Focal length of eye-piece is 5 *cm* and the image is formed at a distance of distinct vision of 25 *cm*. The magnification of the objective lens is

(a) 6 (b) 5

(c) 7.5 (d) 10

118. At Kavalur in India, the astronomers using a telescope whose objective had a diameter of one meter started using a telescope of diameter 2.54 *m*. This resulted in [KCET 2005]

(a) The increase in the resolving power by 2.54 times for the same λ

(b) The increase in the limiting angle by 2.54 times for the same λ

(c) Decrease in resolving power

(d) No effect on the limiting angle

119. A Galileo telescope has an objective of focal length 100 *cm* and magnifying power 50. The distance between the two lenses in normal adjustment will be [BCECE 2005]

(a) 98 *cm* (b) 100 *cm*

(c) 150 *cm* (d) 200 *cm*

120. A compound microscope has an eye piece of focal length 10 *cm* and an objective of focal length 4 *cm*. Calculate the magnification, if an object is kept at a distance of 5 *cm* from the objective so that final image is formed at the least distance vision (20 *cm*)

(a) 12 (b) 11

(c) 10 (d) 13

Photometry

1. If luminous efficiency of a lamp is 2 lumen/watt and its luminous intensity is 42 candela, then power of the lamp is

[AFMC 1998]

(a) 62 *W* (b) 76 *W*

(c) 138 *W* (d) 264 *W*

2. An electric bulb illuminates a plane surface. The intensity of illumination on the surface at a point 2*m* away from the bulb is 5×10^{-4} phot (*lumen/cm*). The line joining the bulb to the point makes an angle of 60° with the normal to the surface. The intensity of the bulb in *candela* is

[IIT-JEE 1980; CPMT 1991]

(a) $40\sqrt{3}$ (b) 40

(c) 20 (d) 40×10^{-4}

3. In a movie hall, the distance between the projector and the screen is increased by 1% illumination on the screen is

[CPMT 1990]

(a) Increased by 1% (b) Decreased by 1%

(c) Increased by 2% (d) Decreased by 2%

4. Correct exposure for a photographic print is 10 *seconds* at a distance of one metre from a point source of 20 *candela*. For an equal fogging of the print placed at a distance of 2 *m* from a 16 *candela* source, the necessary time for exposure is

(a) 100 *sec* (b) 25 *sec*

(c) 50 *sec* (d) 75 *sec*

5. A bulb of 100 *watt* is hanging at a height of one meter above the centre of a circular table of diameter 4 *m*. If the intensity at a point on its rim is I_0, then the intensity at the centre of the table will be [CPMT 1996]

(a) I_0 (b) $2\sqrt{5}I_0$

(c) $2I_0$ (d) $5\sqrt{5}I_0$

6. A movie projector forms an image 3.5*m* long of an object 35 *mm*. Supposing there is negligible absorption of light by aperture then illuminance on slide and screen will be in the ratio of

(a) 100 : 1 (b) 10^4 : 1

(c) 1 : 100 (d) 1 : 10^4

7. A 60 *watt* bulb is hung over the center of a table 4 *m* × 4 *m* at a height of 3 *m*. 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

8. "Lux" is a unit of [Kerala PMT 2001]

(a) Luminous intensity of a source

(b) Illuminance on a surface

(c) Transmission coefficient of a surface

(d) Luminous efficiency of source of light

9. Total flux produced by a source of 1 *cd* is [UP SEAT 2005] [CPMT 2001]

(a) $\frac{1}{4\pi}$ (b) 8π

(c) 4π (d) $\frac{1}{8\pi}$

10. If the luminous intensity of a 100 *W* unidirectional bulb is 100 candela, then total luminous flux emitted from the bulb is

(a) 861 *lumen* (b) 986 *lumen*

(c) 1256 *lumen* (d) 1561 *lumen*

11. 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 [JIMPER 1997]

(a) 1256 *lumen* (b) 1600 *lumen*

(c) 100 *candela* (d) 400 *lumen*

12. A small lamp is hung at a height of 8 feet above the centre of a round table of diameter 16 *feet*. The ratio of intensities of illumination at the centre and at points on the circumference of the table will be [CPMT 1984, 1996]

(a) 1 : 1 (b) 2 : 1

(c) $2\sqrt{2}:1$ (d) 3 : 2

13. Lux is equal to [CPMT 1993]

(a) 1 *lumen/m* (b) 1 *lumen/cm*

(c) 1 *candela/m* (d) 1 *candela/cm*

14. Five *lumen/watt* is the luminous efficiency of a lamp and its luminous intensity is 35 *candela*. The power of the lamp is

[CPMT 1992]

(a) 80 *W* (b) 176 *W*

(c) 88 *W* (d) 36 *W*

15. A lamp rated at 100 *cd* hangs over the middle of a round table with diameter 3 *m* at a height of 2 *m*. It is replaced by a lamp of 25 *cd* and the distance to the table is changed so that the illumination at the centre of the table remains as before. The illumination at edge of the table becomes *X* times the original. Then *X* is

(a) $\frac{1}{3}$ (b) $\frac{16}{27}$

(c) $\frac{1}{4}$ (d) $\frac{1}{9}$

16. The distance between a point source of light and a screen which is 60 *cm* is increased to 180 *cm*. The intensity on the screen as compared with the original intensity will be

[CPMT 1982] [CPMT 1888]

(a) (1 / 9) times (b) (1 / 3) times

(c) 3 times (d) 9 times

17. A source of light emits a continuous stream of light energy which falls on a given area. Luminous intensity is defined as [CPMT 1986]

(a) Luminous energy emitted by the source per second

(b) Luminous flux emitted by source per unit solid angle

(c) Luminous flux falling per unit area of a given surface

(d) Luminous flux coming per unit area of an illuminated surface

18. Venus looks brighter than other stars because [MNR 1985]

(a) It has higher density than other stars

(b) It is closer to the earth than other stars

(c) It has no atmosphere

(d) Atomic fission takes place on its surface

19. To prepare a print the time taken is 5 sec due to lamp of 60 watt at 0.25 *m* distance. If the distance is increased to 40 *cm* then what is the time taken to prepare the similar print [CPMT 1982]

(a) 3.1 *sec* (b) 1 *sec*

(c) 12.8 *sec* (d) 16 *sec*

20. A lamp is hanging 1 *m* above the centre of a circular table of diameter 1*m*. The ratio of illuminaces at the centre and the edge is

(a) $\frac{1}{2}$ (b) $\left(\frac{5}{4}\right)^{\frac{3}{2}}$

(c) $\frac{4}{3}$ (d) $\frac{4}{5}$

21. Two stars situated at distances of 1 and 10 light years respectively from the earth appear to possess the same brightness. The ratio of their real brightness is [NCERT 1981]

(a) 1 : 10 (b) 10 : 1

(c) 1 : 100 (d) 100 : 1

22. The intensity of direct sunlight on a surface normal to the rays is I_0. What is the intensity of direct sunlight on a surface, whose normal makes an angle of 60° with the rays of the sun

(a) I_0 (b) $I_0\left(\frac{\sqrt{3}}{2}\right)$

(c) $\frac{I_0}{2}$ (d) $2I_0$

23. Inverse square law for illuminance is valid for [CPMT 1978]

(a) Isotropic point source (b) Cylindrical source

(c) Search light (d) All types of sources

24. 1% of light of a source with luminous intensity 50 *candela* is incident on a circular surface of radius 10 *cm*. The average illuminance of surface is

(a) 100 *lux* (b) 200 *lux*

(c) 300 *lux* (d) 400 *lux*

25. Two light sources with equal luminous intensity are lying at a distance of 1.2 *m* from each other. Where should a screen be placed between them such that illuminance on one of its faces is four times that on another face

(a) 0.2 *m* (b) 0.4 *m*

(c) 0.8 *m* (d) 1.6 *m*

26. Two lamps of luminous intensity of 8 *Cd* and 32 *Cd* respectively are lying at a distance of 1.2 *m* from each other. Where should a screen be placed between two lamps such that its two faces are equally illuminated due to two sources

(a) 10 *cm* from 8 *Cd* lamp (b) 10 *cm* from 32*Cd* lamp

(c) 40 *cm* from 8 *Cd* lamp (d) 40 *cm* from 32 *Cd* lamp

27. A lamp is hanging along the axis of a circular table of radius *r*. At what height should the lamp be placed above the table, so that the illuminance at the edge of the table is $\frac{1}{8}$ of that at its center

(a) $\frac{r}{2}$ (b) $\frac{r}{\sqrt{2}}$

(c) $\frac{r}{3}$ (d) $\frac{r}{\sqrt{3}}$

[NCERT 1982]

28. A point source of 100 *candela* is held 5*m* above a sheet of blotting paper which reflects 75% of light incident upon it. The illuminance of blotting paper is

(a) 4 *phot* (b) 4 *lux*

(c) 3 *phot* (d) 3 *lux*

29. A lamp is hanging at a height 40 *cm* from the centre of a table. If its height is increased by 10 *cm* the illuminance on the table will decrease by

(a) 10 % (b) 20%

(c) 27% (d) 36%

30. Which has more luminous efficiency

(a) A 40 *W* bulb (b) A 40 *W* fluorescent tube

(c) Both have same (d) Cannot say

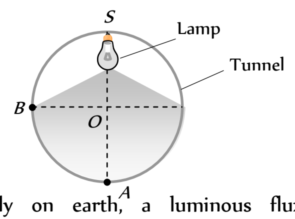
31. An electric lamp is fixed at the ceiling of a circular tunnel as shown is figure. What is the ratio the intensities of light at base *A* and a point *B* on the wall

(a) 1 : 2 [CPMT 1981]

(b) $2:\sqrt{3}$

(c) $\sqrt{3}:1$

(d) $1:\sqrt{2}$



32. When sunlight falls normally on earth, a luminous flux of $1.57\times10^5\ lumen/m^2$ is produced on earth. The distance of earth from sun is $1.5\times10^8\ Km$. The luminous intensity of sun in candela will be

(a) 3.53×10^{27} (b) 3.53×10^{25}

(c) 3.53×10^{29} (d) 3.53×10^{21}

33. In the above problem, the luminous flux emitted by sun will be

(a) $4.43\times10^{25}\ lm$ (b) $4.43\times10^{26}\ lm$

(c) $4.43\times10^{27}\ lm$ (d) $4.43\times10^{28}\ lm$

34. A screen receives 3 *watt* of radiant flux of wavelength 6000 Å. One lumen is equivalent to $1.5\times10^{-3}\,watt$ of monochromatic light of wavelength 5550 Å. If relative luminosity for 6000 Å is 0.685 while that for 5550 Å is 1.00, then the luminous flux of the source is

(a) $4\times10^{3}\,lm$ (b) $3\times10^{3}\,lm$

(c) $2\times10^{3}\,lm$ (d) $1.37\times10^{3}\,lm$

35. A point source of 3000 *lumen* is located at the centre of a cube of side length $2m$. The flux through one side is

(a) 500 *lumen* (b) 600 *lumen*

(c) 750 *lumen* (d) 1500 *lumen*

36. Light from a point source falls on a small area placed perpendicular to the incident light. If the area is rotated about the incident light by an angle of 60°, by what fraction will the illuminance change

(a) It will be doubled (b) It will be halved

(c) It will not change (d) It will become one-fourth

37. A point source of light moves in a straight line parallel to a plane table. Consider a small portion of the table directly below the line of movement of the source. The illuminance at this portion varies with its distance r from the source as

(a) $E \propto \frac{1}{r}$ (b) $E \propto \frac{1}{r^2}$

(c) $E \propto \frac{1}{r^3}$ (d) $E \propto \frac{1}{r^4}$

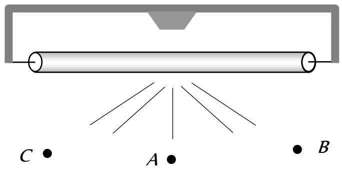
38. Figure shows a glowing mercury tube. The illuminances at point A, B and C are related as

(a) $B > C > A$

(b) $A > C > B$

(c) $B = C > A$

(d) $B = C < A$



39. The relative luminosity of wavelength 600 nm is 0.6. Find the radiant flux of 600 nm needed to produce the same brightness sensation as produced by 120 W of radiant flux at 555 nm

(a) 50 W (b) 72 W

(c) $120 \times (0.6)^2 W$ (d) 200 W

40. Find the luminous intensity of the sun if it produces the same illuminance on the earth as produced by a bulb of 10000 *candela* at a distance 0.3 m. The distance between the sun and the earth is $1.5 \times 10^{11} m$

(a) $25 \times 10^{22} cd$ (b) $25 \times 10^{18} cd$

(c) $25 \times 10^{26} cd$ (d) $25 \times 10^{36} cd$

41. A lamp is hanging at a height of $4m$ above a table. The lamp is lowered by $1m$. The percentage increase in illuminace will be

(a) 40 % (b) 64%

(c) 78% (d) 92%

Critical Thinking

Objective Questions

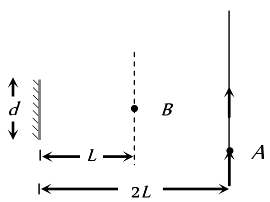
1. A point source of light B is placed at a distance L in front of the centre of a mirror of width d hung vertically on a wall. A man walks in front of the mirror along a line parallel to the mirror at a distance $2L$ from it as shown. The greatest distance over which he can see the image of the light source in the mirror is

(a) $d/2$

(b) d

(c) $2d$

(d) $3d$



2. Two plane mirrors. A and B are aligned parallel to each other, as shown in the figure. A light ray is incident at an angle of $30°$ at a point just inside one end of A. The plane of incidence coincides with the plane of the figure. The maximum number of times the ray undergoes reflections (including the first one) before it emerges out is

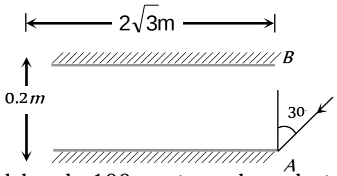
[IIT-JEE (Screening) 2002]

(a) 28

(b) 30

(c) 32

(d) 34



3. A concave mirror of focal length $100cm$ is used to obtain the image of the sun which subtends an angle of $30°$. The diameter of the image of the sun will be

(a) $1.74cm$ (b) $0.87cm$

(c) $0.435cm$ (d) $100cm$

4. A square of side $3cm$ is placed at a distance of $25cm$ from a concave mirror of focal length $10cm$. The centre of the square is at the axis of the mirror and the plane is normal to the axis. The area enclosed by the image of the square is

(a) $4cm^2$ (b) $6cm^2$

(c) $16cm^2$ (d) $36cm^2$

5. A short linear object of length l lies along the axis of a concave mirror of focal length f at a distance u from the pole of the mirror. The size of the image is approximately equal to [IIT-JEE 1988; BHU 2003; CPMT 2

(a) $l\left(\frac{u-f}{f}\right)^{1/2}$ (b) $l\left(\frac{u-f}{f}\right)^{2}$

(c) $l\left(\frac{f}{u-f}\right)^{1/2}$ (d) $l\left(\frac{f}{u-f}\right)^{2}$

6. A thin rod of length $f/3$ lies along the axis of a concave mirror of focal length f. One end of its magnified image touches an end of the rod. The length of the image is

[MP PET 1995]

(a) f (b) $\frac{1}{2}f$

(c) $2f$ (d) $\frac{1}{4}f$

7. A ray of light falls on the surface of a spherical glass paper weight making an angle α with the normal and is refracted in the medium at an angle β. The angle of deviation of the emergent ray from the direction of the incident ray

[IIT-JEE (Screening) 2000] [NCERT 1982]

(a) $(\alpha - \beta)$ (b) $2(\alpha - \beta)$

(c) $(\alpha - \beta)/2$ (d) $(\beta - \alpha)$

8. Light enters at an angle of incidence in a transparent rod of refractive index n. For what value of the refractive index of the material of the rod the light once entered into it will not leave it through its lateral face whatsoever be the value of angle of incidence

[CBSE PMT 1998]

(a) $n > \sqrt{2}$ (b) $n = 1$

(c) $n = 1.1$ (d) $n = 1.3$

9. A glass hemisphere of radius 0.04 m and *R.I.* of the material 1.6 is placed centrally over a cross mark on a paper (i) with the flat face; (ii) with the curved face in contact with the paper. In each case the cross mark is viewed directly from above. The position of the images will be

[ISM Dhanbad 1994]

(a) (i) 0.04 *m* from the flat face; (ii) 0.025 *m* from the flat face

(b) (i) At the same position of the cross mark; (ii) 0.025 *m* below the flat face

(c) (i) 0.025 *m* from the flat face; (ii) 0.04 *m* from the flat face

(d) For both (i) and (ii) 0.025 *m* from the highest point of the hemisphere

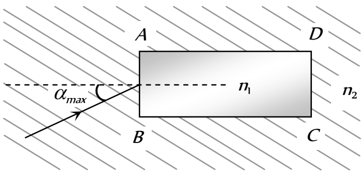
10. One face of a rectangular glass plate 6 *cm* thick is silvered. An object held 8 *cm* in front of the first face, forms an image 12 *cm* behind the silvered face. The refractive index of the glass is

(a) 0.4 (b) 0.8

(c) 1.2 (d) 1.6

11. A rectangular glass slab *ABCD*, of refractive index n_1 is immersed in water of refractive index n_2 ($n_1>n_2$). A ray of light in incident at the surface *AB* of the slab as shown. The maximum value of the angle of incidence α_{max}, such that the ray comes out only from the other surface *CD* is given by

[IIT-JEE (Screening) 2000]

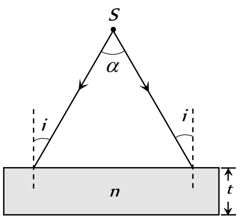


(a) $\sin^{-1}\left[\frac{n_1}{n_2}\cos\left(\sin^{-1}\frac{n_2}{n_1}\right)\right]$ (b) $\sin^{-1}\left[n_1\cos\left(\sin^{-1}\frac{1}{n_2}\right)\right]$

(c) $\sin^{-1}\left(\frac{n_1}{n_2}\right)$ (d) $\sin^{-1}\left(\frac{n_2}{n_1}\right)$

12. A diverging beam of light from a point source *S* having divergence angle α, falls symmetrically on a glass slab as shown. The angles of incidence of the two extreme rays are equal. If the thickness of the glass slab is *t* and the refractive index *n*, then the divergence angle of the emergent beam is

[IIT-JEE (Screening) 2000]



(a) Zero

(b) α

(c) $\sin^{-1}(1/n)$

(d) $2\sin^{-1}(1/n)$

13. A concave mirror is placed at the bottom of an empty tank with face upwards and axis vertical. When sunlight falls normally on the mirror, it is focussed at distance of 32 *cm* from the mirror. If the tank filled with water $\left(\mu = \frac{4}{3}\right)$ upto a height of 20 *cm*, then the sunlight will now get focussed at

[UPSEAT 2002]

(a) 16 *cm* above water level

(b) 9 *cm* above water level

(c) 24 *cm* below water level

(d) 9 *cm* below water level

14. An air bubble in sphere having 4 *cm* diameter appears 1 *cm* from surface nearest to eye when looked along diameter. If $\mu_a = 1.5$, the distance of bubble from refracting surface is

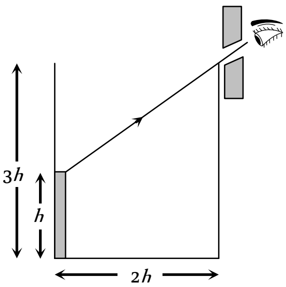
[CPMT 2002]

(a) 1.2 *cm* (b) 3.2 *cm*

(c) 2.8 *cm* (d) 1.6 *cm*

15. An observer can see through a pin–hole the top end of a thin rod of height *h*, placed as shown in the figure. The beaker height is 3*h* and its radius *h*. When the beaker is filled with a liquid up to a height 2*h*, he can see the lower end of the rod. Then the refractive index of the liquid is [CPMT 1999]

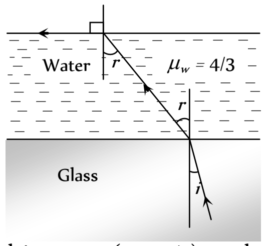
[IIT-JEE (Screening) 2002]



(a) 5/2 (b) $\sqrt{(5/2)}$

(c) $\sqrt{(3/2)}$ (d) 3/2

16. A ray of light is incident at the glass–water interface at an angle *i*, it emerges finally parallel to the surface of water, then the value of μ_g would be **[IIT-JEE (Screening) 2003]**



(a) (4/3) sin *i*

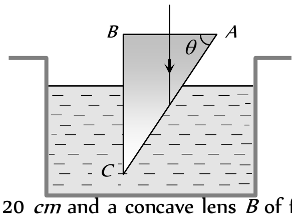
(b) 1/sin *i*

(c) 4/3

(d) 1

17. A glass prism ($\mu = 1.5$) is dipped in water ($\mu = 4/3$) as shown in figure. A light ray is incident normally on the surface *AB*. It reaches the surface BC after totally reflected, if

[IIT JEE 1981; MP PMT 1997]



(a) $\sin\theta \geq 8/9$

(b) $2/3 < \sin\theta < 8/9$

(c) $\sin\theta \leq 2/3$

(d) It is not possible

18. A convex lens *A* of focal length 20 *cm* and a concave lens *B* of focal length 5 *cm* are kept along the same axis with the distance *d* between them. If a parallel beam of light falling on *A* leaves *B* as a parallel beam, then distance *d* in *cm* will be

(a) 25 (b) 15

(c) 30 (d) 50

19. 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 2×10^8 *m/sec*, the focal length of the lens is

[CPMT 1989]

(a) 15 *cm* (b) 20 *cm*

(c) 30 *cm* (d) 10 *cm*

20. A point object *O* is placed on the principal axis of a convex lens of focal length 20 *cm* at a distance of 40 cm to the left of it. The diameter of the lens is 10 *cm*. If the eye is placed 60 *cm* to the right of the lens at a distance *h* below the principal axis, then the maximum value of *h* to see the image will be

(a) 0 (b) 5 *cm*

(c) 2.5 *cm* (d) 10 *cm*

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

[CBSE PMT 1998; JIPMER 2001, 02]

(a) 12 *cm* (b) 30 *cm*

(c) 50 *cm* (d) 60 *cm*

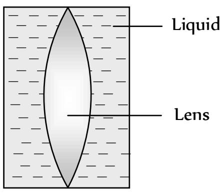
22. Shown in the figure here is a convergent lens placed inside a cell filled with a liquid. The lens has focal length + 20 *cm* when in air and its material has refractive index 1.50. If the liquid has refractive index 1.60, the focal length of the system is [NSEP 1994; DPMT 2000]

(a) + 80 *cm*

(b) – 80 *cm*

(c) – 24 *cm*

(d) –100 *cm*



23. A hollow double concave lens is made of very thin transparent material. It can be filled with air or either of two liquids L_1 and L_2 having refractive indices n_1 and n_2 respectively ($n_2>n_1>1$). The lens will diverge a parallel beam of light if it is filled with

(a) Air and placed in air

(b) Air and immersed in L_1

(c) L_1 and immersed in L_2

(d) L_2 and immersed in L_1

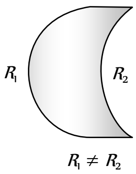
24. The object distance *u*, the image distance *v* and the magnification *m* in a lens follow certain linear relations. These are

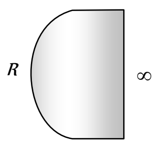
(a) $\frac{1}{u}$ versus $\frac{1}{v}$ (b) *m* versus *u*

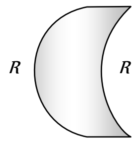
(c) *u* versus *v* (d) *m* versus *v*

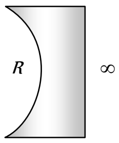
25. Which one of the following spherical lenses does not exhibit dispersion? The radii of curvature of the surfaces of the lenses are as given in the diagrams

[IIT-JEE (Screening) 2002]

(a) 

(b) 

(c) 

(d) 

26. The size of the image of an object, which is at infinity, as formed by a convex lens of focal length 30*cm* is 2 *cm*. If a concave lens of focal length 20 *cm* is placed between the convex lens and the image at a distance of 26 *cm* from the convex lens, calculate the new size of the image

[MP PMT 1999]

[IIT-JEE (Screening) 2003]

(a) 1.25 *cm* (b) 2.5 *cm*

(c) 1.05 *cm* (d) 2 *cm*

27. An achromatic prism is made by crown glass prism $(A_c = 19^o)$ and flint glass prism $(A_F = 6^o)$. If ${}^C\mu_v = 1.5$ and ${}^F\mu_v = 1.66$, then resultant deviation for red coloured ray will be

(a) 1.04° (b) 5°

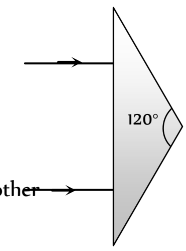
(c) 0.96° (d) 13.5°

28. The refracting angle of prism is *A* and refractive index of material of prism is $\cot\frac{A}{2}$. The angle of minimum deviation is

(a) 180°– 3A (b) 180° + 2A

(c) 90° –A (d) 180° – 2A

29. An isosceles prism of angle 120° has a refractive index of 1.44. Two parallel monochromatic rays enter the prism parallel to each other in air as shown. The rays emerging from the opposite faces



[IIT-JEE (Screening) 2000]

(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 $2\{\sin^{-1}(0.72) - 30^o\}$ with each other

30. A ray of light is incident on the hypotenuse of a right-angled prism after travelling parallel to the base inside the prism. If μ is the refractive index of the material of the prism, the maximum value of the base angle for which light is totally reflected from the hypotenuse is [EAMCET 2003]

[Roorkee 2000]

(a) $\sin^{-1}\left(\frac{1}{\mu}\right)$ (b) $\tan^{-1}\left(\frac{1}{\mu}\right)$

(c) $\sin^{-1}\left(\frac{\mu-1}{\mu}\right)$ (d) $\cos^{-1}\left(\frac{1}{\mu}\right)$

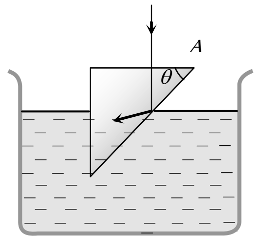
31. The refractive index of the material of the prism and liquid are 1.56 and 1.32 respectively. What will be the value of θ for the following refraction [BHU 2003; CPMT 2004]

(a) $\sin\theta \geq \frac{13}{11}$

(b) $\sin\theta \geq \frac{11}{13}$

(c) $\sin\theta \geq \frac{\sqrt{3}}{2}$

(d) $\sin\theta \geq \frac{1}{\sqrt{2}}$



32. A spherical surface of radius of curvature R separates air (refractive index 1.0) from glass (refractive index 1.5). The centre of curvature is in the glass. A point object P placed in air is found to have a real image Q in the glass. The line PQ cuts the surface at a point O, and PO = OQ. The distance PO is equal to

(a) 5 R (b) 3 R

(c) 2 R (d) 1.5 R

33. A plano-convex lens when silvered in the plane side behaves like a concave mirror of focal length 30*cm*. However, when silvered on the convex side it behaves like a concave mirror of focal length 10 *cm*. Then the refractive index of its material will be

(a) 3.0 (b) 2.0

(c) 2.5 (d) 1.5

34. A ray of light travels from an optically denser to rarer medium. The critical angle for the two media is C. The maximum possible deviation of the ray will be

[KCET (Engg./Med.) 2002]

(a) $\left(\frac{\pi}{2} - C\right)$ (b) $2C$

(c) $\pi - 2C$ (d) $\pi - C$

35. 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 object of the size of about [AIIMS 2003]

(a) 0.5 m (b) $5\,m$

(c) 50 m (d) 500 m

36. The average distance between the earth and moon is 38.6×10^4 *km*. The minimum separation between the two points on the surface of the moon that can be resolved by a telescope whose objective lens has a diameter of 5 m with $\lambda = 6000\ \AA$ is

(a) 5.65 m (b) 28.25 m

(c) 11.30 m (d) 56.51 m

37. The distance of the moon from earth is $3.8 \times 10^5\,km$. The eye is most sensitive to light of wavelength 5500 Å. The separation of two points on the moon that can be resolved by a 500 *cm* telescope will be [AMU (Med.) 2002]

(a) 51 m (b) 60 m

(c) 70 m (d) All the above

38. A small source of light is to be suspended directly above the centre of a circular table of radius R. What should be the height of the light source above the table so that the intensity of light is maximum at the edges of the table compared to any other height of the source

(a) $\frac{R}{2}$ (b) $\frac{R}{\sqrt{2}}$

(c) R (d) $\sqrt{2}R$

39. A light source is located at P_1 as shown in the figure. All sides of the polygon are equal. The intensity of illumination at P_2 is I_0. What will be the intensity of illumination at P_3

[IIT JEE 1998; DPMT 2000]

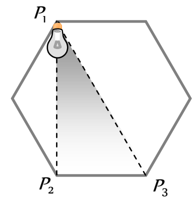
(a) $\frac{3\sqrt{3}}{8}I_0$

(b) $\frac{I_0}{8}$

(c) $\frac{3}{8}I_0$

(d) $\frac{\sqrt{3}}{8}I_0$

[BHU 1997; UPSEAT 1995]



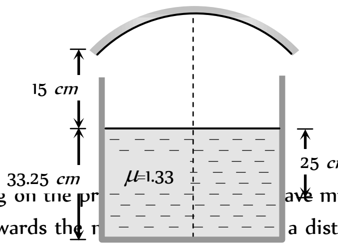
40. A container is filled with water (μ = 1.33) upto a height of 33.25 *cm*. A concave mirror is placed 15 *cm* above the water level and the image of an object placed at the bottom is formed 25 *cm* below the water level. The focal length of the mirror is

(a) 10

(b) 15

(c) 20

(d) 25



41. A point object is moving on the pr… ave mirror of focal length $24cm$ towards the r… a distance of $60cm$ from the mirror, its velocity is $9cm/sec$. What is the velocity of the image at that instant

[MP PMT 1997]

(a) $5cm/sec$ towards the mirror

(b) $4cm/sec$ towards the mirror

(c) $4cm/sec$ away from the mirror

(d) $9cm/sec$ away from the mirror

42. A concave mirror is placed on a horizontal table with its axis directed vertically upwards. Let O be the pole of the mirror and C its centre of curvature. A point object is placed at C. It has a real image, also located at C. If the mirror is now filled with water, the image will be [IIT-JEE 1998]

[MP PMT 1993]

(a) Real, and will remain at C

(b) Real, and located at a point between C and ∞

(c) Virtual and located at a point between C and O

(d) Real, and located at a point between C and O

43. The diameter of moon is 3.5×10^3 *km* and its distance from the earth is 3.8×10^5 *km*. If it is seen through a telescope whose focal length for objective and eye lens are 4 *m* and 10 *cm* respectively, then the angle subtended by the moon on the eye will be approximately

[NCERT 1982; CPMT 1991]

(a) 15° (b) 20°

(c) 30° (d) 35°

44. The focal length of an objective of a telescope is 3 *metre* and diameter 15 *cm*. Assuming for a normal eye, the diameter of the pupil is 3 *mm* for its complete use, the focal length of eye piece must be [MP PET 1989]

(a) 6 *cm* (b) 6.3 *cm*

(c) 20 *cm* (d) 60 *cm*

45. We wish to see inside an atom. Assuming the atom to have a diameter of 100 *pm*, this means that one must be able to resolved a width of say 10 *p.m.* If an electron microscope is used, the minimum electron energy required is about

[AIIMS 2004]

(a) 1.5 *KeV* (b) 15 *KeV*

(c) 150 *KeV* (d) 1.5 *KeV*

46. A telescope has an objective lens of 10 *cm* diameter and is situated at a distance of one kilometre from two objects. The minimum distance between these two objects, which can be resolved by the telescope, when the mean wavelength of light is 5000 Å, is of the order of [CBSE PMT 2004]

(a) 0.5 *m* (b) 5 *m*

(c) 5 *mm* (d) 5 *cm*

47. Two point white dots are 1*mm* apart on a black paper. They are viewed by eye of pupil diameter 3 *mm*. Approximately, what is the maximum distance at which dots can be resolved by the eye ? [Take wavelength of light = 500 *nm*]

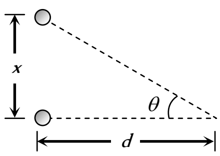
[AIEEE 2005]

(a) 6 *m*

(b) 3 *m*

(c) 5 *m*

(d) 1 *m*



48. A convex lens of focal length 30 *cm* and a concave lens of 10 *cm* focal length are placed so as to have the same axis. If a parallel beam of light falling on convex lens leaves concave lens as a parallel beam, then the distance between two lenses will be

(a) 40 *cm* (b) 30 *cm*

(c) 20 *cm* (d) 10 *cm*

49. A small plane mirror placed at the centre of a spherical screen of radius *R*. A beam of light is falling on the mirror. If the mirror makes *n* revolution. per second, the speed of light on the screen after reflection from the mirror will be

(a) $4\pi nR$ (b) $2\pi nR$

(c) $\frac{nR}{2\pi}$ (d) $\frac{nR}{4\pi}$

50. A room (cubical) is made of mirrors. An insect is moving along the diagonal on the floor such that the velocity of image of insect on two adjacent wall mirrors is 10 cms^{-1}. The velocity of image of insect in ceiling mirror is

(a) 10 cms^{-1} (b) 20 cms^{-1}

(c) $\frac{10}{\sqrt{2}}$ cms^{-1} (d) $10\sqrt{2}$ cms^{-1}

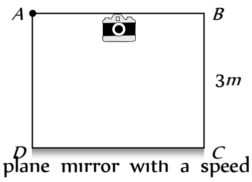
51. Figure shows a cubical room *ABCD* with the wall *CD* as a plane mirror. Each side of the room is 3*m*. We place a camera at the midpoint of the wall *AB*. At what distance should the camera be focussed to photograph an object placed at *A*

(a) 1.5 *m*

(b) 3 *m*

(c) 6 *m*

(d) More than 6 *m*



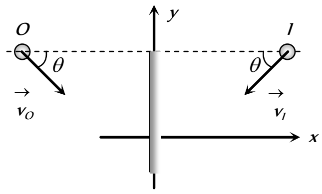
52. If an object moves towards a plane mirror with a speed *v* at an angle θ to the perpendicular to the plane of the mirror, find the relative velocity between the object and the image

(a) v

(b) $2v$

(c) $2v\cos\theta$

(d) $2v\sin\theta$



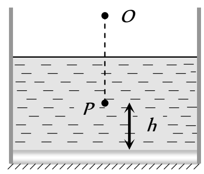
53. A plane mirror is placed at the bottom of the tank containing a liquid of refractive index μ. *P* is a small object at a height *h* above the mirror. An observer *O*-vertically above *P* outside the liquid see *P* and its image in the mirror. The apparent distance between these two will be

(a) $2\mu h$

(b) $\frac{2h}{\mu}$

(c) $\frac{2h}{\mu-1}$

(d) $h\left(1+\frac{1}{\mu}\right)$



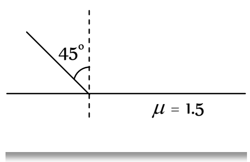
54. One side of a glass slab is silvered as shown. A ray of light is incident on the other side at angle of incidence $i=45^o$. Refractive index of glass is given as 1.5. The deviation of the ray of light from its initial path when it comes out of the slab is

(a) 90°

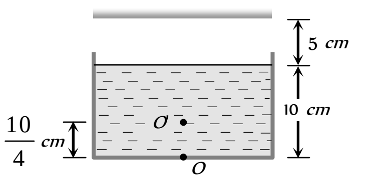
(b) 180°

(c) 120°

(d) 45°



55. Consider the situation shown in figure. Water $\left(\mu_w = \frac{4}{3}\right)$ is filled in a breaker upto a height of 10 *cm*. A plane mirror fixed at a height of 5 *cm* from the surface of water. Distance of image from the mirror after reflection from it of an object O at the bottom of the beaker is

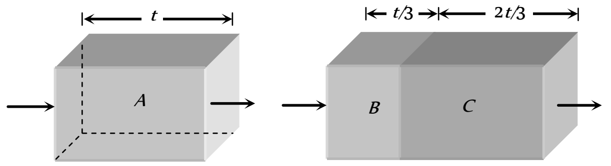


(a) 15 *cm*
(b) 12.5 *cm*
(c) 7.5 *cm*
(d) 10 *cm*

56. A person runs with a speed u towards a bicycle moving away from him with speed v. The person approaches his image in the mirror fixed at the rear of bicycle with a speed of

(a) $u - v$ (b) $u - 2v$
(c) $2u - v$ (d) $2(u - v)$

57. Two transparent slabs have the same thickness as shown. One is made of material A of refractive index 1.5. The other is made of two materials B and C with thickness in the ratio 1 : 2. The refractive index of C is 1.6. If a monochromatic parallel beam passing through the slabs has the same number of waves inside both, the refractive index of B is

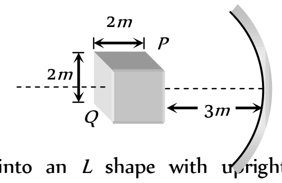


(a) 1.1 (b) 1.2
(c) 1.3 (d) 1.4

58. An object is placed infront of a convex mirror at a distance of 50 *cm*. A plane mirror is introduced covering the lower half of the convex mirror. If the distance between the object and plane mirror is 30 *cm*, it is found that there is no parallax between the images formed by two mirrors. Radius of curvature of mirror will be

(a) 12.5 *cm* (b) 25 *cm*
(c) $\frac{50}{3}$ *cm* (d) 18 *cm*

59. A cube of side 2 *m* is placed in front of a concave mirror focal length 1*m* with its face P at a distance of 3 *m* and face Q at a distance of 5 *m* from the mirror. The distance between the images of face P and Q and height of images of P and Q are

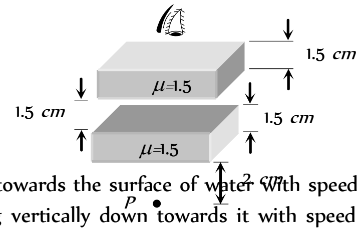


(a) 1 *m*, 0.5 *m*, 0.25 *m*
(b) 0.5 *m*, 1 *m*, 0.25 *m*
(c) 0.5 *m*, 0.25 *m*, 1*m*
(d) 0.25 *m*, 1*m*, 0.5 *m*

60. A small piece of wire bent into an L shape with upright and horizontal portions of equal lengths, is placed with the horizontal portion along the axis of the concave mirror whose radius of curvature is 10 *cm*. If the bend is 20 *cm* from the pole of the mirror, then the ratio of the lengths of the images of the upright and horizontal portions of the wire is

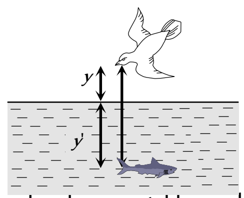
(a) 1 : 2 (b) 3 : 1
(c) 1 : 3 (d) 2 : 1

61. The image of point P when viewed from top of the slabs will be



(a) 2.0 *cm* above P
(b) 1.5 *cm* above P
(c) 2.0 *cm* below P
(d) 1 *cm* above P

62. A fish rising vertically up towards the surface of water with speed 3 *ms* observes a bird diving vertically down towards it with speed 9 *ms*. The actual velocity of bird is



(a) 4.5 *ms*
(b) 5. *ms*
(c) 3.0 *ms*
(d) 3.4 *ms*

63. A beaker containing liquid is placed on a table, underneath a microscope which can be moved along a vertical scale. The microscope is focussed, through the liquid onto a mark on the table when the reading on the scale is a. It is next focussed on the upper surface of the liquid and the reading is b. More liquid is added and the observations are repeated, the corresponding readings are c and d. The refractive index of the liquid is

(a) $\frac{d-b}{d-c-b+a}$ (b) $\frac{b-d}{d-c-b+a}$

(c) $\frac{d-c-b+a}{d-b}$ (d) $\frac{d-b}{a+b-c-d}$

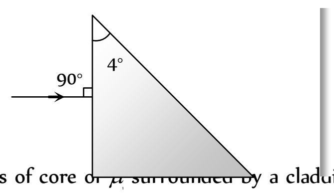
64. Two point light sources are 24 *cm* apart. Where should a convex lens of focal length 9 *cm* be put in between them from one source so that the images of both the sources are formed at the same place

(a) 6 *cm* (b) 9 *cm*
(c) 12 *cm* (d) 15 *cm*

65. There is an equiconvex glass lens with radius of each face as R and ${}_a\mu_g = 3/2$ and ${}_a\mu_w = 4/3$. If there is water in object space and air in image space, then the focal length is

(a) $2R$ (b) R
(c) $3R/2$ (d) R^2

66. A prism having an apex angle 4 and refraction index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror



(a) 176
(b) 4
(c) 178
(d) 2

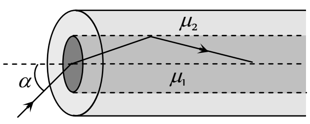
67. An optical fibre consists of core of μ surrounded by a cladding of μ < μ. A beam of light enters from air at an angle α with axis of fibre. The highest α for which ray can be travelled through fibre is

(a) $\cos^{-1}\sqrt{\mu_2^2-\mu_1^2}$

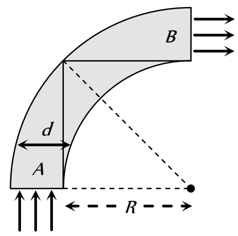
(b) $\sin^{-1}\sqrt{\mu_1^2-\mu_2^2}$

(c) $\tan^{-1}\sqrt{\mu_1^2-\mu_2^2}$

(d) $\sec^{-1}\sqrt{\mu_1^2-\mu_2^2}$



68. A rod of glass (μ = 1.5) and of square cross section is bent into the shape shown in the figure. A parallel beam of light falls on the plane flat surface A as shown in the figure. If d is the width of a side and R is the radius of circular arc then for what maximum value of $\frac{d}{R}$ light entering the glass slab through surface A emerges from the glass through B



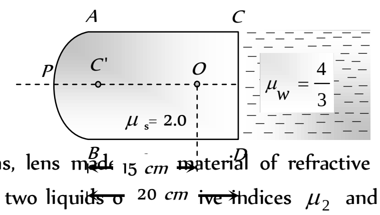
(a) 1.5

(b) 0.5

(c) 1.3

(d) None of these

69. The slab of a material of refractive index 2 shown in figure has curved surface APB of radius of curvature 10 cm and a plane surface CD. On the left of APB is air and on the right of CD is water with refractive indices as given in figure. An object O is placed at a distance of 15 cm from pole P as shown. The distance of the final image of O from P, as viewed from the left is



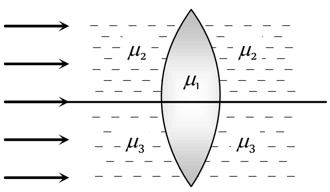
(a) 20 cm

(b) 30 cm

(c) 40 cm

(d) 50 cm

70. A double convex lens, lens made of material of refractive index μ_1, is placed inside two liquids of refractive indices μ_2 and μ_3, as shown. $\mu_2 > \mu_1 > \mu_3$. A wide, parallel beam of light is incident on the lens from the left. The lens will give rise to



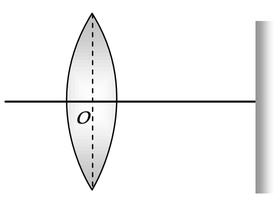
(a) A single convergent beam

(b) Two different convergent beams

(c) Two different divergent beams

(d) A convergent and a divergent beam

71. The distance between a convex lens and a plane mirror is 10 cm. The parallel rays incident on the convex lens after reflection from the mirror form image at the optical centre of the lens. Focal length of lens will be



(a) 10 cm

(b) 20 cm

(c) 30 cm

(d) Cannot be determined

72. A compound microscope is used to enlarge an object kept at a distance 0.03m from it's objective which consists of several convex lenses in contact and has focal length 0.02m. If a lens of focal length 0.1m is removed from the objective, then by what distance the eye-piece of the microscope must be moved to refocus the image

(a) 2.5 cm (b) 6 cm

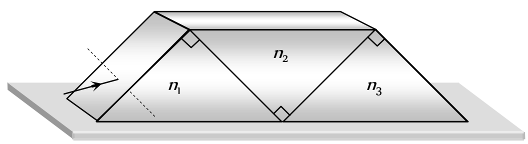
(c) 15 cm (d) 9 cm

73. If the focal length of the objective lens and the eye lens are 4 mm and 25 mm respectively in a compound microscope. The length of the tube is 16 cm. Find its magnifying power for relaxed eye position

(a) 32.75 (b) 327.5

(c) 0.3275 (d) None of the above

74. Three right angled prisms of refractive indices n_1, n_2 and n_3 are fixed together using an optical glue as shown in figure. If a ray passes through the prisms without suffering any deviation, then



(a) $n_1 = n_2 = n_3$ (b) $n_1 = n_2 \neq n_3$

(c) $1 + n_1 = n_2 + n_3$ (d) $1 + n_2^2 = n_1^2 + n_3^2$

75. In a compound microscope, the focal length of the objective and the eye lens are 2.5 cm and 5 cm respectively. An object is placed at 3.75 cm before the objective and image is formed at the least distance of distinct vision, then the distance between two lenses will be (*i.e.* length of the microscopic tube)

(a) 11.67 cm (b) 12.67 cm

(c) 13.00 cm (d) 12.00 cm

76. In a grease spot photometer light from a lamp with dirty chimney is exactly balanced by a point source distance 10 cm from the grease spot. On clearing the chimney, the point source is moved 2 cm to obtain balance again. The percentage of light absorbed by dirty chimney is nearly

(a) 56% (b) 44%

(c) 36% (d) 64%

77. The separation between the screen and a plane mirror is 2r. An isotropic point source of light is placed exactly midway between the mirror and the screen. Assume that mirror reflects 100% of incident light. Then the ratio of illuminances on the screen with and without the mirror is

(a) 10 : 1 (b) 2 : 1

(c) 10 : 9 (d) 9 : 1

78. The separation between the screen and a concave mirror is 2r. An isotropic point source of light is placed exactly midway between the mirror and the point source. Mirror has a radius of curvature r and reflects 100% of the incident light. Then the ratio of illuminances on the screen with and without the mirror is

(a) 10 : 1 (b) 2 : 1

(c) 10 : 9 (d) 9 : 1

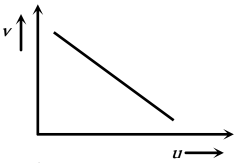
79. The apparent depth of water in cylindrical water tank of diameter 2R cm is reducing at the rate of x cm/minute when water is being drained out at a constant rate. The amount of water drained in *c.c.* per minute is (n_1 = refractive index of air, n_2 = refractive index of water) **[AIIMS 2005]**

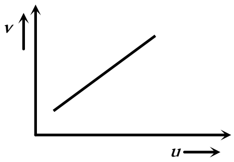
(a) $x \pi R^2 n_1/n_2$ (b) $x \pi R^2 n_2/n_1$

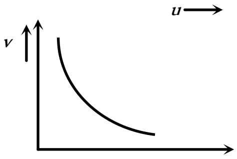
(c) $2 \pi R n_1/n_2$ (d) $\pi R^2 x$

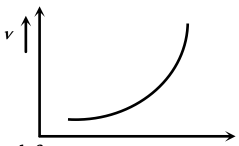
Graphical Questions

1. In an experiment of find the focal length of a concave mirror a graph is drawn between the magnitudes of u and v. The graph looks like [AIIMS 2003]

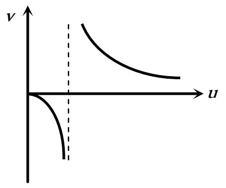
(a) 

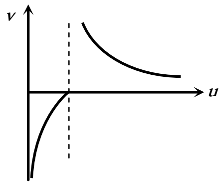
(b) 

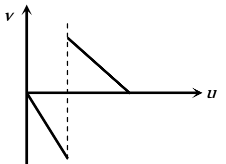
(c) 

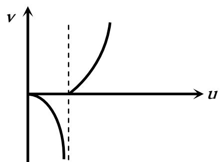
(d) 

2. As the position of an object (u) reflected from a concave mirror is varied, the position of the image (v) also varies. By letting the u changes from 0 to $+\infty$ the graph between v versus u will be

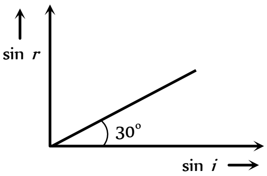
(a) 

(b) 

(c) 

(d) 

3. When light is incident on a medium at angle i and refracted into a second medium at an angle r, the graph of sin i *vs* sin$r$ is as shown in the graph. From this, one can conclude that



(a) Velocity of light in the second medium is 1.73 times the velocity of light in the I medium

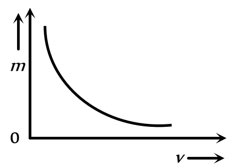
(b) Velocity of light in the I medium is 1.73 times the velocity in the II medium

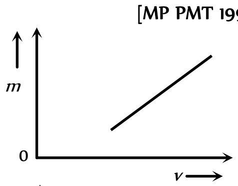
(c) The critical angle for the two media is given by

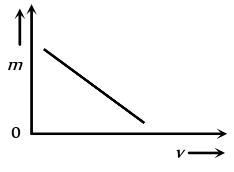
$$\sin i_c = \frac{1}{\sqrt{3}}$$

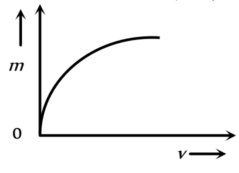
(d) $\sin i_c = \frac{1}{2}$

4. The graph between the lateral magnification (m) produced by a lens and the distance of the image (v) is given by [MP PMT 1994]

(a) 

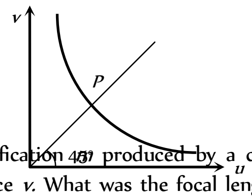
(b) 





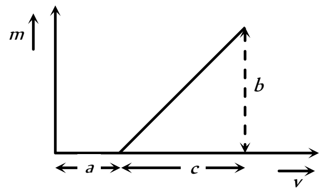
(c) (d)

5. The graph shows variation of v with change in u for a mirror. Points plotted above the point P on the curve are for values of v



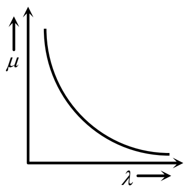
(a) Smaller then f
(b) Smaller then $2f$
(c) Larger then $2f$
(d) Larger than f

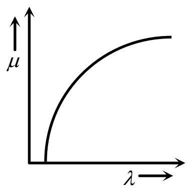
6. The graph shows how the magnification m produced by a convex thin lens varies with image distance v. What was the focal length of the used [DPMT 1995]

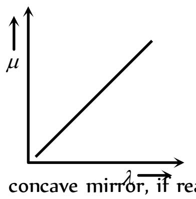


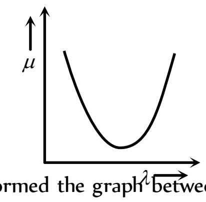
(a) $\frac{b}{c}$
(b) $\frac{b}{ca}$
(c) $\frac{bc}{a}$
(d) $\frac{c}{b}$

7. Which of the following graphs shows appropriate variation of refractive index μ with wavelength λ

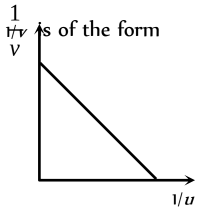
(a) 

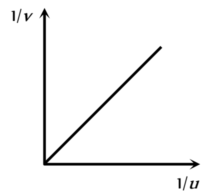
(b) 

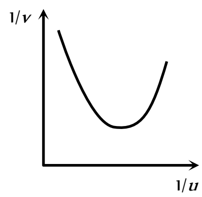
(c) 

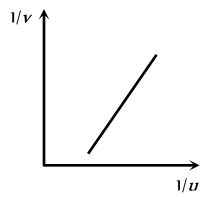
(d) 

8. For a concave mirror, if real image is formed the graph between $\frac{1}{u}$ and $\frac{1}{v}$ is of the form

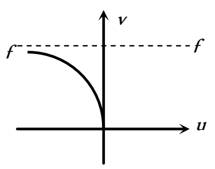
(a) 

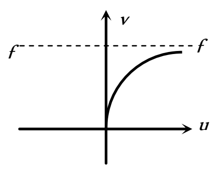
(b) 

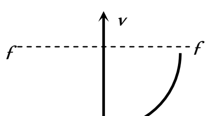
(c) 

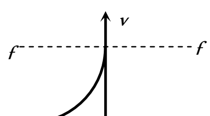
(d) 

9. The graph between u and v for a convex mirror is

(a) 

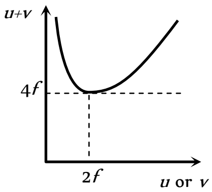
(b) 

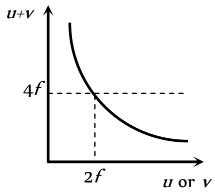


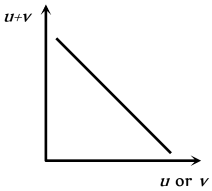


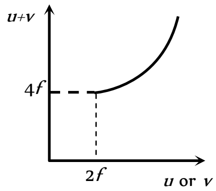
(c) (d)

10. For a convex lens, if real image is formed the graph between ($u + v$) and u or v is as follows

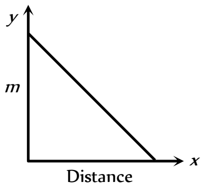
(a) 

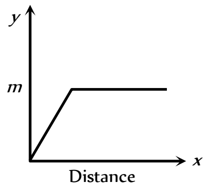
(b) 

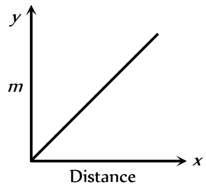
(c) 

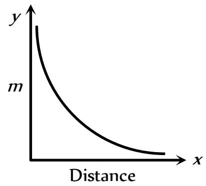
(d) 

11. Which of the following graphs is the magnification of a real image against the distance from the focus of a concave mirror

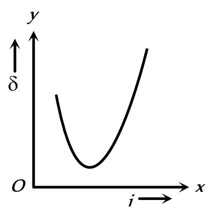
(a) 

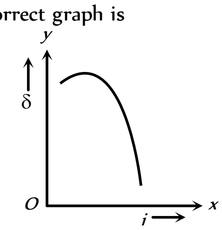
(b) 

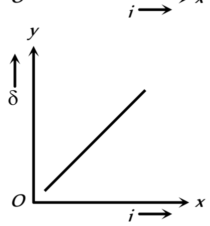
(c) 

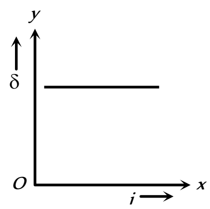
(d) 

12. A graph is plotted between angle of deviation (δ) and angle of incidence (i) for a prism. The nearly correct graph is

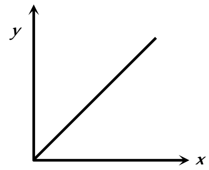
(a) 

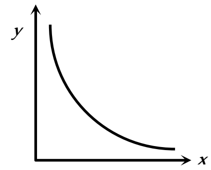
(b) 

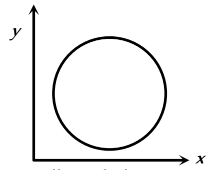
(c) 

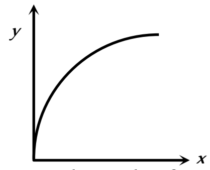
(d) 

13. If x is the distance of an object from the focus of a concave mirror and y is the distance of image from the focus, then which of the following graphs is correct between x and y

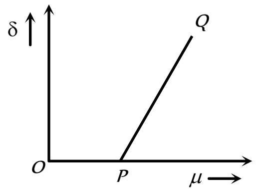
(a) 

(b) 

(c) 

(d) 

14. For a small angled prism, angle of prism A, the angle of minimum deviation (δ) varies with the refractive index of the prism as shown in the graph



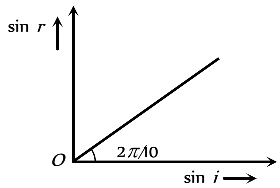
(a) Point P corresponds to $\mu = 1$

(b) Slope of the line $PQ = A/2$

(c) Slope $= A$

(d) None of the above statements is true

15. The graph between sine of angle of refraction (sin r) in medium 2 and sine of angle of incidence (sin i) in medium 1 indicates that ($\tan 36° \approx \frac{3}{4}$)



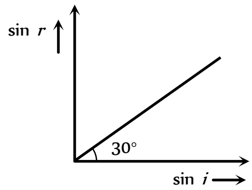
(a) Total internal reflection can take place

(b) Total internal reflection cannot take place

(c) Any of (a) and (b)

(d) Data is incomplete

16. A medium shows relation between i and r as shown. If speed of light in the medium is nc then value of n is



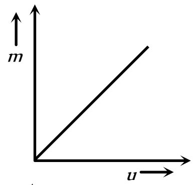
(a) 1.5

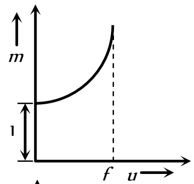
(b) 2

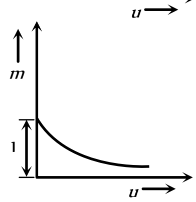
(c) 2

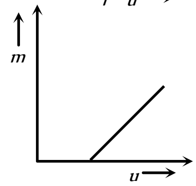
(d) 3

17. For a concave mirror, if virtual image is formed, the graph between m and u is of the form

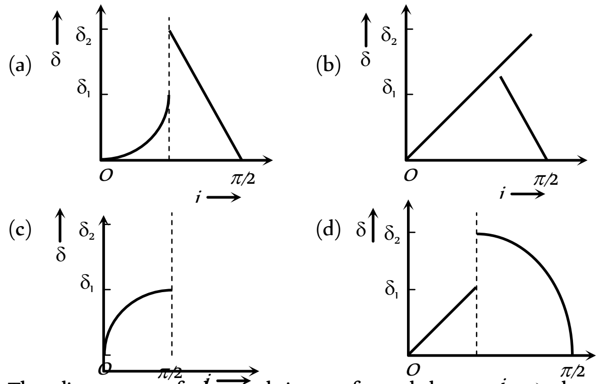
(a) 

(b) 

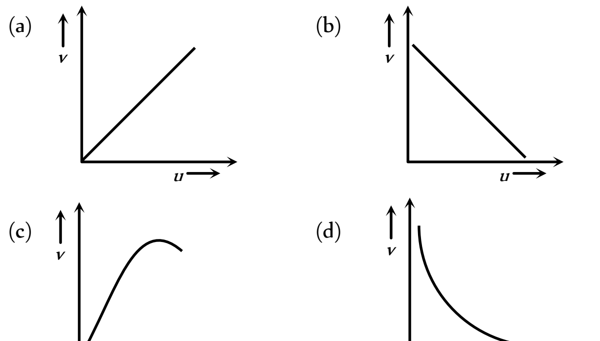
(c) 

(d) 

18. A ray of light travels from a medium of refractive index μ to air. Its angle of incidence in the medium is i, measured from the normal to the boundary, and its angle of deviation is δ. δ is plotted against i which of the following best represents the resulting curve



19. The distance v of the real image formed by a convex lens is measured for various object distance u. A graph is plotted between v and u, which one of the following graphs is correct



20. For a convex lens the distance of the object is taken on X-axis and the distance of the image is taken on Y-axis, the nature of the graph so obtained is [BVP 2003]

(a) Straight line (b) Circle

(c) Parabola (d) Hyperbola

AR Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) *If both assertion and reason are true and the reason is the correct explanation of the assertion.*
(b) *If both assertion and reason are true but reason is not the correct explanation of the assertion.*
(c) *If assertion is true but reason is false.*
(d) *If the assertion and reason both are false.*
(e) *If assertion is false but reason is true.*

1. Assertion : A red object appears dark in the yellow light
   Reason : A red colour is scattered less [AIIMS 2004]

2. Assertion : The stars twinkle while the planets do not.
   Reason : The stars are much bigger in size than the planets. [AIIMS 2003]

3. Assertion : Owls can move freely during night.
   Reason : They have large number of rods on their retina. [AIIMS 2003]

4. Assertion : The air bubble shines in water.
   Reason : Air bubble in water shines due to refraction of light [AIIMS 2002]

5. Assertion : In a movie, ordinarily 24 frames are projected per second from one end to the other of the complete film.
   Reason : The image formed on retina of eye is sustained upto 1/10 second after the removal of stimulus. [AIIMS 2001]

6. Assertion : Blue colour of sky appears due to scattering of blue colour.
   Reason : Blue colour has shortest wave length in visible spectrum. [AIIMS 2001]

7. Assertion : The refractive index of diamond is $\sqrt{6}$ and that of liquid is $\sqrt{3}$. If the light travels from diamond to the liquid, it will totally reflected when the angle of incidence is 30°. [BVP 2003]
   Reason : $\mu = \dfrac{1}{\sin C}$, where μ is the refractive index of diamond with respect to liquid. [AIIMS 2000]

8. Assertion : The setting sun appears to be red.
   Reason : Scattering of light is directly proportional to the wavelength. [AIIMS 2000]

9. Assertion : A double convex lens (μ = 1.5) has focal length 10 *cm*. When the lens is immersed in water (μ = 4/3) its focal length becomes 40 *cm*.
   Reason : $\dfrac{1}{f} = \dfrac{\mu_l - \mu_m}{\mu_m}\left(\dfrac{1}{R_1} - \dfrac{1}{R_2}\right)$ [AIIMS 1999]

10. Assertion : Different colours travel with different speed in vacuum.
    Reason : Wavelength of light depends on refractive index of medium. [AIIMS 1998]

11. Assertion : The colour of the green flower seen through red glass appears to be dark.
    Reason : Red glass transmits only red light. [AIIMS 1997]

12. Assertion : The focal length of the mirror is f and distance of the object from the focus is u, the magnification of the mirror is f/u.
    Reason : Magnification $= \dfrac{\text{Size of image}}{\text{Size of object}}$ [AIIMS 1994]

13. Assertion : If a plane glass slab is placed on the letters of different colours all the letters appear to be raised up to the same height.
    Reason : Different colours have different wavelengths.

14. Assertion : The fluorescent tube is considered better than an electric bulb.
    Reason : Efficiency of fluorescent tube is more than the efficiency of electric bulb.

15. Assertion : The polar caps of earth are cold in comparison to equatorial plane.
    Reason : The radiation absorbed by polar caps is less than the radiation absorbed by equatorial plane.

16. Assertion : The illumination of earth's surface from sun is more at noon than in the morning.

Reason : Luminance of a surface refers to brightness of the surface.

17. Assertion : When an object is placed between two plane parallel mirrors, then all the images found are of equal intensity.

Reason : In case of plane parallel mirrors, only two images are possible.

18. Assertion : The mirrors used in search lights are parabolic and not concave spherical.

Reason : In a concave spherical mirror the image formed is always virtual.

19. Assertion : The size of the mirror affect the nature of the image.

Reason : Small mirrors always forms a virtual image.

20. Assertion : Just before setting, the sun may appear to be elliptical. This happens due to refraction.

Reason : Refraction of light ray through the atmosphere may cause different magnification in mutually perpendicular directions.

21. Assertion : Critical angle of light passing from glass to air is minimum for violet colour.

Reason : The wavelength of blue light is greater than the light of other colours.

22. Assertion : We cannot produce a real image by plane or convex mirrors under any circumstances.

Reason : The focal length of a convex mirror is always taken as positive.

23. Assertion : A piece of red glass is heated till it glows in dark. The colour of glowing glass would be orange.

Reason : Red and orange is complementary colours.

24. Assertion : Within a glass slab, a double convex air bubble is formed. This air bubble behaves like a converging lens.

Reason : Refractive index of air is more than the refractive index of glass.

25. Assertion : The images formed by total internal reflections are much brighter than those formed by mirrors or lenses.

Reason : There is no loss of intensity in total internal reflection.

26. Assertion : The focal length of lens does not change when red light is replaced by blue light.

Reason : The focal length of lens does not depends on colour of light used.

27. Assertion : There is no dispersion of light refracted through a rectangular glass slab.

Reason : Dispersion of light is the phenomenon of splitting of a beam of white light into its constituent colours.

28. Assertion : All the materials always have the same colour, whether viewed by reflected light or through transmitted light.

Reason : The colour of material does not depend on nature of light.

29. Assertion : A beam of white light gives a spectrum on passing through a hollow prism.

Reason : Speed of light outside the prism is different from the speed of light inside the prism.

30. Assertion : By increasing the diameter of the objective of telescope, we can increase its range.

Reason : The range of a telescope tells us how far away a star of some standard brightness can be spotted by telescope.

31. Assertion : For the sensitivity of a camera, its aperture should be reduced.

Reason : Smaller the aperture, image focussing is also sharp.

32. Assertion : If objective and eye lenses of a microscope are interchanged then it can work as telescope.

Reason : The objective of telescope has small focal length.

33. Assertion : The illuminance of an image produced by a convex lens is greater in the middle and less towards the edges.

Reason : The middle part of image is formed by undeflected rays while outer part by inclined rays.

34. Assertion : Although the surfaces of a goggle lens are curved, it does not have any power.

Reason : In case of goggles, both the curved surfaces have equal radii of curvature.

35. Assertion : The resolving power of an electron microscope is higher than that of an optical microscope.

Reason : The wavelength of electron is more than the wavelength of visible light.

36. Assertion : If the angles of the base of the prism are equal, then in the position of minimum deviation, the refracted ray will pass parallel to the base of prism.

Reason : In the case of minimum deviation, the angle of incidence is equal to the angle of emergence.

37. Assertion : Dispersion of light occurs because velocity of light in a material depends upon its colour.

Reason : The dispersive power depends only upon the material of the prism, not upon the refracting angle of the prism.

38. Assertion : An empty test tube dipped into water in a beaker appears silver, when viewed from a suitable direction.

Reason : Due to refraction of light, the substance in water appears silvery.

39. Assertion : Spherical aberration occur in lenses of larger aperture.

Reason : The two rays, paraxial and marginal rays focus at different points.

40. Assertion : It is impossible to photograph a virtual image.

Reason : The rays which appear diverging from a virtual image fall on the camera and a real image is captured.

41. Assertion : The speed of light in a rarer medium is greater than that in a denser medium

Reason : One light year equals to 9.5×10^{12} *km*

[AIIMS 1999]

42. Assertion : The frequencies of incident, reflected and refracted beam of monochromatic light incident from one medium to another are same

Reason : The incident, reflected and refracted rays are coplanar [EAMCET (Engg.) 2000]

43. Assertion : The refractive index of a prism depends only on the kind of glass of which it is made of and the colour of light

Reason : The refractive index of a prism depends upon the refracting angle of the prism and the angle of minimum deviation [AIIMS 2000]

44. Assertion : The resolving power of a telescope is more if the diameter of the objective lens is more.

Reason : Objective lens of large diameter collects more light.[AIIMS

45. Assertion : By roughening the surface of a glass sheet its transparency can be reduced.

Reason : Glass sheet with rough surface absorbs more light.[AIIMS

46. Assertion : Diamond glitters brilliantly.

Reason : Diamond does not absorb sunlight.

[AIIMS 2005]

47. Assertion : The cloud in sky generally appear to be whitish.

Reason : Diffraction due to cloud is efficient in equal measure at all wavelengths. [AIIMS 2005]

Answers

Plane Mirror

1	d	2	b	3	b	4	c,d	5	c
6	c	7	d	8	b	9	b	10	c
11	b	12	d	13	a	14	c	15	c
16	b	17	c	18	b	19	c	20	a
21	c	22	b	23	c	24	b	25	b
26	b	27	c	28	c	29	c	30	c
31	b	32	a	33	b	34	c		

Spherical Mirror

1	a	2	c	3	d	4	c	5	a
6	b	7	c	8	b	9	a	10	b
11	d	12	b	13	b	14	b	15	c
16	d	17	b	18	b	19	a	20	a
21	a	22	b	23	d	24	d	25	b
26	bc	27	c	28	b	29	a	30	b
31	d	32	c	33	a	34	d	35	d
36	b	37	d	38	d	39	d	40	a
41	d	42	d	43	a	44	a		

Refraction of Light at Plane Surfaces

1	d	2	a	3	b	4	a	5	d
6	a	7	c	8	d	9	c	10	a
11	b	12	d	13	b	14	a	15	b
16	a	17	c	18	c	19	d	20	a
21	b	22	b	23	c	24	a	25	c
26	a	27	b	28	d	29	a	30	c
31	c	32	c	33	b	34	b	35	b
36	b	37	a	38	b	39	c	40	d
41	a	42	d	43	c	44	c	45	a
46	a	47	c	48	a	49	c	50	c
51	d	52	b	53	b	54	b	55	b
56	a	57	d	58	b	59	c	60	b
61	d	62	a	63	b	64	d	65	b
66	a	67	b	68	b	69	a	70	d
71	c	72	c	73	d	74	d	75	b
76	d	77	c	78	c	79	b	80	b
81	a	82	a	83	b	84	b	85	c
86	b	87	d	88	d	89	b	90	d

Total Internal Reflection

1	b	2	c	3	d	4	d	5	c
6	c	7	b	8	c	9	a	10	d
11	b	12	c	13	c	14	d	15	d
16	c	17	c	18	cd	19	c	20	d
21	a	22	c	23	b	24	c	25	a
26	c	27	c	28	a	29	d	30	d
31	a	32	c	33	a	34	c	35	a
36	d	37	b	38	b	39	c	40	a
41	c	42	b	43	b	44	d	45	B
46	a								

Refraction at Curved Surface

1	a	2	a	3	d	4	c	5	a
6	d	7	b	8	a	9	c	10	c
11	c	12	d	13	b	14	c	15	b
16	d	17	c	18	d	19	c	20	c
21	c	22	a	23	d	24	a	25	d
26	a	27	b	28	a	29	a	30	c
31	c	32	d	33	d	34	c	35	b
36	b	37	c	38	d	39	b	40	d
41	a	42	c	43	a	44	c	45	d
46	d	47	c	48	b	49	a	50	b
51	c	52	a	53	a	54	b	55	a

56	b	57	a	58	a	59	d	60	c
61	b	62	b	63	d	64	d	65	d
66	a	67	d	68	c	69	c	70	b
71	d	72	b	73	a	74	c	75	a
76	c	77	a	78	b	79	b	80	d
81	c	82	a	83	d	84	a	85	c
86	c	87	b	88	a	89	a	90	b
91	b	92	d	93	c	94	a	95	c
96	c	97	c	98	a	99	d	100	a
101	a	102	d	103	c	104	d	105	a
106	c	107	b	108	a	109	d	110	b
111	c	112	c	113	c	114	d	115	a
116	c	117	a	118	d	119	c	120	b
121	c	122	d	123	a	124	b	125	d
126	c	127	d	128	b	129	b	130	c
131	b	132	b	133	b	134	d	135	b
136	d	137	d	138	b	139	a	140	c
141	b	142	b	143	c	144	b	145	c

Prism Theory & Dispersion of Light

1	b	2	b	3	b	4	c	5	c
6	a	7	a	8	d	9	d	10	d
11	c	12	b	13	b	14	a	15	a
16	b	17	d	18	a	19	d	20	b
21	a	22	c	23	a	24	a	25	b
26	c	27	c	28	b	29	a	30	a
31	c	32	b	33	a	34	c	35	d
36	a	37	b	38	a	39	d	40	b
41	b	42	b	43	a	44	c	45	a
46	c	47	b	48	a	49	c	50	c
51	c	52	a	53	d	54	d	55	a
56	c	57	a	58	a	59	a	60	c
61	c	62	b	63	d	64	d	65	a
66	b	67	c	68	c	69	b	70	c
71	a	72	d	73	a	74	b	75	a
76	b	77	b	78	b	79	d	80	a
81	b	82	a	83	b	84	c	85	a
86	c	87	c	88	a	89	b	90	b
91	c	92	a	93	c	94	c	95	b
96	c	97	c	98	a	99	a	100	c
101	a	102	b	103	a	104	b	105	d
106	b	107	b	108	a	109	b	110	a
111	a	112	d	113	a	114	b	115	a
116	d	117	d	118	d	119	c	120	d
121	a	122	d	123	c	124	d	125	b
126	a	127	c	128	c	129	d	130	a

131	a	132	c	133	a	134	c	135	b
136	c	137	a	138	d	139	c	140	b
141	a	142	a	143	b	144	b	145	a
146	a	147	d	148	b	149	c	150	a
151	c								

Human Eye and Lens Camera

1	c	2	a	3	b	4	d	5	b
6	c	7	b	8	a	9	d	10	a
11	c	12	c	13	a	14	b	15	d
16	b	17	c	18	c	19	b	20	c
21	b	22	a	23	a	24	a	25	d
26	a	27	d	28	c	29	b	30	c
31	c	32	c	33	b	34	b	35	a
36	c	37	d	38	a	39	d	40	a
41	b	42	c	43	d	44	a	45	b
46	b	47	d	48	d	49	b	50	b
51	c	52	a	53	a	54	c	55	d
56	a	57	a	58	d	59	a	60	d
61	d	62	a	63	b	64	d	65	a

Microscope and Telescope

1	c	2	b	3	b	4	b	5	b
6	d	7	c	8	a	9	b	10	b
11	a	12	b	13	b	14	a	15	c
16	d	17	a	18	b	19	b	20	b
21	a	22	d	23	c	24	a	25	d
26	c	27	c	28	d	29	d	30	b
31	a	32	d	33	d	34	c	35	d
36	b	37	a	38	a	39	b	40	d
41	d	42	b	43	d	44	a	45	c
46	b	47	b	48	d	49	b	50	d
51	c	52	a	53	a	54	a	55	b
56	a	57	d	58	d	59	c	60	c
61	c	62	a	63	b	64	a	65	b
66	a	67	a	68	c	69	a	70	b
71	c	72	b	73	a	74	a	75	b
76	d	77	c	78	b	79	a	80	c
81	b	82	b	83	b	84	a	85	b
86	abcd	87	a	88	a	89	b	90	c
91	b	92	d	93	c	94	d	95	c
96	c	97	d	98	a	99	b	100	d
101	c	102	b	103	a	104	b	105	b
106	c	107	c	108	a	109	c	110	c
111	d	112	a	113	d	114	a	115	a

116	a	117	b	118	a	119	a	120	a

Photometry

1	d	2	b	3	d	4	c	5	d
6	b	7	a	8	b	9	c	10	c
11	a	12	c	13	c	14	c	15	a
16	a	17	b	18	b	19	c	20	b
21	c	22	c	23	a	24	b	25	bc
26	c	27	d	28	b	29	d	30	b
31	d	32	a	33	d	34	d	35	a
36	c	37	c	38	d	39	d	40	c
41	c								

Critical Thinking Questions

1	d	2	b	3	b	4	a	5	d
6	b	7	b	8	a	9	b	10	c
11	a	12	b	13	b	14	a	15	b
16	b	17	a	18	b	19	c	20	c
21	c	22	d	23	d	24	ad	25	c
26	b	27	d	28	d	29	d	30	d
31	b	32	a	33	d	34	c	35	c
36	d	37	a	38	b	39	a	40	c
41	c	42	d	43	b	44	a	45	b
46	c	47	c	48	c	49	a	50	d
51	d	52	c	53	b	54	a	55	b
56	d	57	c	58	b	59	d	60	b
61	d	62	a	63	a	64	a	65	c
66	c	67	b	68	b	69	b	70	d
71	b	72	d	73	b	74	d	75	a
76	c	77	c	78	b	79	b		

Graphical Questions

1	c	2	a	3	bc	4	c	5	c
6	d	7	a	8	a	9	a	10	a
11	d	12	a	13	b	14	ac	15	b
16	d	17	b	18	a	19	d	20	d

Assertion and Reason

1	b	2	b	3	c	4	c	5	c
6	a	7	e	8	c	9	a	10	e
11	a	12	a	13	e	14	a	15	c
16	b	17	d	18	c	19	d	20	a
21	c	22	e	23	d	24	d	25	a

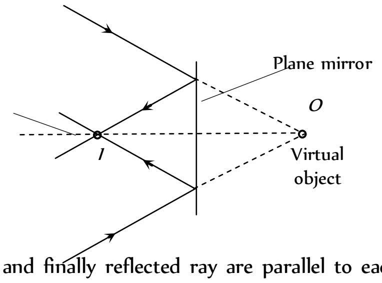
26	d	27	b	28	d	29	d	30	b
31	c	32	d	33	a	34	a	35	c
36	a	37	b	38	c	39	a	40	e
41	b	42	b	43	c	44	a	45	c
46	b	47	c						

Answers and Solutions

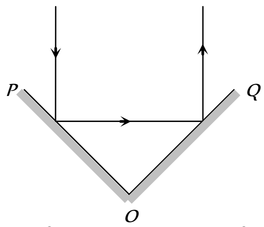
Plane Mirror

1. (d) $\delta = (360 - 2\theta) = (360 - 2 \times 60) = 240^o$

2. (b) When converging beam incident on plane mirror, real image is formed as shown

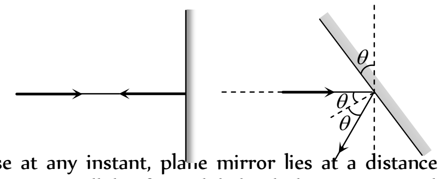


3. (b) Incident ray and finally reflected ray are parallel to each other means $\delta = 180^o$

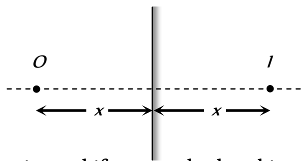


From $\delta = 360 - 2\theta \Rightarrow 180 = 360 - 2\theta \Rightarrow \theta = 90^o$

4. (c, d) By keeping the incident ray is fixed, if plane mirror rotates through an angle θ reflected ray rotates through an angle 2θ.

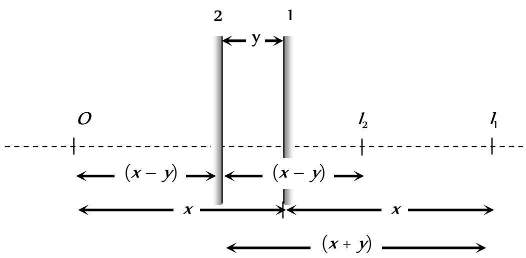


5. (c) Suppose at any instant, plane mirror lies at a distance x from object. Image will be formed behind the mirror at the same distance x.



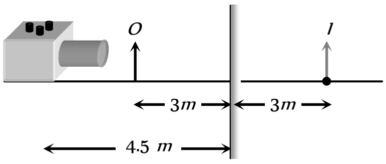
When the mirror shifts towards the object by distance 'y' the image shifts $= x + y - (x - y) = 2y$

So speed of image = 2 × speed of mirror

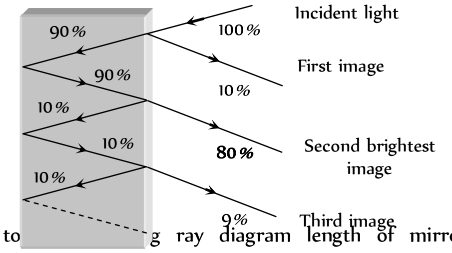


6. (c) Number of images $=\left(\frac{360}{\theta}-1\right)=\left(\frac{360}{60}-1\right)=5$

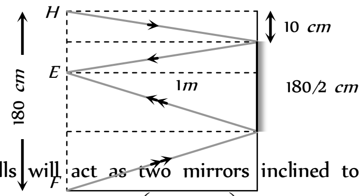
7. (d) F using distance of image = 4.5 m + 3 m = 7.5 m.



8. (b) Several images will be formed but second image will be brightest



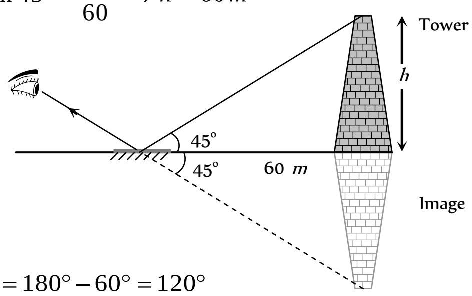
9. (b) According to g ray diagram length of mirror $=\frac{1}{2}(10+170)=90\,cm$



10. (c) The walls will act as two mirrors inclined to each other at $90°$ and so will form $\left(\frac{360}{90}-1\right)=4-1$ *i.e.* 3 images of the person. Now these images with person will act as objects for the ceiling mirror and so ceiling mirror will form 4 images further. Therefore total number of images formed $=3+3+1=7$

Note : He can see. 6 images of himself.

11. (b) $\tan 45°=\frac{h}{60}\ \Rightarrow h=60\,m$



12. (d) $\delta=180°-60°=120°$

13. (a) $<i=<r=0°$

14. (c) When light is reflected from denser medium, a phase difference of π always occurs.

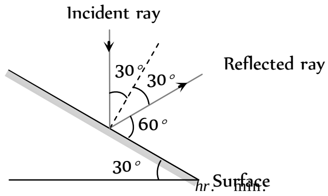
15. (c) Ray after reflection from three mutually perpendicular mirrors becomes anti-parallel.

16. (b) In two images man will see himself using left hand.

17. (c) In plane mirror, size of the image is independent of the angle of incidence.

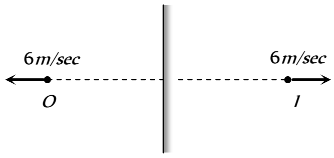
18. (b) Size of image formed by a plane mirror is same as that of the object. Hence its magnification will be 1.

19. (c)



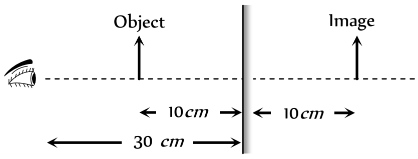
20. (a) Subtract the given time from $11:60$

21. (c) Relative velocity of image *w.r.t.* object $=6-(-6)=12\,m/\sec$



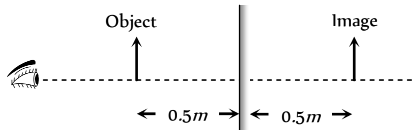
22. (b)

23. (c) See following ray diagram

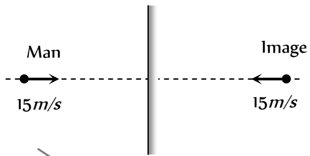


The distance focussed for eye $=30+10=40\,cm$

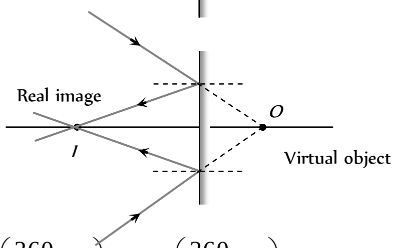
24. (b) Distance between object and image $=0.5+0.5=1\,m$



25. (b) Relative velocity of image *w.r.t.* man $=15-(-15)=30\ m/s$



26. (b)



27. (c) $n=\left(\frac{360}{\theta}-1\right)\Rightarrow n=\left(\frac{360}{72}-1\right)=4$

28. (c) $n=\left(\frac{360}{\theta}-1\right)\Rightarrow 3=\left(\frac{360}{\theta}-1\right)\Rightarrow \theta=90°$

29. (c)

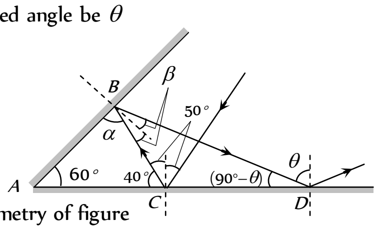
30. (c) $n=\frac{360}{45}-1=7$

31. (b) Diminished, erect image is formed by convex mirror.

32. (a) When a mirror is rotated by an angle θ, the reflected ray deviate from its original path by angle 2θ.

33. (b) $f = \frac{R}{2}$, and $R = \infty$ for plane mirror.

34. (c) Let required angle be θ



From geometry of figure

In Δ ABC; $\alpha = 180° - (60° + 40°) = 80°$

$\Rightarrow \beta = 90° - 80° = 10°$

In Δ ABD; $\angle A = 60°$, $\angle B = (\alpha + 2\beta)$

$= (80 + 2 \times 10) = 100°$ and $\angle D = (90° - \theta)$

$\because \angle A + \angle B + \angle D = 180° \Rightarrow 60° + 100° + (90° - \theta) = 180° \Rightarrow \theta = 70°$

Spherical Mirror

1. (a) $m = +\frac{1}{n} = -\frac{v}{u} \Rightarrow v = -\frac{u}{n}$

By using mirror formula $\frac{1}{f} = \frac{1}{-\frac{u}{n}} + \frac{1}{u} \Rightarrow u = -(n-1)f$

2. (c)

3. (d)

4. (c) $\frac{I}{O} = \frac{f}{(f-u)} \Rightarrow \frac{I}{+5} = \frac{-10}{-10-(-100)} \Rightarrow I = 0.55\ cm$

5. (a) For real image $m = -2$, so by using $m = \frac{f}{f-u}$

$\Rightarrow -2 = \frac{-50}{-50-u} \Rightarrow u = -75\ cm$

6. (b) By using $\frac{I}{O} = \frac{f}{f-u}$

$\Rightarrow \frac{I}{+(7.5)} = \frac{(25/2)}{\left(\frac{25}{2}\right) - (-40)} \Rightarrow I = 1.78\ cm$

7. (c)

8. (b) $\frac{I}{O} = \frac{f}{f-u}$; where $u = f + x$ $\therefore \frac{I}{O} = -\frac{f}{x}$

9. (a) Image formed by convex mirror is virtual for real object placed anywhere.

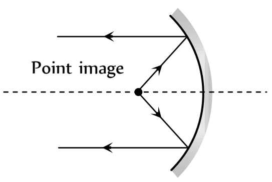
10. (b) Given $u = (f + x_1)$ and $v = (f + x_2)$

The focal length $f = \frac{uv}{u+v} = \frac{(f+x_1)(f+x_2)}{(f+x_1)+(f+x_2)}$

On solving, we get $f^2 = x_1 x_2$ or $f = \sqrt{x_1 x_2}$

11. (d) The image formed by a convex mirror is always virtual.

12. (b) Object should be placed on focus of concave mirror.



13. (b) $m = \frac{f}{(f-u)} \Rightarrow \left(+\frac{1}{4}\right) = \frac{(+30)}{(+30)-u} \Rightarrow u = -90\ cm$

14. (b) Size is $\frac{1}{5}$. It can't be plane and concave mirror, because both conditions are not satisfied in plane or concave mirror. Convex mirror can meet all the requirements.

15. (c) Plane mirror and convex mirror always forms erect images. Image formed by concave mirror may be erect or inverted depending on position of object.

16. (d) Virtual image is seen on the photograph.

17. (b) $\because m = -\frac{v}{u}$ also $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{u}{f} = \frac{u}{v} + 1$

$\Rightarrow -\frac{u}{v} = 1 - \frac{u}{f} \Rightarrow \frac{-v}{u} = \frac{f}{f-u}$ so $m = \frac{f}{f-u}$.

18. (b) To make the light diverging as much as possible.

19. (a) Let distance $= u$. Now $\frac{v}{u} = 16$ and $v = u + 120$

$\therefore \frac{120+u}{u} = 16 \Rightarrow 15u = 120 \Rightarrow u = 8\ cm$.

20. (a) Virtual image formed is larger in size in case of concave mirror.

21. (a) Real, inverted and same in size because object is at the centre of curvature of the mirror.

22. (b) Image is virtual so $m = +3$. and $f = \frac{R}{2} = 18\ cm$

So from $m = \frac{f}{f-u} \Rightarrow 3 = \frac{(-18)}{(-18)-u} \Rightarrow u = -12\ cm$.

23. (d) $f = \frac{R}{2} = 20\,cm$, $m = 2$ For real image; $m = -2$,

By using $m = \frac{f}{f-u}$, $-2 = \frac{-20}{-20-u} \Rightarrow u = -30\,cm$

For virtual image; $m = +2$

So, $+2 = \frac{-20}{-20-u} \Rightarrow u = -10\,cm$

24. (d) Convex mirror always forms, virtual, erect and smaller image.

25. (b) When object is placed. Between focus and pole, image formed is erect, virtual and enlarged.

26. (b, c) Convex mirror and concave lens form virtual image for all positions of object.

27. (c) Here focal length $= f$ and $u = -f$

On putting these values in $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

$\Rightarrow \frac{1}{f} = -\frac{1}{f} + \frac{1}{v} \Rightarrow v = \frac{f}{2}$

28. (b) Erect and enlarged image can produced by concave mirror.

$\frac{I}{O} = \frac{f}{f-u} \Rightarrow \frac{+3}{+1} = \frac{f}{f-(-4)} \Rightarrow f = -6\,cm$

$\Rightarrow R = 2f = -12\,cm$

29. (a)

30. (b) $m = \frac{f}{f-u} \Rightarrow -3 = \frac{f}{f-(-20)} \Rightarrow f = -15\,cm$

31. (d) When object is kept at centre of curvature. It's real image is also formed at centre of curvature.

32. (c) $u = -20\,cm$, $f = +10\,cm$ also $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

$\Rightarrow \frac{1}{+10} = \frac{1}{v} + \frac{1}{(-20)} \Rightarrow v = \frac{20}{3}\ cm$; virtual image.

33. (a) Mirror formula

$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \Rightarrow \frac{1}{f}=\frac{1}{-20}+\frac{1}{(-10)} \Rightarrow f=\frac{20}{3}\ cm$. If object moves towards the mirror by $0.1\,cm$ then.

$u=(10-0.1)=9.9\,cm$. Hence again from mirror formula

$\frac{1}{-20/3}=\frac{1}{v'}+\frac{1}{-9.9} \Rightarrow v'=20.4\ cm$ i.e. image shifts away from the mirror by $0.4\,cm$.

34. (d) Image formed by convex mirror is always. Erect diminished and virtual.

35. (d) $f=\frac{R}{2} \Rightarrow R=40\,cm$

36. (b) $f=-15\,cm,\ \ m=+2$ (Positive because image is virtual)

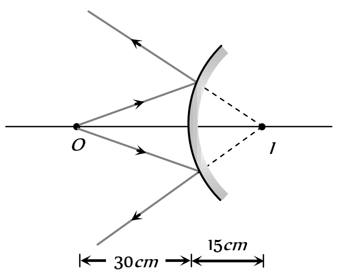
$\because m=-\frac{v}{u} \Rightarrow v=-2u$. By using mirror formula

$\frac{1}{-15}=\frac{1}{(-2u)}+\frac{1}{u} \Rightarrow u=-7.5\,cm$

37. (d) $u=-30\,cm,\ \ f=+30\,cm,$ by using mirror formula

$\frac{1}{f}=\frac{1}{v}+\frac{1}{u} \Rightarrow \frac{1}{+30}=\frac{1}{v}+\frac{1}{(-30)}$

$v=15\ cm,$ behind the mirror



38. (d) $R=-30\,cm \Rightarrow f=-15\,cm$

$O=+2.5\,cm,\ \ u=-10\,cm$

By mirror formula $\frac{1}{-15}=\frac{1}{v}+\frac{1}{(-10)} \Rightarrow v=30\,cm.$

Also $\frac{I}{O}=-\frac{v}{u} \Rightarrow \frac{I}{(+2.5)}=-\frac{30}{(-10)} \Rightarrow I=+7.5\,cm.$

39. (d)

40. (a) $\frac{I}{O}=\frac{f}{f-u} \Rightarrow \frac{I}{+6}=\frac{-f}{-f-(-4f)} \Rightarrow I=-2\,cm.$

41. (d) Convergence (or power) is independent of medium for mirror.

42. (d) $\frac{I}{O}=\frac{f}{f-u} \Rightarrow \frac{I}{2}=\frac{20}{20+20}=\frac{1}{2} \Rightarrow I=1\,mm$

43. (a) $m=\pm 3$ and $f=-6\ cm$

Now $m=\frac{f}{f-u} \Rightarrow \pm 3=\frac{-6}{-6-u}$

For real image $-3=\frac{-6}{-6-u} \Rightarrow u=-8\ cm$

For virtual image $3=\frac{-6}{-6-u} \Rightarrow u=-4\ cm$

44. (a) Focal length of the mirror remains unchanged.

Refraction of Light at Plane Surfaces

1. (d)

2. (a) $\mu_{blue} > \mu_{red}$

3. (b) $\mu \propto \frac{1}{\lambda}, \lambda_r > \lambda_v$

4. (a) $\lambda_{medium}=\frac{\lambda_{air}}{\mu}=\frac{6000}{1.5}=4000\ \mathring{A}$

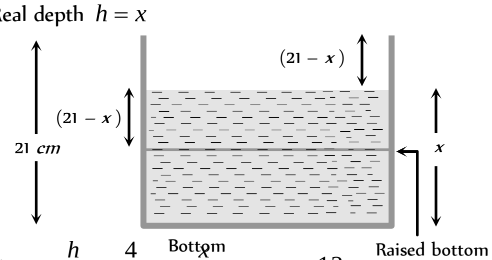
5. (d) Velocity and wavelength change but frequency remains same.

6. (a) $\mu=\frac{c}{v}=\frac{c}{v\lambda}=\frac{3\times 10^8}{4\times 10^{14}\times 5\times 10^{-7}}=1.5$

7. (c) To see the container half-filled from top, water should be filled up to height x so that bottom of the container should appear to be raised upto height $(21-x)$.

As shown in figure apparent depth $h'=(21-x)$

Real depth $h=x$



$\therefore\ \mu=\frac{h}{h'} \Rightarrow \frac{4}{3}=\frac{x}{21-x} \Rightarrow x=12\ cm$

8. (d) In vacuum, the speed of light is independent of wave length. Thus vacuum (or air) is a non dispersive medium in which all colours travel with the same speed.

9. (c) $\lambda \propto \frac{1}{\mu} \Rightarrow \frac{\lambda_1}{\lambda_2}=\frac{\mu_2}{\mu_1}=\frac{\mu}{1}$

10. (a) $v \propto \frac{1}{\mu}, \mu_{\text{rarer}} < \mu_{\text{denser}}$

11. (b) $\mu \propto \frac{1}{\lambda}$

12. (d) $v=\frac{c}{\mu}=\frac{3\times 10^8}{2}=1.5\times 10^8\ m/s=1.5\times 10^{10}\ cm/s$

13. (b) $\because \angle i > \angle r,$ it means light ray is going from rarer medium (A) to denser medium.

So $v(A) > v(B)$ and $n(A) < n(B)$

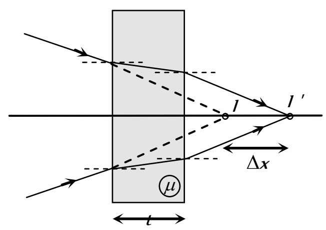
14. (a) $\mu=\frac{h}{h'} \Rightarrow h'=\frac{8}{4/3}=6\ m$

15. (b) $h'=\frac{d_1}{\mu_1}+\frac{d_2}{\mu_2}=d\left(\frac{1}{\mu_1}+\frac{1}{\mu_2}\right)$

16. (a) Normal

shift $\Delta x=\left(1-\frac{1}{\mu}\right)t$

and shift takes place in direction of ray.



17. (c)

$\text{time}=\frac{\text{distance}}{\text{speed}}=\frac{t}{c/x}=\frac{nt}{c}$

18. (c) Let ν' and λ' represents frequency and wavelength of light in medium respectively.

so $\nu' = \frac{v}{\lambda'} = \frac{c/\mu}{\lambda/\mu} = \frac{c}{\lambda} = \nu$

19. (d) $\mu = \frac{c_a}{c_w} = \frac{t_w}{t_a} \Rightarrow t_w = \frac{25}{3} \times \frac{4}{9} = 11\frac{1}{9} = 11\ min\ 6\ sec$

20. (a) Optical path = μt

In medium (1), optical path = $\mu_1 d_1$

In medium (2), optical path = $\mu_2 d_2$

$\therefore$ Total path = $\mu_1 d_1 + \mu_2 d_2$

21. (b) Refractive index of liquid C is same as that of glass piece. So it will not be visible in liquid C.

22. (b) ${}_a\mu_g = \frac{3}{2}$, ${}_a\mu_w = \frac{4}{3}$

$\therefore\ {}_w\mu_g = \frac{{}_a\mu_g}{{}_a\mu_w} = \frac{3/2}{4/3} = \frac{9}{8}$

23. (c) ${}_2\mu_1 \times {}_3\mu_2 \times {}_4\mu_3 = \frac{\mu_1}{\mu_2} \times \frac{\mu_2}{\mu_3} \times \frac{\mu_3}{\mu_4} = \frac{\mu_1}{\mu_4} = {}_4\mu_1 = \frac{1}{{}_1\mu_4}$

24. (a) Colour of light is determined by its frequency and as frequency does not change, colour will also not change and will remains green.

25. (c) Ray optics fails if the size of the object is of the order of the wavelength.

26. (a) ${}_a n_w \times {}_w n_{gl} \times {}_{gl} n_{gas} \times {}_{gas} n_a = \frac{n_w}{n_a} \times \frac{n_{gl}}{n_w} \times \frac{n_{gas}}{n_{gl}} \times \frac{n_a}{n_{gas}} = 1$

27. (b) $v \propto \lambda \Rightarrow \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2}$

$\therefore\ v_2 = \frac{v_1}{\lambda_1} \times \lambda_2 = 3 \times 10^8 \times \frac{4500}{6000} = 2.25 \times 10^8\ m/s$

28. (d) Since ${}_a\mu_g = \sqrt{2}$, so ${}_g\mu_a = \frac{\sin i}{\sin r} = \frac{1}{\sqrt{2}}$

$\therefore\ \sin r = 1 \Rightarrow r = 90^o$

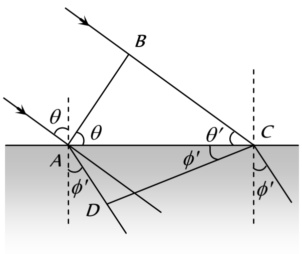
29. (a) $\mu = \frac{c}{v} = \frac{1/\sqrt{\mu_o \varepsilon_o}}{1/\sqrt{\mu\varepsilon}} = \sqrt{\frac{\mu\varepsilon}{\mu_o \varepsilon_o}}$

30. (c) $\mu \propto \frac{1}{\lambda} \Rightarrow \frac{1}{4/3} = \frac{x}{4200} \Rightarrow x = 3150\ Å$

31. (c) $\mu = \sqrt{\frac{\mu\,\varepsilon}{\mu_0 \varepsilon_0}} = \sqrt{\mu_r K}$

32. (c) $\mu = \frac{C}{C_m} \Rightarrow C_m = \frac{C}{1.5}$

33. (b) In the case of refraction if CD is the refracted wave front and v and v are the speed of light in the two media, then in the time the wavelets from B reaches C, the wavelet from A will reach D, such that



$t = \frac{BC}{v_a} = \frac{AD}{v_g} \Rightarrow \frac{BC}{AD} = \frac{v_a}{v_g}$

But in ΔACB, $BC = AC\sin\theta$ .....(ii)

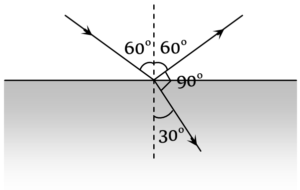
while in ΔACD, $AD = AC\sin\phi'$ .....(iii)

From equations (i), (ii) and (iii) $\frac{v_a}{v_g} = \frac{\sin\theta}{\sin\phi'}$

Also $\mu \propto \frac{1}{v} \Rightarrow \frac{v_a}{v_g} = \frac{\mu_g}{\mu_a} = \frac{\sin\theta}{\sin\phi'} \Rightarrow \mu_g = \frac{\sin\theta}{\sin\phi'}$

34. (b)

35. (b) From figure



$< i = 60^o$, $< r = 30^o$

so $\mu = \frac{\sin 60}{\sin 30} = \sqrt{3}$

36. (b) $\mu \propto \frac{1}{v} \Rightarrow \frac{\mu_g}{\mu_w} = \frac{v_w}{v_g} \Rightarrow \frac{3/2}{4/3} = \frac{v_w}{2 \times 10^8}$

$\Rightarrow v_w = 2.25 \times 10^8\ m/s$

37. (a) $\lambda_m = \frac{\lambda_a}{\mu} = \frac{c}{\nu\mu} = \frac{3 \times 10^8}{5 \times 10^{14} \times 1.5} = 4000\ Å$

38. (b) $\lambda_{glass} = \frac{\lambda_{air}}{\mu} = \frac{7200}{1.5} = 4800\ Å$

39. (c)

40. (d) $\frac{{}_a\mu_r}{{}_w\mu_r} = \frac{\mu_r/\mu_a}{\mu_r/\mu_w} = \frac{\mu_w}{\mu_a} = {}_a\mu_w$

41. (a) $t = \frac{\mu x}{c} = \frac{\frac{3}{2} \times 5 \times 10^{-3}}{3 \times 10^8} = 0.25 \times 10^{-10}\ s$

42. (d) Distance $= v \times t = \frac{c}{\mu} \times t = \frac{3 \times 10^8}{1.5} \times 10^{-9}$

$= 0.2\ m = 20\ cm.$

43. (c) $f \propto \frac{1}{\lambda}$. As $\lambda_b < \lambda_g \Rightarrow f_b > f_g$

44. (c) Real depth = $1\ m$

Apparent depth = $1 - 0.1 = 0.9\ m$

Refractive index $\mu = \frac{\text{Real depth}}{\text{Apparent depth}} = \frac{1}{0.9} = \frac{10}{9}$

45. (a) $\mu = \frac{h}{h'} \Rightarrow h' = \frac{h}{n}$

46. (a) Refractive index $\propto \frac{1}{(\text{Temperatu re})}$

47. (c) Snell's law in vector form is $\hat{i} \times \hat{n} = \mu(\hat{r} \times \hat{n})$

48. (a)

49. (c) $v = \frac{c}{\mu} = \frac{3 \times 10^8}{2.4} = 1.25 \times 10^8\ m/s$

50. (c) Velocity of light in the window

$= \frac{3 \times 10^8}{1.5} ms^{-1} = 2 \times 10^8\ ms^{-1}$

Hence $t = \dfrac{4\times10^{-3}}{2\times10^{8}} s = 2\times10^{-11} s$

51. (d) Ray optics is valid when size of the objects is much larger than the order of wavelength of light.

52. (b) $v = \dfrac{c}{\mu} = \dfrac{3\times10^8}{1.33} = 2.25\times10^8$ *m/s*

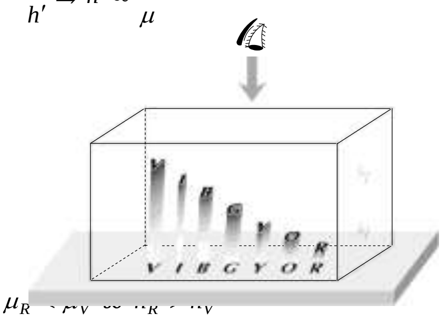
53. (b) $t = \dfrac{\mu x}{c} = \dfrac{1.5\times2\times10^{-3}}{3\times10^8} = 10^{-11}$ *sec*

54. (b) ${}_g\mu_w = \dfrac{\mu_w}{\mu_g} = \dfrac{4/3}{3/2} = \dfrac{8}{9}$

55. (b) Frequency does not change with medium but wavelength and velocity decrease with the increase in refractive index.

56. (a) $t = \dfrac{\mu x}{c} = \dfrac{3\times4\times10^{-3}}{3\times10^8} = 4\times10^{-11}$ *sec*

57. (d) $\mu = \dfrac{h}{h'} \Rightarrow h' \propto \dfrac{1}{\mu}$



$\because \mu_R < \mu_V$ so $h_R > h_V$

i.e. Red colour letter appears least raised.

58. (b) $\mu = \dfrac{c}{v} = \dfrac{\sin i}{\sin r} = \dfrac{\sin 45^o}{\sin 30^o}$

$\Rightarrow v = \dfrac{3\times10^8}{\sqrt{2}} = 2.12\times10^8\ m/s$

59. (c) $v \propto \dfrac{1}{\mu} \Rightarrow \dfrac{v_1}{v_2} = \dfrac{\mu_2}{\mu_1} \Rightarrow \dfrac{v_g}{v_w} = \dfrac{\mu_w}{\mu_g} = \dfrac{4/3}{3/2} = \dfrac{8}{9}$

60. (b) Time taken by light to travel distance *x* through a medium of refractive index μ is

$t = \dfrac{\mu x}{c} \Rightarrow \dfrac{\mu_B}{\mu_A} = \dfrac{x_A}{x_B} = \dfrac{6}{4} \Rightarrow {}_A\mu_B = \dfrac{3}{2} = 1.5$

61. (d) ${}_w\mu_g = \dfrac{{}_a\mu_g}{{}_a\mu_w} = \dfrac{1.5}{1.3}$

62. (a) $\mu = \dfrac{\text{Real depth}}{\text{apparent depth}} = \dfrac{120}{80} = 1.5$

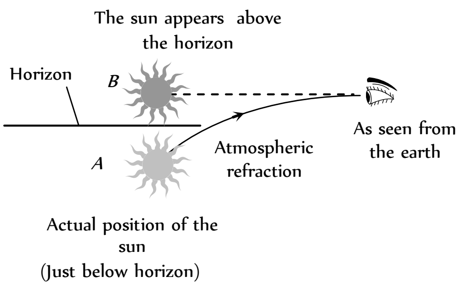
63. (b) Apparent depth of bottom

$= \dfrac{H/4}{\mu_1} + \dfrac{H/4}{\mu_2} + \dfrac{H/4}{\mu_3} + \dfrac{H/4}{\mu_4}$

$= \dfrac{H}{4}\left(\dfrac{1}{\mu_1} + \dfrac{1}{\mu_2} + \dfrac{1}{\mu_3} + \dfrac{1}{\mu_4}\right)$

64. (d) For successive refraction through different media $\mu \sin\theta =$ constant. Here as θ is same in the two extreme media, $\mu_1 = \mu_4$.

65. (b)



66. (a) $\mu = \dfrac{h'}{h} \Rightarrow h' = \mu h = \dfrac{4}{3}\times18 = 24\ cm$

67. (b) Optical path $\mu x =$ constant *i.e.* $\mu_1 x_1 = \mu_2 x_2$

$\Rightarrow 1.53\times4 = \mu_2\times4.5 \Rightarrow \mu_2 = 1.36$

68. (b) Velocity of light is maximum in vacuum.

69. (a) $\mu = \tan i \Rightarrow i = \tan^{-1}\mu = \tan^{-1}1.62 = 58.3°$

70. (d) Suppose water is poured up to the height *h*,

So $h\left(1 - \dfrac{1}{\mu}\right) = 1 \Rightarrow h = 4\ cm$

71. (c) $\mu \propto \dfrac{1}{v} \Rightarrow \dfrac{\mu_l}{\mu_g} = \dfrac{v_g}{v_l} \Rightarrow \dfrac{\mu_l}{1.5} = \dfrac{2\times10^8}{2.5\times10^8} \Rightarrow \mu_l = 1.2$

72. (c) Stars twinkle due to variation in *R.I.* of atmosphere.

73. (d) Refraction at air-oil point $\mu_{oil} = \dfrac{\sin i}{\sin r_1}$

$\therefore \sin r_1 = \dfrac{\sin 40}{1.45} = 0.443$

Refraction at oil-water point ${}_{oil}\mu_{water} = \dfrac{\sin r_1}{\sin r}$

$\therefore \dfrac{1.33}{1.45} = \dfrac{0.443}{\sin r}$ or $\sin r = \dfrac{0.443\times1.45}{1.33} \Rightarrow r = 28.9^o$

74. (d) Objects are invisible in liquid of R.I. equal to that of object.

75. (b) When light ray travels from denser to rarer, it deviates away from the normal.

76. (d) $\mu = \dfrac{c}{v} = \dfrac{3\times10^8}{1.5\times10^8} = 2.$

77. (c) Frequency remain unchanged.

78. (c) ${}_w\mu_g = \dfrac{{}_a\mu_g}{{}_a\mu_w} = \dfrac{1.5}{1.2} = \dfrac{5}{4} = 1.25$.

79. (b) $\lambda_g = \dfrac{\lambda_a}{\mu_g} = \dfrac{5890}{1.6} = 3681 Å$.

80. (b) $t = \dfrac{s}{v} = \dfrac{1.5\times10^8\times10^3}{3\times10^8} = 500 \sec = 8.33$ *min.*

81. (a) For vacuum $t = n\lambda_o$ .....(i)

For air $t = (n+1)\lambda_a$ .....(ii)

From equation (i) and (ii)

$t = \dfrac{\lambda}{\mu - 1} = \dfrac{6\times10^{-7}}{1.0003 - 1} \quad \left(\mu = \dfrac{\lambda_o}{\lambda_a}\right)$

$= 2\times10^{-3} m = 2mm.$

82. (a) $\mu_m = \dfrac{c}{v} = \dfrac{n\lambda_a}{n\lambda_m} = \dfrac{\lambda_a}{\lambda_m}$

83. (b) As no scattering of light occurs. Space appears black.

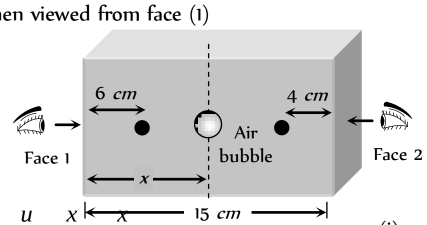
84. (b) $v \propto \dfrac{1}{\mu}$, μ is smaller for air than water, glass and diamond.

85. (c) In vacuum speed of light is constant and it is equal to 3×10^8 *m/sec*

86. (b) $\lambda_{medium} = \dfrac{\lambda_{vacuum}}{\mu}$

87. (d) In vacuum speed of light is constant and is equal to $3 \times 10^8 m/s$.

88. (d) When viewed from face (1)



$\mu = \dfrac{u}{v} = \dfrac{x}{v} = \dfrac{x}{6}$ .....(i)

Now when viewed from face (2)

$\mu = \dfrac{15 - x}{v} = \dfrac{15 - x}{4}$ .....(ii)

From equation (i) and (ii) $\mu = \dfrac{15 - 6\mu}{4} \Rightarrow \mu = 1.5$.

89. (b) The apparent depth of ink mark

$= \dfrac{\text{real depth}}{\mu} = \dfrac{3}{3/2} = 2\,cm$

Thus person views mark at a distance $= 2 + 2 = 4\,cm$.

90. (d) Apparent rise $= d\left(1 - \dfrac{1}{_a\mu_w}\right) = 12 \times \left(1 - \dfrac{3}{4}\right) = 3$ *cm*.

Total Internal Reflection

1. (b) Due to high refractive index its critical angle is very small so that most of the light incident on the diamond is total internally reflected repeatedly and diamond sparkles.

2. (c) When incident angle is greater than critical angle, then total internal reflection takes place and will come back in same medium.

3. (d)

4. (d) $_a\mu_g = \dfrac{1}{\sin C} \Rightarrow \sin C = \dfrac{1}{_a\mu_g}$

As μ for violet colour is maximum, so sin C is minimum and hence critical angle C is minimum for voilet colour.

5. (c) The critical angle C is given by

$\sin C = \dfrac{n_2}{n_1} = \dfrac{\lambda_1}{\lambda_2} = \dfrac{3500}{7000} = \dfrac{1}{2} \Rightarrow C = 30^o$

6. (c) From figure given in question $\theta = 2c = 98°$.

7. (b) $\mu = \dfrac{1}{\sin C} = \dfrac{1}{\sin 30} = 2$

$\therefore v = \dfrac{3 \times 10^8}{2} = 1.5 \times 10^8 m/s$

8. (c) $_D\mu_R = \dfrac{\sin i}{\sin r'} \Rightarrow {}_R\mu_D = \dfrac{\sin r'}{\sin i} = \dfrac{1}{\sin C}$

$\Rightarrow \sin C = \dfrac{\sin i}{\sin(90 - r)} = \dfrac{\sin i}{\cos r} = \dfrac{\sin i}{\cos i}$ (as $\angle i = \angle r$)

$\Rightarrow \sin C = \tan i \Rightarrow C = \sin^{-1}(\tan i)$

9. (a) For total internal reflection $i > C$

$\Rightarrow \sin i > \sin C \Rightarrow \sin i > \dfrac{1}{\mu} \Rightarrow \dfrac{1}{\sin i} < \mu.$

10. (d) For total internal reflection light must travel from denser medium to rarer medium.

11. (b)

12. (c) Semi vertical angle $= C = \sin^{-1}\left(\dfrac{1}{\mu}\right) = \sin^{-1}\left(\dfrac{3}{4}\right)$

13. (c)

14. (d) $\mu = \dfrac{1}{\sin C} \Rightarrow C = \sin^{-1}\left(\dfrac{1}{2}\right) = 30^o$

15. (d)

16. (c) Critical angle = $\sin^{-1}\left(\dfrac{1}{\mu}\right)$

$\therefore \theta = \sin^{-1}\left(\dfrac{1}{\mu_{\lambda_1}}\right)$ and $\theta' = \sin^{-1}\left(\dfrac{1}{\mu_{\lambda_2}}\right)$

Since $\mu_{\lambda_2} > \mu_{\lambda_1}$, hence $\theta' < \theta$

17. (c)

18. (c, d) For TIR $i > C$

$\Rightarrow \sin i > \sin C \Rightarrow \sin 45° > \dfrac{1}{n} \Rightarrow n > \sqrt{2} \Rightarrow n > 1.4$

19. (c)

20. (d)

21. (a) $_w\mu_g = \dfrac{1}{\sin C} \Rightarrow \dfrac{\mu_g}{\mu_w} = \dfrac{5/3}{4/3} = \dfrac{1}{\sin C}$

$\Rightarrow \sin C = \dfrac{4}{5} \Rightarrow C = \sin^{-1}\left(\dfrac{4}{5}\right)$

22. (c) Total internal reflection occurs when light ray travels from denser medium to rarer medium.

23. (b) $\mu = \dfrac{c}{v} \Rightarrow \mu = \dfrac{c}{c/2} = 2$ also for total internal reflection

$i > c \Rightarrow \sin i \geq \sin c \Rightarrow \sin i \geq \dfrac{1}{\mu}$

Hence $i \geq \sin^{-1}\left(\dfrac{1}{\mu}\right)$ or $i \geq 30^o$

24. (c) $C = \sin^{-1}\left(\dfrac{1}{_w\mu_g}\right) = \sin^{-1}\left(\dfrac{\mu_w}{\mu_g}\right) = \sin^{-1}\left(\dfrac{8}{9}\right)$

25. (a) $\mu_w < \mu_g \Rightarrow c_w > c_g$.

26. (c) $\mu = \dfrac{1}{\sin C} = \dfrac{1}{\sin 30} = 2$

27. (c) Ray from setting sum will be refracted at angle equal to critical angle.

28. (a) Optical fibres are used to send signals from one place to another.

29. (d)

30. (d) When total internal reflection just takes place from lateral surface $i = C$ i.e. $60^o = C$

$\Rightarrow \sin 60^o = \sin C = \dfrac{1}{\mu} \Rightarrow \mu = \dfrac{2}{\sqrt{3}}$

Time taken by light to traverse some distance in a medium

$t = \dfrac{\mu x}{c} = \dfrac{\dfrac{2}{\sqrt{3}} \times 10^3}{3 \times 10^8} = 3.85\,\mu$ *sec*.

31. (a) $\dfrac{\mu_2}{\mu_1} = \dfrac{v_1}{v_2} = \dfrac{1}{2} \Rightarrow \dfrac{\mu_1}{\mu_2} = 2 (\mu_1 > \mu_2)$

For total internal reflection ${}_2\mu_1 = \frac{1}{\sin C} \Rightarrow \frac{\mu_1}{\mu_2}$

$= \frac{1}{\sin C} \Rightarrow 2 = \frac{1}{\sin C} \Rightarrow C = 30^o$

So, for total (Internal reflection angle of incidence must be greater than 30°.

32. (c)

33. (a) $\mu = \frac{1}{\sin C} = \frac{1}{\sin 60^o} = \frac{2}{\sqrt{3}}$

34. (c) ${}_a\mu_g = \frac{1}{\sin\theta} \Rightarrow \mu = \frac{1}{\sin\theta}$ .....(i)

Now from Snell's law $\mu = \frac{\sin i}{\sin r} = \frac{\sin\theta}{\sin r}$

$\Rightarrow \sin r = \frac{\sin\theta}{\mu}$ .....(ii)

From equation (i) and (ii)

$\sin r = \frac{1}{\mu^2} \Rightarrow r = \sin^{-1}\left(\frac{1}{\mu^2}\right)$

35. (a) $C = \sin^{-1}\left(\frac{1}{\mu}\right)$ and $\mu \propto \frac{1}{\lambda}$

Yellow, orange and red have higher wavelength than green, so μ will be less for these rays, consequently critical angle for these rays will be high, hence if green is just totally internally reflected then yellow, orange and red rays will emerge out.

36. (d) We know $C = \sin^{-1}\left(\frac{1}{\mu}\right)$

Given critical angle $i_B > i_A$

So $\mu_B < \mu_A$ *i.e.* B is rarer and A is denser.

Hence light can be totally internally reflected when it passes from A to B

Now critical angle for A to B

$C_{AB} = \sin^{-1}\left(\frac{1}{{}_B\mu_A}\right) = \sin^{-1}\left[{}_A\mu_B\right]$

$= \sin^{-1}\left[\frac{\mu_B}{\mu_A}\right] = \sin^{-1}\left[\frac{\sin i_A}{\sin i_B}\right]$

37. (b) At point A, by Snell's law

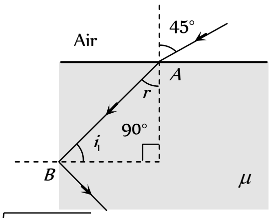
$\mu = \frac{\sin 45}{\sin r} \Rightarrow \sin r = \frac{1}{\mu\sqrt{2}}$ .....(i)

At point B, for total internal reflection $\sin i_1 = \frac{1}{\mu}$

From figure, $i_1 = 90 - r$

$\therefore \sin(90° - r) = \frac{1}{\mu}$

$\Rightarrow \cos r = \frac{1}{\mu}$ .....(ii)



Now $\cos r = \sqrt{1 - \sin^2 r} = \sqrt{1 - \frac{1}{2\mu^2}}$

$= \sqrt{\frac{2\mu^2 - 1}{2\mu^2}}$ .....(iii)

From equation (ii) and (iii) $\frac{1}{\mu} = \sqrt{\frac{2\mu^2 - 1}{2\mu^2}}$

Squaring both side and then solving we get $\mu = \sqrt{\frac{3}{2}}$

38. (b) ${}_2\mu_1 = \frac{1}{\sin\theta} \Rightarrow \frac{\mu_1}{\mu_2} = \frac{1}{\sin\theta} \Rightarrow \frac{v_2}{v_1} = \frac{1}{\sin\theta} \Rightarrow \frac{v_2}{v} = \frac{1}{\sin\theta}$

$\Rightarrow v_2 = \frac{v}{\sin\theta}$

39. (c) From the formula $\sin C = \frac{1}{{}_1\mu_2} \Rightarrow \sin C = {}_2\mu_1$

$= \frac{u_1}{u_2} = \frac{v_2}{v_1} \Rightarrow \sin C = \frac{10x/t_2}{x/t_1}$

$\Rightarrow \sin C = \frac{10\,t_1}{t_2} \Rightarrow C = \sin^{-1}\left(\frac{10\,t_1}{t_2}\right)$

40. (a) $\sin 45^o = \frac{1}{\mu} \Rightarrow \mu = \sqrt{2} = 1.41$

41. (c)

42. (b) Critical angle C is equal to incident angle if ray reflected normally $\therefore C = 90^o$

43. (b)

44. (d) $r = \frac{3h}{\sqrt{7}} = \frac{3 \times 12}{\sqrt{7}} = \frac{36}{\sqrt{7}}$.

45. (b) Here $\sin i = \frac{1}{\mu} = \frac{3}{5}$ and hence $\tan i = \frac{3}{4} = \frac{r}{4}$

This gives $r = 3\,m$, hence diameter = $6m$

46. (a) Radius of horizon circle $= \frac{3h}{\sqrt{7}} = \frac{3\sqrt{7}}{\sqrt{7}} = 3\,cm$.

Refraction at Curved Surface

1. (a) By formula $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (1.5 - 1)\left(\frac{1}{40} + \frac{1}{40}\right) = 0.5 \times \frac{1}{20} = \frac{1}{40}$

$\therefore f = 40\ cm$

2. (a) $\frac{v}{-u} = -m$ and $v + u = x \Rightarrow u = \frac{x}{1+m}$

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow f = \frac{mx}{(m+1)^2}$.

3. (d) $I \propto A^2 \Rightarrow \frac{I_2}{I_1} = \left(\frac{A_2}{A_1}\right)^2 = \frac{\pi r^2 - \frac{\pi r^2}{4}}{\pi r^2} = \frac{3}{4}$

$\Rightarrow I_2 = \frac{3}{4} I_1$ and focal length remains unchanged.

4. (c) $\frac{1}{f}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{P_1}{100}+\frac{P_2}{100}=\frac{1}{100}\Rightarrow f=100\ cm$

$\therefore$ A convergent lens of focal length 100 *cm*.

5. (a) Focal length of the combination can be calculated as

$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}\Rightarrow\frac{1}{F}=\frac{1}{(+40)}+\frac{1}{(-25)}\Rightarrow F=-\frac{200}{3}cm$

$\therefore P=\frac{100}{F}=\frac{100}{-200/3}=-1.5\ D$

6. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}\Rightarrow\frac{1}{80}=\frac{1}{20}+\frac{1}{f_2}\Rightarrow f_2=-\frac{80}{3}cm$

$\therefore$ Power of second lens

$P_2=\frac{100}{f_2}=\frac{100}{-80/3}=-3.75\ D$

7. (b) In each case two plane-convex lens are placed close to each other, and $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$.

8. (a) Power of the combination $P=P_1+P_2\quad=12-2=10\,D$

$\therefore$ Focal length of the combination

$F=\frac{100}{P}=\frac{100}{10}=10\,cm$

9. (c) Resultant focal length $=\infty$

$\therefore$ It behaves as a plane slab of glass.

10. (c) $f=\frac{R}{(\mu-1)}\Rightarrow 30=\frac{10}{(\mu-1)}\Rightarrow\mu=1.33$.

11. (c) In case of convex lens if rays are coming from the focus, then the emergent rays after refraction are parallel to principal axis.

12. (d) Because to form the complete image only two rays are to be passed through the lens and moreover, since the total amount of light released by the object is not passing through the lens, therefore image is faint (intensity is decreased).

13. (b) $f=\frac{f_1 f_2}{f_1+f_2}=\frac{10(-10)}{10+(-10)}=\frac{-100}{10-10}=\infty$

14. (c) Focal length of the combination

$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{(+84)}+\frac{1}{(-12)}\Rightarrow F=-14\ cm$

$\therefore P=\frac{100}{F}=\frac{100}{-14}=-\frac{50}{7}D$

15. (b) $O=\sqrt{I_1 I_2}=\sqrt{4\times16}=8\,cm$

16. (d) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow\frac{f_w}{f_a}=\frac{(1.5-1)}{\left(\frac{1.5}{1.33}-1\right)}\Rightarrow f_w=32\,cm$

17. (c) If $n_l>n_g$ then the lens will be in more denser medium. Hence its nature will change and the convex lens will behave like a concave lens.

18. (d) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow\frac{f_l}{15}=\frac{(1.5-1)}{\left(\frac{1.5}{4/3}-1\right)}\Rightarrow f_l=60\,cm$

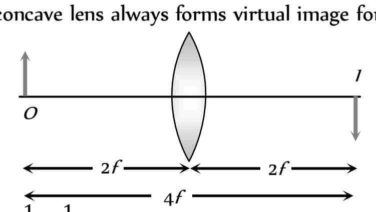
19. (c) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}\Rightarrow f_l=\infty$ if ${}_l\mu_g=1\Rightarrow{}_a\mu_l={}_a\mu_g$.

20. (c) $\frac{I_1}{O}=\frac{v}{u}$ and $\frac{I_2}{O}=\frac{u}{v}\Rightarrow O^2=I_1 I_2$

21. (c) A lens shows opposite behaviour if $\mu_{\text{medium}}>\mu_{\text{lens}}$

22. (a) A concave lens always forms virtual image for real objects.

23. (d)



24. (a) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ (Given $u=-20\ cm,\ f=10\ cm,\ v=?$)

$\therefore\ \frac{1}{10}=\frac{1}{v}-\frac{1}{(-20)}\Rightarrow v=20\,cm$

25. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{60}+\frac{1}{(-20)}\Rightarrow F=-30$

26. (a) $f_{\text{water}}=4\times f_{\text{air}}$, air lens is made up of glass.

27. (b) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{20}+\frac{1}{25}\Rightarrow F=\frac{100}{9}\ cm=\frac{1}{9}\ metre$

$\therefore\ P=\frac{1}{1/9}D=9D$

28. (a) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$ (Given $u=\frac{-f}{2}$)

$\Rightarrow\frac{1}{f}=\frac{1}{v}+\left(\frac{1}{f/2}\right)\Rightarrow\frac{1}{v}=\frac{1}{f}-\frac{2}{f}$

$\Rightarrow\frac{1}{v}=\frac{-1}{f}$ and $m=\frac{v}{u}=\frac{f}{f/2}=2$

So virtual at the focus and of double size.

29. (a) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Given $R_1=+20cm, R_2=-20\,cm$, $\mu=1.5$

$\Rightarrow f=20\ cm$. Parallel rays converge at focus. So *L=f.*

30. (c) $\mu_{air}<\mu_{lens}<\mu_{water}$ *i.e.,* $1<\mu_{lens}<1.33$

31. (c) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

For biconvex lens $R_2=-R_1\quad\therefore\ \frac{1}{f}=(\mu-1)\left(\frac{2}{R}\right)$

Given $R=\infty\ \therefore\ f=\infty$, so no focus at real distance.

32. (d) $f=\frac{R}{(\mu-1)}=\frac{15}{(1.6-1)}=25\,cm$

$\therefore P=\frac{100}{f}=\frac{100}{25}=+4\ D$

33. (d) $f\propto\frac{1}{(\mu-1)}$ and $\mu\propto\frac{1}{\lambda}$. Hence $f\propto\lambda$ and $\lambda_r>\lambda_v$

34. (c) $m_1=\frac{A_1}{O}$ and $m_2=\frac{A_2}{O}\quad\Rightarrow m_1 m_2=\frac{A_1 A_2}{O_2}$

Also it can be proved that $m_1 m_2=1$

So $O = \sqrt{A_1 A_2}$

35. (b) Combined power $P = P_1 + P_2 = 6 - 2 = 4D$. So focal length of combination $F = \frac{1}{P} = \frac{1}{4} m$

36. (b) $\frac{1}{60} = \frac{1}{f_1} + \frac{1}{f_2}$ ...(i)

and $\frac{1}{30} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{10}{f_1 f_2}$ ...(ii)

On solving (i) and (ii) $f_1 f_2 = -600$ and $f_1 + f_2 = -10$

Hence $f_1 = 20\ cm$ and $f_2 = -30\ cm$

37. (c) For an achromatic combination $\frac{\omega_1}{f_1} + \frac{\omega_2}{f_2} = 0$

i.e. 1 convex lens and 1 concave lens.

38. (d) $\frac{1}{F} = \frac{2}{f_l} + \frac{1}{f_m} \Rightarrow \frac{1}{F} = \frac{2}{20} + \frac{1}{\infty} \Rightarrow F = 10\ cm$

39. (b) Since aperture of lens reduces so brightness will reduce but their will be no effect on size of image.

40. (d) Convex mirror and concave lens do not form real image. For concave mirror $v > u$, so image will be enlarged, hence only convex lens can be used for the purpose.

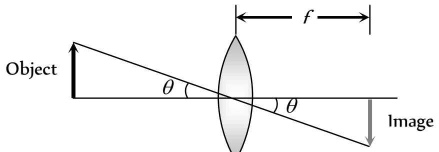
41. (a) $m = \frac{f}{f+u} \Rightarrow -\frac{1}{4} = \frac{30}{30+u} \Rightarrow u = -150\,cm$

42. (c) Covering a portion of lens does not effect position and size of image.

43. (a) $\frac{1}{f} = ({}_g\mu_a - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = \left(\frac{2}{3} - 1\right)\left(\frac{2}{10}\right)$

$\Rightarrow f = -15\,cm$, so behaves as concave lens.

44. (c) Size of image = $f\theta = 0.5 \times (1 \times 10^{-3})$ = 0.5 *mm*



45. (d) $\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)} = \frac{\left(\frac{3}{2} - 1\right)}{\left(\frac{3/2}{5/4} - 1\right)} = \frac{5}{2}$

$\therefore\ f_l = f_a\left(\frac{5}{2}\right) = \frac{12 \times 5}{2} = 30\ cm$

46. (d) $P = \frac{1}{F} = \frac{f_1 + f_2}{f_1 f_2}$

47. (c) $f = \frac{R}{(\mu - 1)} = \frac{R}{(1.5 - 1)} = 2R$

48. (b) For achromatic combination, $\frac{w_1}{f_1} + \frac{w_2}{f_2} = 0$

$\Rightarrow w_1 f_2 + w_2 f_1 = 0$

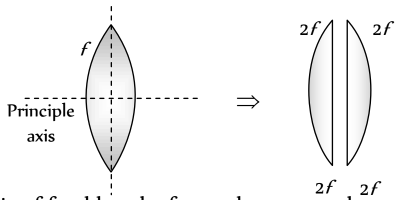
49. (a) $\frac{\omega_1}{\omega_2} = -\frac{f_1}{f_2} \Rightarrow \frac{5}{3} = \frac{-(-15)}{f_2} \Rightarrow f_2 = 9\ cm$

50. (b) $f = \frac{R}{2(\mu - 1)} \Rightarrow f = \frac{40}{2(1.65 - 1)} \approx 31\,cm$

51. (c) Focal length of effective lens

$\frac{1}{F} = \frac{2}{f_l} + \frac{1}{f_m} = \frac{2}{f_l} + \frac{1}{\infty} \Rightarrow F = \frac{f_l}{2}$

52. (a)



Ratio of focal length of new plano convex lenses is 1 : 1

53. (a) $\frac{1}{f} = \left(\frac{n-1}{1}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ and $\frac{1}{f'} = \left(\frac{n - n'}{n'}\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\therefore\ \frac{f'}{f} = \frac{n-1}{1} \times \frac{n'}{n - n'} \Rightarrow f' = -\frac{fn'(n-1)}{n' - n}$

54. (b) $\frac{I}{O} = \frac{f - v}{f} \Rightarrow \frac{I}{+1.5} = \frac{(25 - 75)}{25} = -2 \Rightarrow I = -3\,cm$

55. (a) $P = P_1 + P_2$, if $P_1 = P_2 = P' \Rightarrow P' = P/2 = 2D.$

56. (b) $f = \frac{R}{(\mu - 1)} = \frac{60}{(1.6 - 1)} = 100\ cm.$

57. (a) $\frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} = \frac{1.5 - 1}{\frac{1.5}{1.75} - 1} = -\frac{1.75 \times 0.50}{0.25} = -3.5$

$\therefore f_l = -3.5\ f_a \Rightarrow f_l = +3.5\ R$ $(\because f_a = R)$

Hence on immersing the lens in the liquid, it behaves as a converging lens of focal length 3.5 *R*.

58. (a) $P = P_1 + P_2 = \frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{(0.5)} + \frac{1}{(-1)} = 1D$

59. (d) $f = \frac{R}{2(\mu - 1)} \Rightarrow 30 = \frac{R}{2(1.5 - 1)} \Rightarrow R = 30\ cm$

60. (c) Total power $P = P_1 + P_2 = 11 - 6 = 5D$

Also $\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)} \Rightarrow \frac{P_a}{P_l} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)}$

$\Rightarrow \frac{5}{P_l} = \frac{(1.5 - 1)}{(1.5/1.6 - 1)} \Rightarrow P_l = -0.625\,D$

61. (b) For first case : $\frac{1}{f} = \frac{1}{v} - \frac{1}{\infty} \Rightarrow f = v$

For second case $\frac{1}{f} = \frac{1}{(f+5)} - \frac{1}{-(f+20)} \Rightarrow f = 10\ cm$

Alternative sol. – $f^2 = x_1 x_2 \Rightarrow f = 10cm.$

62. (b) $f = \frac{D^2 - x^2}{4D}$ (Focal length by displacement method)

$\Rightarrow f = \frac{(100)^2 - (40)^2}{4 \times 40} = 21\ cm$

$\therefore P = \frac{100}{f} = \frac{100}{21} \approx 5\,D$

63. (d) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u} \Rightarrow \frac{1}{+5}=\frac{1}{v}-\frac{1}{(-10)} \Rightarrow v=10\ cm$

64. (d) $\omega / f=-2\omega / f' \Rightarrow f'=-2f$

65. (d) $f=\frac{R}{2(\mu-1)} \Rightarrow 10=\frac{R}{2(1.6-1)} \Rightarrow R=12\ cm$

66. (a)

67. (d) $P=P_1+P_2=2.50-3.75=-1.25D$

So $f=\frac{100}{1.25}=-80\ cm$

68. (c) $\frac{f_l}{f_a}=\frac{{}_a\mu_g-1}{{}_l\mu_g-1} \Rightarrow f_l=4R$

69. (c) $\frac{f_l}{f_a}=\frac{{}_a\mu_g-1}{{}_l\mu_g-1}=\frac{{}_a\mu_g-1}{\frac{{}_a\mu_g}{{}_a\mu_l}-1} \Rightarrow \frac{f_l}{2}=\frac{1.5-1}{\frac{1.5}{1.25}-1} \Rightarrow f_l=5\ cm$

70. (b) $f \propto \frac{1}{\mu-1}$ and $\mu \propto \frac{1}{\lambda}$

71. (d) $P=\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}=\frac{1}{(+0.8)}+\frac{1}{(-0.5)}=-0.75\ D$

72. (b) According to lens makers formula

$\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \Rightarrow \frac{1}{f} \propto (\mu-1)$

Since $\mu_{Red}<\mu_{violet} \Rightarrow f_v<f_r$ and $F_v<F_r$

Always keep in mind that whenever you are asked to compare (greater than or less than) *u, v* or *f* you must not apply sign conventions for comparison.

73. (a) Since light transmitting area is same, there is no effect on intensity.

74. (c) $m=\frac{f}{(f+u)} \Rightarrow -\frac{1}{n}=\frac{f}{(f+u)} \Rightarrow u=-(n+1)f$

75. (a) $P=P_1+P_2=2D-4D=-2D.$

76. (c)

77. (a) $\frac{1}{F}=\frac{2}{f}+\frac{1}{f_m}$. Here $f_m=\infty$, hence $F=\frac{f}{2}=10\,cm$

78. (b) $O=\sqrt{I_1I_2} \Rightarrow O=\sqrt{4\times 9}=6\ cm$

79. (b) $P=P_1+P_2 \Rightarrow P=+6-4=+2\,D$. So focal length

$f=\frac{100}{2}=+50\ cm$, convex lens

80. (d) $f=\frac{R}{2(\mu-1)} \Rightarrow P=\frac{2(\mu-1)}{R}=\frac{2(1.5-1)}{0.2}=+5\,D$

81. (c) $P=\frac{1}{f} \Rightarrow f=\frac{1}{0.5}=2m$

82. (a) $\frac{f_l}{f_a}=\left(\frac{{}_a\mu_g-1}{{}_l\mu_g-1}\right) \Rightarrow \frac{f_l}{4}=\frac{(1.4-1)}{\frac{1.4}{1.6}-1} \Rightarrow f_l=-12.8\,cm$

83. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2} \Rightarrow \frac{1}{F}=\frac{1}{(+18)} \Rightarrow F=18\,cm$

84. (a) $\frac{f_l}{f_a}=\frac{({}_a\mu_g-1)}{({}_l\mu_g-1)}$; $f_a=\frac{R}{2(\mu_g-1)}=\frac{15}{2(1.6-1)}=12.5$

$\Rightarrow \frac{f_l}{12.5}=\frac{(1.6-1)}{\left(\frac{1.6}{1.63}-1\right)} \Rightarrow f_l=-407.5\ cm$

85. (c) $P=P_1+P_2 \Rightarrow P=+2+(-1)=+1D,$

$f=\frac{+100}{P}=\frac{+100}{1}=100\,cm$

86. (c)

87. (b) Nature of lens changes, if $\mu_{mediume}>\mu_{lens}$

88. (a) $u=-25\ cm, v=+75\,cm$

$\Rightarrow \frac{1}{f}=\frac{1}{+75}-\frac{1}{-25} \Rightarrow f=+18.75\ cm$; convex lens.

89. (a) $F=\frac{f_1f_2}{f_2-f_1}$, F will be negative if $f_1>f_2$

90. (b) $f=\frac{R}{2(\mu-1)}=\frac{10}{2(1.5-1)}=10\,cm$

91. (b) $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

$\Rightarrow \frac{1}{+10}=(1.5-1)\left(\frac{1}{+7.5}-\frac{1}{R_2}\right) \Rightarrow R_2=-15\,cm$

92. (d) $f=\frac{R}{2(\mu-1)}$, $f'=\frac{R}{(\mu-1)} \Rightarrow f'=2f$

93. (c) $m=\pm 3$, using $m=\frac{f}{f+u}$

For virtual image $3=\frac{f}{f-8}$ .....(i)

For real image $-3=\frac{f}{f-16}$ .....(ii)

Solving (i) and (ii) we get $f=12\,cm$

94. (a) $\frac{1}{F}=\frac{1}{+18}+\frac{1}{(-9)} \Rightarrow F=-18\ cm$ (*i.e.* concave lens)

95. (c) $O=\sqrt{I_1I_2}=\sqrt{8\times 2}=4cm$

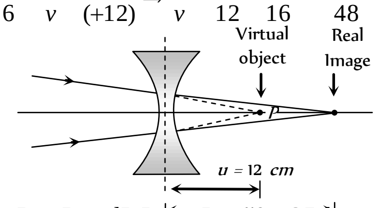
96. (c) $P=\frac{100}{f_1}+\frac{100}{f_2}=\frac{100}{(+25)}+\frac{100}{(-10)}=-6D$

97. (c)

98. (a) $f_w=4\times f_a=4\times 12=48\ cm.$

99. (d) By using lens formula

$\frac{1}{-16}=\frac{1}{v}-\frac{1}{(+12)} \Rightarrow \frac{1}{v}=\frac{1}{12}-\frac{1}{16}=\frac{4-3}{48} \Rightarrow v=48\ cm$



100. (a) $P=P_1+P_2-dP_1P_2 \Rightarrow P=10-25d$

$\Rightarrow$ For P to be negative $25d>10$

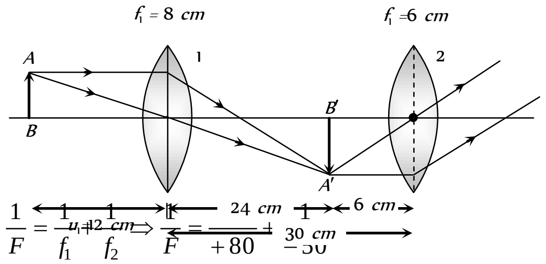
$\Rightarrow d>0.4\,m$ or $d>40\ cm$

101. (a) $m=\frac{f}{f+u} \Rightarrow -m=\frac{f}{f+u} \Rightarrow u=-\left(\frac{m+1}{m}\right)f$

102. (d) Number of images = (Number of materials)

103. (c) For lens (1) $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{(+8)} = \frac{1}{v} - \frac{1}{(-12)}$

$\Rightarrow v = 24\ cm$ *i.e.* Image $A'B'$ is obtained 6 *cm* before the lens 2 or at the focus of lens 2. Hence final image formed by lens 2 will be real enlarged and it is obtained at ∞.



104. (d) $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow \frac{1}{F} = \frac{1}{+80} + \frac{1}{-50}$

$\Rightarrow F = -\frac{400}{3} \Rightarrow P = \frac{-3}{4} D$

105. (a) By using formula $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$\Rightarrow \frac{1.5}{v} - \frac{1}{(-15)} = \frac{(1.5-1)}{+30} \Rightarrow v = -30\,cm$.

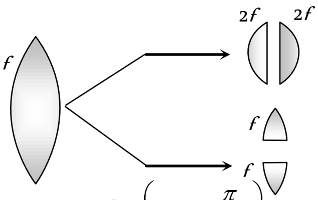
Negative sign shows that, image is obtained on the same side of object *i.e.* towards left.

106. (c) By using $\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)} \Rightarrow f_w = 4 f_a = 4 \times 30 = 120\ cm$.

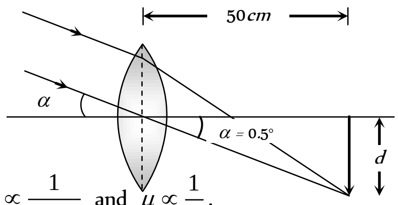
107. (b)

108. (a)

109. (d)



110. (b) Diameter of image $d = \left(0.5 \times \frac{\pi}{180}\right) \times 500 = 4.36\ mm$



111. (c) $f \propto \frac{1}{\mu - 1}$ and $\mu \propto \frac{1}{\lambda}$.

112. (c) Since intensity ∝ (Aperature)', so intensity of image will decrease but no change in the size occurs.

113. (c) In liquids converging ability (power) of convex lens decreases.

114. (d) Since $f \propto \frac{1}{\mu} \propto \lambda$, so voilet colour is focused nearer to the lens.

115. (a) Focal length for voilet is minimum.

116. (c) $m = \frac{v}{u} = 5 \Rightarrow v = 5$ *inch* (Given $u = 1$ *inch*)

Using sign convention $u = -1\ inch,\ v = -5\ inch$

$\therefore \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-5} - \frac{1}{-1} \Rightarrow f = 1.25\ inch$

117. (a) $m_L = 4$

$m_A = (m_1)^2$ so that $A' = A_0 \times 16 = 1600\ cm^2$

118. (d) $u = -10\ cm,\ v = 20\ cm$

$\frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{20} - \left(-\frac{1}{10}\right) = \frac{3}{20} \Rightarrow f = \frac{20}{3}\ cm$

Now $P = \frac{100}{f} = \frac{100}{20/3} = +15\ D$

119. (c) $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$

120. (b) $f = \frac{R}{2(\mu - 1)} \Rightarrow R = 2f(\mu - 1) = 2 \times 0.2(1.5 - 1) = 0.2m$.

121. (c) Using refraction formula $\frac{{}_1\mu_2 - 1}{R} = \frac{{}_1\mu_2}{v} - \frac{1}{u}$

in given case, medium (1) is glass and (2) is air

So $\frac{{}_g\mu_a - 1}{R} = \frac{{}_g\mu_a}{v} - \frac{1}{u} \Rightarrow \frac{\frac{1}{1.5} - 1}{-6} = \frac{1}{1.5v} - \frac{1}{-6}$

$\Rightarrow \frac{1 - 1.5}{-6} = \frac{1}{v} + \frac{1.5}{6} \Rightarrow \frac{0.5}{6} = \frac{1}{v} + \frac{1}{4}$

$\Rightarrow \frac{1}{v} = \frac{1}{12} - \frac{1}{4} = -\frac{2}{12} = -\frac{1}{6} \Rightarrow v = 6\ cm.$

122. (d) For real image $m = -2$

$\therefore m = \frac{f}{u + f} \Rightarrow -2 = \frac{f}{u + f} = \frac{20}{u + 20} \Rightarrow u = -30\ cm.$

123. (a) Focal length of the system (concave mirror)

$F = \frac{R}{2\mu} = \frac{30}{2 \times 1.5} = 10\ cm$

In order to have a real image of the same size of the object, object must be placed at centre of curvature u = (2*f*).

124. (b) $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$= (1.5 - 1)\left(\frac{1}{10} + \frac{1}{10}\right) = \frac{1}{10} \Rightarrow f = 10\ cm$

∴ Radius of curvature of concave mirror = $2f$ = 20 *cm*.

125. (d) $m = -\frac{1}{2}$

$\therefore m = \frac{f}{u + f} \Rightarrow -\frac{1}{2} = \frac{30}{u + 30} \Rightarrow u = -90\ cm$

126. (c) $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$\frac{1}{f} = (1.6 - 1)\left(\frac{1}{60} - \frac{1}{\infty}\right) = \frac{1}{100} \Rightarrow f = 100\ cm$

127. (d) $\frac{1}{F} = (1.5 - 1)\left(\frac{1}{20} - \frac{1}{\infty}\right) \Rightarrow F = 40\ cm$.

128. (b) For minimum spherical and chromatic aberration distance between lenses.

$d = f_1 - f_2 = 0.3 - 0.1 = 0.2\,m$.

129. (b) $\frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} = \frac{(1.5-1)\times 1.7}{(1.5-1.7)}$

$\Rightarrow f_l = \frac{0.85}{-0.2} f_a = -4.25 f_a$.

130. (c)

131. (b) $\omega = \frac{f_R - f_V}{f_y} = \frac{f_R - f_V}{\sqrt{f_V f_R}}$

Putting value of f_V and f_R we get $\omega = 0.0325$.

132. (b) $P_1 + P_2 = 2D$ and $P_1 = 5\,D$, so $P_2 = -3\,D$

For achromatic combination

$\frac{\omega_1}{\omega_2} = \left(-\frac{p_2}{p_1}\right) = -\left(\frac{-3}{5}\right) = \frac{3}{5}$

133. (b) $f \propto \frac{1}{\mu - 1}$ and $\mu \propto \frac{1}{\lambda}$

134. (d) $P = P_1 + P_2 = +12 - 2 = 10D$

Now $F = \frac{1}{P} = \frac{1}{10} m = 10\,cm$.

135. (b) Focal length for voilet colour is minimum

136. (d) $\frac{f_1}{f_2} = \frac{2}{3}$ .....(i)

$\frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{30}$ .....(ii)

Solving equation (i) and (ii)

$f_2 = -15\,cm$ (Concave)

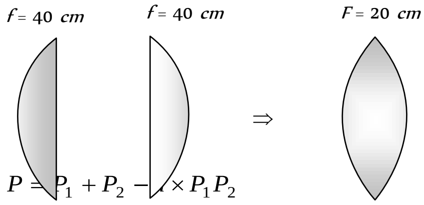
$f_1 = 10\,cm$ (Convex)

137. (d) $\frac{f_l}{f_a} = \frac{({}_a\mu_g - 1)}{({}_l\mu_g - 1)}$

$\Rightarrow \frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} = \frac{1.5 - 1}{\frac{1.5}{1.6} - 1} = \frac{0.5 \times 1.6}{-0.1} = -8$

$\Rightarrow P_l = \frac{P_a}{8} = \frac{5}{8}$

138. (b) To obtain, an inverted and equal size image, object must be paced at a distance of $2f$ from lens, *i.e.* 40 *cm* in this case.



139. (a) Using $P = P_1 + P_2 - d \times P_1 P_2$

for equivalent power to be negative

$d \times P_1 P_2 > P_1 + P_2 \Rightarrow d \times 25 > 10$

$\Rightarrow d > \frac{10}{25} m \Rightarrow d > \frac{10 \times 100}{25} \Rightarrow d > 40cm$.

140. (c) Combination of lenses will act as a simple glass plate.

141. (b) For achromatic combination $\frac{f_1}{f_2} = -\frac{\omega_2}{\omega_1} = -\frac{0.036}{0.024} = -\frac{3}{2}$

and $\frac{1}{f_1} - \frac{1}{f_2} = \frac{1}{90}$

solving above equations be get $f_1 = 30cm,\ f_2 = -45cm$

142. (b)

143. (c) $f \propto \frac{1}{\mu - 1}$ and $\mu \propto \frac{1}{\lambda}$.

144. (b) $\frac{f_l}{f_a} = \frac{{}_a\mu_g - 1}{{}_l\mu_g - 1} \Rightarrow \frac{-0.5}{0.2} = \frac{1.5 - 1}{{}_l\mu_g - 1} \Rightarrow {}_l\mu_g - 1 = -0.2$

$\Rightarrow {}_l\mu_g = 0.8 = \frac{4}{5} \Rightarrow \frac{{}_a\mu_g}{{}_a\mu_l} = \frac{4}{5} \Rightarrow \frac{1.5}{{}_a\mu_l} = \frac{4}{5}$

$\Rightarrow {}_a\mu_l = \frac{15}{8}$.

145. (c) Longitudinal chromatic aberration

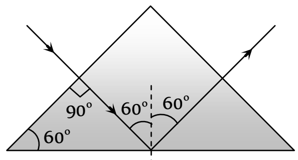
$= \omega f = 0.08 \times 20 = 1.6cm$.

Prism Theory & Dispersion of Light

1. (b) Neon street sign emits light of specific wavelengths.

2. (b)

3. (b)



4. (c) $\delta \propto (\mu - 1) \Rightarrow \mu_R$ is least so δ_R is least.

5. (c)

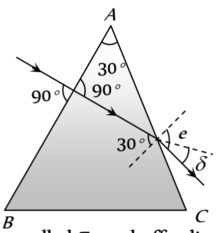
6. (a) For surface $AC\ \frac{1}{\mu} = \frac{\sin 30°}{\sin e} \Rightarrow \sin e = \mu \sin 30°$

$\Rightarrow \sin e = 1.5 \times \frac{1}{2} = 0.75$

$\Rightarrow e = \sin^{-1}(0.75) = 48°36'$

From figure $\delta = e - 30°$

$= 48°\ 36' - 30° = 18°36'$



7. (a) The black lines in solar spectrum are called Fraunhoffer lines.

8. (d) $\frac{\sin\frac{A + \delta m}{2}}{\sin\frac{A}{2}} = \mu$, But $\frac{A + \delta_m}{2} = i = 45°$

So $\frac{\sin 45°}{\sin(A/2)} = \sqrt{2} \Rightarrow \frac{1}{2} = \sin\frac{A}{2} \Rightarrow A = 60°$

9. (d) We know that $\frac{\delta_v - \delta_r}{\delta_{mean}} = \omega$

$\Rightarrow$ Angular dispersion $= \delta_v - \delta_r = \theta = \omega\delta_{mean}$

10. (d) According to Kirchhoff's law, a substance in unexcited state will absorb these wavelength which it emits in de-excitation.

11. (c) By prism formula $n = \frac{\sin\frac{A + A}{2}}{\sin\frac{A}{2}} = \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}}$

$\therefore \cos\frac{A}{2} = \frac{n}{2} = \frac{1.5}{2} = 0.75 = \cos 41^o \Rightarrow A = 82^o$

12. (b)

13. (b) ω depend only on nature of material.

14. (a) Because achromatic combination has same μ for all wavelengths.

15. (a) $\because \mu = a + \frac{b}{\lambda^2}$ (Cauchy's equation)

and dispersion $D = -\frac{d\mu}{d\lambda} \Rightarrow D = -(-2\lambda^{-3})b = \frac{2b}{\lambda^3}$

$\Rightarrow D \propto \frac{1}{\lambda^3} \Rightarrow \frac{D'}{D} = \left(\frac{\lambda}{\lambda'}\right)^3 = \left(\frac{\lambda}{2\lambda}\right) = \frac{1}{8} \Rightarrow D' = \frac{D}{8}$

16. (b) $\mu = \frac{\sin i}{\sin A/2} \Rightarrow \sqrt{2} = \frac{\sin i}{\sin\left(\frac{60}{2}\right)}$

$\Rightarrow \sqrt{2} \times \sin 30 = \sin i \Rightarrow i = 45^o$

17. (d) $\frac{\delta_w}{\delta_a} = \frac{({}_w\mu_g - 1)}{({}_a\mu_g - 1)} = \frac{\left(\frac{9}{8} - 1\right)}{\left(\frac{3}{2} - 1\right)} = \frac{1}{4}$

18. (a) Since $A(\mu_y - 1) + A'(\mu_{y'} - 1) = 0 \Rightarrow \frac{A'}{A} = -\left(\frac{\mu_y - 1}{\mu_{y'} - 1}\right)$

19. (d)

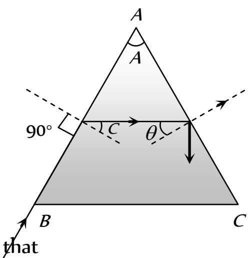
20. (b)

21. (a)

22. (c) From ray diagram

$A = C + \theta$ for TIR at AC

$\theta > C$ so $A > 2C$



23. (a) By the hypothesis, we know that

$i_1 + i_2 = A + \delta \Rightarrow 55^o + 46^o = 60^o + \delta \Rightarrow \delta = 41^o$

But $\delta_m < \delta$, so $\delta_m < 41^o$

24. (a)

25. (b) $\delta_m = (\mu - 1)A$. $A =$ angle of prism.

26. (c)

27. (c)

28. (b)

29. (a) Total deviation = 0

$\delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 = (\mu_1 - 1)A_1 - (\mu_2 - 1)A_2$

$+(\mu_3 - 1)A_3 - (\mu_4 - 1)A_4 + (\mu_5 - 1)A_5 = 0$

$\Rightarrow 2 \times A_2(1.6 - 1) = 3(1.53 - 1)9$

$\Rightarrow A_2 = 3\left(\frac{0.53 \times 9}{1.2}\right) = 11.9^o$

30. (a) The dispersive power for crown glass $\omega = \frac{n_v - n_r}{n_y - 1}$

$= \frac{1.5318 - 1.5140}{(1.5170 - 1)} = \frac{0.0178}{0.5170} = 0.034$

and for flint glass $\omega' = \frac{1.6852 - 1.6434}{(1.6499 - 1)} = 0.064$

31. (c)

32. (b)

33. (a) For dispersion without deviation $\frac{A}{A'} = \left(\frac{\mu'_y - 1}{\mu_y - 1}\right)$

$\therefore \frac{A}{10} = \frac{(1.602 - 1)}{(1.500 - 1)} = \frac{0.602}{0.500} \Rightarrow A = 12°2.4'$

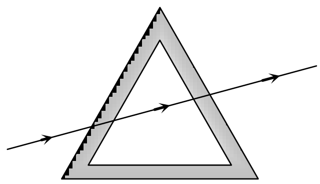
34. (c) $i = \frac{A + \delta_m}{2}$ =50°

35. (d) In minimum deviation position $\angle i = \angle e$

36. (a) Yellow (Primary) + Blue (Primary) = Green (Secondary)

37. (b) All colours are reflected.

38. (a) Effectively there is no deviation or dispersion.

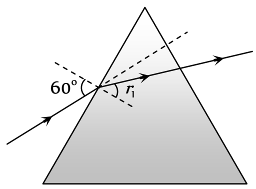


39. (d) From figure it is clear that $\angle e = \angle r_2 = 0$

From $A = r_1 + r_2$

$\Rightarrow r_1 = A = 45^o$

$\therefore \mu = \frac{\sin i}{\sin r_1} = \frac{\sin 60}{\sin 45} = \sqrt{\frac{3}{2}}$



Also from $i + e = A + \delta \Rightarrow 60 + 0 = 45 + \delta \Rightarrow \delta = 15^o$

40. (b) Deviation is zero only for a particular colour, it is generally taken to be yellow.

41. (b) $5 = (\mu - 1)A = (1.5 - 1)A \Rightarrow A = 10^o$

42. (b) $\delta = (\mu_v - \mu_r)A = 0.02 \times 10 = 0.2$

43. (a) $\mu = \frac{\sin\left(\frac{A + \delta_m}{2}\right)}{\sin(A/2)} = \frac{\sin 45^o}{\sin 30^o} = \sqrt{2}$

44. (c) $\omega = \frac{\mu_V - \mu_R}{\mu_Y - 1} = \frac{1.65 - 1.61}{1.63 - 1}$

45. (a) For minimum angle of deviation for a prism

$A = 2r$, $\therefore A = 60^o$

Now $\mu = \frac{\sin\frac{60 + 30}{2}}{\sin\frac{60}{2}} = \frac{\sin 45^o}{\sin 30^o} = \frac{1}{\sqrt{2}} \times \frac{2}{1} = \sqrt{2}$

46. (c) In minimum deviation condition $\angle i = \angle e$, $\angle r_1 = \angle r_2$

47. (b) For dispersion without deviation $\frac{A}{A'} = \frac{(\mu' - 1)}{(\mu - 1)}$

$$\frac{4}{A_F}=\frac{(1.72-1)}{(1.54-1)}=\frac{0.72}{0.54} \text{ or } A_F=\frac{4\times 0.54}{0.72}=3^o$$

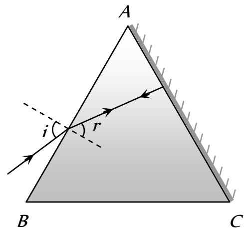
48. (a) $A(\mu_v-\mu_r)+A'(\mu_v'-\mu_r')=0^o \Rightarrow A'=5^o$

49. (c) $A=r+0 \Rightarrow r=30^o$

From Snell's law at surface *AB*

$$\mu=\frac{\sin i}{\sin r}$$

$$\Rightarrow \sqrt{2}=\frac{\sin i}{\sin 30^o} \Rightarrow i=45^o$$



50. (c) $\omega=\frac{1.64-1.52}{1.6-1}=\frac{0.12}{0.6}=0.2$

51. (c) Because band spectrum can be found in case of molecules (generally gas).

52. (a) Solids and liquids give continuous and line spectra. Only gases are known to give band spectra.

53. (d)

54. (d)

55. (a) Hydrogen is molecular, therefore it gives band spectrum but not continuous spectrum.

56. (c)

57. (a) Dispersion take place because the refractive index of medium for different colour is different, for example, red light bends less than violet, refractive index of the material of the prism for red light is less than that for violet light. Equivalently, we can say that red light travels faster than violet light in a glass prism.

58. (a) We know that $\delta=i+e-A \Rightarrow e=\delta+A-i$

$= 30^o+30^o-60^o=0^o$

$\therefore$ Emergent ray will be perpendicular to the face.

Therefore it will make an angle of 90° with the face through which it emerges.

59. (a) $\delta_m=(\mu-1)(2r)=(1.5-1)2r=0.5\times 2r=r$

60. (c)

61. (c)

62. (b)

63. (d) Given $i=e=\frac{3}{4}A=\frac{3}{4}\times 60=45^o$

In the position of minimum deviation

$2i=A+\delta_m$ or $\delta_m=2i-A=90-60=30^o$

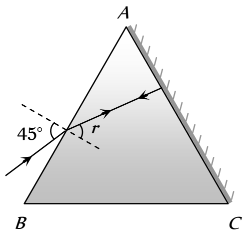
64. (d)

65. (a) Sky appears white due to scattering. In absence of atmosphere no scattering will occur.

66. (b)

67. (c) $A=r+0 \Rightarrow r=30°$

$$\therefore \mu=\frac{\sin i}{\sin r}=\frac{\sin 45°}{\sin 30°}=\sqrt{2}$$



68. (c) By formula $\delta=(n-1)A \Rightarrow 34=(n-1)A$ and in the second position $\delta'=(n-1)\frac{A}{2}$

$$\therefore \frac{34}{\delta'}=\frac{(n-1)A}{(n-1)\frac{A}{2}} \text{ or } \delta'=\frac{34}{2}=17^o$$

69. (b) From figure

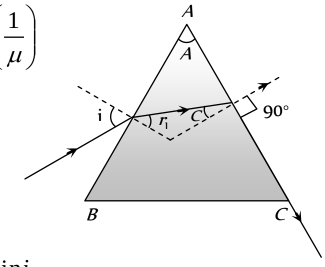
$$A=r_1+c=r_1+\sin^{-1}\left(\frac{1}{\mu}\right)$$

$$\Rightarrow r_1=75-\sin^{-1}\left(\frac{1}{\mu}\right)$$

$$\Rightarrow 75-45=30^o$$

From Snell's law At *B*

$$\mu=\frac{\sin i}{\sin r_1} \Rightarrow \sqrt{2}=\frac{\sin i}{\sin 30^o} \Rightarrow i=45^o$$



70. (c) In both *A* and *B*, the refracted ray is parallel to the base of prism.

71. (a) According to given conditions TIR must take place at both the surfaces *AB* and *AC*. Hence only option (*a*) is correct.

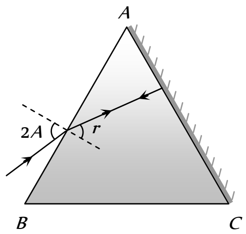
72. (d)

73. (a)

74. (b) $A=r+0$ and $\mu=\frac{\sin i}{\sin r}$

$$\Rightarrow \mu=\frac{\sin 2A}{\sin A}$$

$$=\frac{2\sin A\cos A}{\sin A}=2\cos A$$



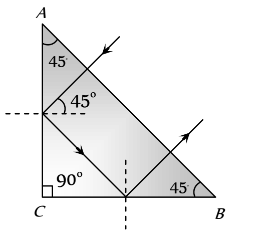
75. (a) From figure it is clear that TIR takes place at surface *AC* and *BC*

i.e. $45^o > C$

$\Rightarrow \sin 45^o > \sin C$

$\Rightarrow \frac{1}{\sqrt{2}} > \frac{1}{\mu} \Rightarrow \mu > \sqrt{2}$

Hence $\mu_{\text{least}}=\sqrt{2}$



76. (b)

77. (b) According to Rayleigh's law of scattering, intensity scattered is inversely proportional to the forth power of wavelength. So red is least scattered and sun appears Red.

78. (b)

79. (d)

80. (a) Only red colour will be seen in spectrum.

81. (b) $i=\frac{A+\delta_m}{2}=\frac{60°+30°}{2}=45°$

82. (a) $$\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}=\frac{\sin\left(\frac{60°+60°}{2}\right)}{\sin\left(\frac{60°}{2}\right)}=\sqrt{3}$$

83. (b) Because in dispersion of white light, the rays of different colours are not parallel to each other. Also deviation takes place in same direction.

84. (c)

85. (a) $\omega = \dfrac{\mu_F - \mu_C}{(\mu_D - 1)} = \dfrac{(1.6333 - 1.6161)}{(1.622 - 1)} = 0.0276$

86. (c) For total internal reflection $\theta > C$

$\Rightarrow \sin\theta > \sin C \Rightarrow \sin\theta > \dfrac{1}{\mu}$

or $\mu > \dfrac{1}{\sin\theta} \Rightarrow \mu > \dfrac{1}{\sin 45^o} \Rightarrow \mu > \sqrt{2} \Rightarrow \mu > 1.41$

87. (c)

88. (a) $\theta = (\mu_v - \mu_r)A = 0.02 \times 5^o = 0.1^o$

89. (b)

90. (b) $\dfrac{A'}{A} = \dfrac{(\mu_y - 1)}{(\mu_{y'} - 1)} \Rightarrow \dfrac{A'}{6} = -\dfrac{(1.54 - 1)}{(1.72 - 1)}$

$\Rightarrow A' = -4.5^o = 4^o 30'$

91. (c) $\mu = \dfrac{\sin\left(\dfrac{A + \delta_m}{2}\right)}{\sin\dfrac{A}{2}} \Rightarrow \sqrt{3} = \dfrac{\sin\left(\dfrac{60° + \delta_m}{2}\right)}{\sin\dfrac{60°}{2}}$

$\Rightarrow \dfrac{\sqrt{3}}{2} = \sin\left(30° + \dfrac{\delta_m}{2}\right) \Rightarrow \delta_m = 60^o$

92. (a) Dispersion is caused due to refraction as μ depends on λ.

93. (c) From colour triangle

94. (c) Due to the absorption of certain wavelengths by the elements in outer layers of sun.

95. (b)

96. (c)

97. (c) $\omega = \dfrac{\mu_v - \mu_R}{\mu_y - 1} = \dfrac{1.62 - 1.52}{1.55 - 1} = 0.18$

98. (a) $\dfrac{\omega_1}{\omega_2} = -\dfrac{f_1}{f_2} = -\dfrac{2}{3}$.

99. (a) $\omega = \dfrac{\mu_V - \mu_R}{\mu_Y - 1} = \dfrac{1.62 - 1.42}{1.5 - 1} = 0.4$

100. (c) Since the ray emerges normally, therefore $e = 0$.

According to relation $A + \delta = i + e$, we get $i = A + \delta$.

Hence by $\delta = (\mu - 1)A$, we get $i = \mu A$.

101. (a) The atoms in the chromosphere absorb certain wavelengths of light coming from the photosphere. This gives rise to absorption lines.

102. (b) $\mu = \dfrac{\sin\left(\dfrac{A + \delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)} \Rightarrow \sqrt{2}\mu = \dfrac{\sin\left(\dfrac{60 + \delta_m}{2}\right)}{\sin\left(\dfrac{60}{2}\right)}$

$\Rightarrow \sqrt{2} \times \sin 30 = \sin\left(\dfrac{60 + \delta_m}{2}\right) \Rightarrow \sin 45^o$

$= \sin\left(\dfrac{60 + \delta_m}{2}\right) \Rightarrow \delta_m = 30^o$

103. (a) Intensity of scattered light $I \propto \dfrac{1}{\lambda^4}$, since λ_{blue} is least that's why sky looks blue.

104. (b) In continuos spectrum all wavelength are present.

105. (d)

106. (b) Deviation is greater for lower wavelengths.

107. (b) $\dfrac{\delta_a}{\delta_w} = \dfrac{({}_a\mu_g - 1)}{({}_w\mu_g - 1)} = \dfrac{\left(\dfrac{3}{2} - 1\right)}{\left(\dfrac{3/2}{4/3} - 1\right)} = 4 \Rightarrow \delta_w = \dfrac{\delta_a}{4}$

108. (a) $\theta = (\mu_v - \mu_r)A = (1.66 - 1.64) \times 10^o = 0.2^o$

109. (b) $\omega = \dfrac{(\mu_v - \mu_R)}{(\mu_y - 1)} \Rightarrow \dfrac{(1.69 - 1.65)}{(1.66 - 1)} = 0.06$

110. (a) $\omega = \dfrac{\delta_V - \delta_R}{\delta_Y} = \dfrac{3.72 - 2.84}{3.28} = 0.268$

111. (a)

112. (d) $\mu = \dfrac{\sin\left(\dfrac{A + \delta_m}{2}\right)}{\sin\left(\dfrac{A}{2}\right)} = \dfrac{\sin\left(\dfrac{60° + 30°}{2}\right)}{\sin\dfrac{60°}{2}} = \dfrac{\sin 45^o}{\sin 30^o} = 1.414$

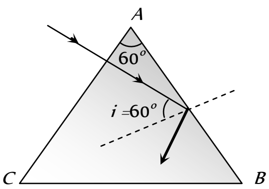
113. (a) Rock salt prism is used to see infrared radiations.

114. (b) For different colours μ changes so deviation of different colour is also different.

115. (a) By using $\dfrac{\omega_1}{f_1} + \dfrac{\omega_2}{f_2} = 0 \Rightarrow \dfrac{0.02}{f_1} + \dfrac{0.04}{40} = 0$

$f_1 = -20\ cm$

116. (d) Critical angle for the material of prism $C = \sin^{-1}\left(\dfrac{1}{\mu}\right) = \sin^{-1} = 42^o$ since angle of incidence at surface $AB\,(60^o)$ is greater then the critical angle (42^o) so total internal reflection takes place.



117. (d) Line and band spectrum are also known as atomic and molecular spectra respectively.

118. (d) In minimum deviation $i = e = 30^o$, so angle between emergent ray and second refracting surface is $90^o - 30^o = 60^o$

119. (c) $\theta = (\mu_v - \mu_R)A = (1.6 - 1.5) \times 5 = 0.5^o$

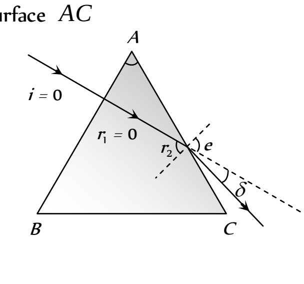
120. (d) $\dfrac{\delta_1}{\delta_2} = \dfrac{A_1}{A_2}$

121. (a) Sunlight consists of all the wavelength with some black lines.

122. (d) $A = 30^o, \mu = \sqrt{2}$. As we know

$A = r_1 + r_2 = 0 + r_2 \Rightarrow A = r_2$.

Applying Snell's law for the surface AC



$\frac{1}{\mu} = \frac{\sin r_2}{\sin e} = \frac{\sin A}{\sin e}$

$\Rightarrow \frac{1}{\sqrt{2}} = \frac{\sin 30^o}{\sin e} \Rightarrow e = 45^o$

$\delta = e - r_2 = 45^o - 30^o = 15°$

123. (c) $\mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{A+A}{2}}{\sin\frac{A}{2}} = \frac{\sin A}{\sin\frac{A}{2}}$

$= \frac{2\sin\frac{A}{2}\cos\frac{A}{2}}{\sin\frac{A}{2}} = 2\cos\frac{A}{2}$

So, $\sqrt{3} = 2\cos\frac{A}{2} \Rightarrow \frac{\sqrt{3}}{2} = \cos\frac{A}{2} \Rightarrow A = 60°$

124. (d) Light from lamp or electric heater gives continuos spectrum.

125. (b) $A = 60^o, \delta_m = 30^o$ so $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\mu = \frac{\sin\left(\frac{60°+30°}{2}\right)}{\sin\left(\frac{60°}{2}\right)} = \frac{\sin 45°}{\sin 30°} = \sqrt{2}$

Also $\mu = \frac{1}{\sin C} \Rightarrow C = \sin^{-1}\left(\frac{1}{\mu}\right) \Rightarrow C = 45^o$

126. (a) $\delta \propto (\mu - 1)$

127. (c) In minimum deviation position $\angle i_1 = \angle i_2$ and $\angle r_1 = \angle r_2$.

128. (c) $\theta_{net} = \theta + \theta' = 0 \Rightarrow \omega d + \omega' d' = 0$

(θ = Angular dispersion = $\omega.\ \delta_y$)

129. (d) $A = 60^o, i = e = 45^o$ By $i + e = A + \delta$

$\Rightarrow\ 45 + 45 = 60 + \delta \Rightarrow \delta = 30^o$

130. (a) At the time of solar eclipse light received from chromosphere. The bright lines appear exactly at the places where dark lines were there. Hence at the time of solar eclipse continuos spectrum is obtained.

131. (a) In the morning or evening, the sun is at the horizon and refractive index in the atmosphere of the earth decreases with height. Due to this, the light reaching the earth's atmosphere, bends unequally, and the image of the sun get's distorted and it appears elliptical and larger.

132. (c) In Rainbow formation dispersion and TIR both takes place.

133. (a)

134. (c) Given $\delta_m = A$, as $\mu = \frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\Rightarrow \mu = \frac{\sin\left(\frac{A+A}{2}\right)}{\sin\left(\frac{A}{2}\right)} = 2\cos\frac{A}{2} \Rightarrow A = 2\cos^{-1}\left(\frac{\mu}{2}\right)$

135. (b) As the prisms Q and R are of the same material and have identical shape they combine to form a slab with parallel faces. Such a slab does not cause any deviation.

136. (c) Angle of prism is the angle between incident and emergent surfaces.

137. (a) $\mu = \frac{\sin i}{\sin\frac{A}{2}} \Rightarrow \sqrt{2} = \frac{\sin i}{\sin\left(\frac{60}{2}\right)} \Rightarrow i = 45^o$

138. (d) Convex lens, glass slab, prism and glass sphere they all disperse the light.

139. (c) For a lens $f_r - f_v = \omega f_y$

$\Rightarrow \omega = \frac{f_r - f_v}{f_y} = \frac{0.214 - 0.200}{0.205} = \frac{14}{205}$.

140. (b) $\omega = \frac{(\mu_v - \mu_R)}{(\mu_y - 1)} \Rightarrow \frac{(1.69 - 1.65)}{(1.66 - 1)} = 0.06$

141. (a) In minimum deviation condition $r = \frac{A}{2} = \frac{60}{2} = 30^o$

142. (a) $\omega = \frac{\mu_v - \mu_r}{\mu_y - 1} = \frac{1.67 - 1.63}{1.65 - 1} = 0.615$.

143. (b) In minimum deviation position refracted ray inside the prism is parallel to the base of the prism.

144. (b) Angle of refraction will be different, due to which red and green emerge from different points and will be parallel.

145. (a) Deviation $\delta \propto \mu \propto \frac{1}{\lambda}$

146. (a) $\mu = \frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}} = \frac{\sin\frac{60+38}{2}}{\sin\frac{60}{2}}$

$= \frac{\sin 49^o}{\sin 30^o} = \frac{0.7547}{0.5} = 1.5$.

147. (d) Using $\delta = i_1 + i_2 - A \Rightarrow 55 = 15 + i_2 - 60 \Rightarrow i_2 = 100^o$

148. (b) Sodium light gives emission spectrum having two yellow lines.

149. (c) Colour of the sky is highly scattered light (colour).

150. (a)

151. (c)

Human Eye and Lens Camera

1. (c) Man is suffering from hypermetropia. The hole works like a convex lens.

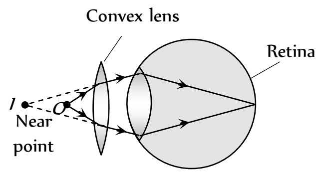
2. (a)

3. (b) In myopia, $u = \infty$, $v = d$ = distance of far point

By $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$, we get $f = -d$

Since f is negative, hence the lens used is concave.

4. (d) Hypermetropia is removed by convex lens.



5. (b)

6. (c) Cylindrical lens are used for removing astigmatism.

7. (b)

8. (a) Image formed at retina is real and inverted.

9. (d) Visible region decreases, so the depth of image will not be seen.

10. (a) $P = \frac{1}{f} = -\frac{1}{v} + \frac{1}{u} = -\frac{1}{100} + \frac{1}{25} = \frac{3}{100} = +3\ D$

11. (c) If eye is kept at a distance d, then $MP = \frac{L(D-d)}{f_0 f_e}$, MP decreases.

12. (c) For lens u = want's to see = ∞

v = can see = – 5 m

$\therefore$ From $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{-5} - \frac{1}{\infty} \Rightarrow f = -5\,m.$

13. (a) For improving near point, convex lens is required and for this convex lens

$u = -25\ cm,\ \ v = -75\ cm$

$\therefore \frac{1}{f} = \frac{1}{-75} - \frac{1}{-25} \Rightarrow f = \frac{75}{2}\,cm$

So power $P = \frac{100}{f} = \frac{100}{75/2} = +\frac{8}{3}D$

14. (b) In short sightedness, the focal length of eye lens decreases, so image is formed before retina.

15. (d) The image of object at infinity should be formed at 100 *cm* from the eye

$\frac{1}{f} = \frac{1}{\infty} - \frac{1}{100} = -\frac{1}{100}$

So the power $= \frac{-100}{100} = -1\ D$

(Distance is given in *cm* but $P = \frac{1}{f}$ in *metres*)

16. (b) For improving far point, concave lens is required and for this concave lens $u = \infty,\ v = -30\ cm$

So $\frac{1}{f} = \frac{1}{-30} - \frac{1}{\infty} \Rightarrow f = -30\ cm$

for near point $\frac{1}{-30} = \frac{1}{-15} - \frac{1}{u} \Rightarrow u = -30\ cm$

17. (c) For myopic eye f = – (defected far point)

$\Rightarrow f = -40\,cm \ \Rightarrow\ P = \frac{100}{-40} = -2.5\ D$

18. (c) For lens u = want's to see $= -60\,cm$

v = can see $= -10\,cm$

$\therefore \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{-10} - \frac{1}{(-60)} \Rightarrow f = -12\,cm$

19. (b) Focal length = – (Detected far point)

20. (c) In this case, for seeing distant objects the far point is 40 *cm.* Hence the required focal length is

$f = -d$ (distance of far point) = – 40 *cm*

Power $P = \frac{100}{f}\,cm = \frac{100}{-40} = -2.5\ D$

21. (b)

22. (a)

23. (a)

24. (a) For viewing far objects, concave lenses are used and for concave lens

u = wants to see $= -60\,cm$; v = can see $= -15\,cm$

so from $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow f = -20\,cm$.

25. (d)

26. (a) In short sightedness, the focal length of eye lens decreases and so the power of eye lens increases.

27. (d) Colour blindness is a genetic disease and still cannot be cured.

28. (c) Convexity to lens changes by the pressure applied by ciliary muscles.

29. (b) $f = -d = -100\ cm = -1\ m$

$\therefore P = \frac{1}{f} = \frac{1}{-1} = -1\ D$

30. (c) For correcting myopia, concave lens is used and for lens.

u = wants to see $= -50\,cm$

v = can see $= -25\,cm$

From $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{f} = \frac{1}{-25} - \frac{1}{(-50)} \Rightarrow f = -50\,cm$

So power $P = \frac{100}{f} = \frac{100}{-50} = -2\,D$

31. (c)

32. (c) $f = -d = -60\ cm$

$\therefore P = \frac{100}{f} = -\frac{100}{60} = -\frac{10}{6} = -1.66\ D$

33. (b) For correcting the near point, required focal length

$f = \frac{50 \times 25}{(50-25)} = 50\,cm$

So power $P = \frac{100}{50} = +2\,D$

For correcting the far point, required focal length

$f = -(\text{defected far point}) = -3\,m$

$\therefore P = -\frac{1}{3}D = -0.33\,D$

34. (b) Negative power is given, so defect of eye is nearsigntedness

Also defected far point $= -f = -\frac{1}{p} = -\frac{100}{(-2.5)} = 40\,cm$

35. (a) In myopia, eye ball may be elongated so, light rays focussed before the retina.

36. (c)

37. (d) $P = \frac{1}{f} = \frac{1}{-(\text{defected far point})} = -\frac{1}{2} = -0.5\,D$

38. (a) Resolving limit of eye is one minute (1′).

39. (d) Because for healthy eye image is always formed at retina.

40. (a) The defect is myopia (nearsightness)

As we know for myopic person f = – (defected far point)

$\Rightarrow$ Defected far point = – f = $-\frac{1}{P} = -\frac{1}{(-2)} = 0.5\,m$

= 50 *cm*

41. (b) Power of convex lens $P_1 = \frac{100}{40} = 2.5\ D$

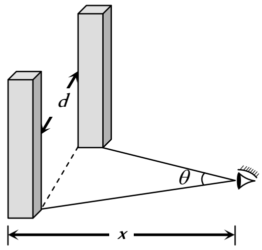
Power of concave lens $P_2 = -\frac{100}{25} = -4\ D$

Now $P = P_1 + P_2 = 2.5\ D - 4\ D = -1.5\ D$

42. (c)

43. (d)

44. (a) As limit of resolution of eye is $\left(\frac{1}{60}\right)^o$, the pillars will be seen distinctly if $\theta > \left(\frac{1}{60}\right)^o$



i.e., $\frac{d}{x} > \left(\frac{1}{60}\right) \times \frac{\pi}{180}$

$\Rightarrow d > \frac{\pi \times x}{60 \times 180}$

$\Rightarrow d > \frac{3.14 \times 11 \times 10^3}{60 \times 180} \Rightarrow d > 3.2\ m$

45. (b)

46. (b)

47. (d)

48. (d) f = – (defected far point) = – 20 *cm*

49. (b) Power of the lens given positive so defect is hypermetropia.

50. (b) Far point of the eye = focal length of the lens

$= \frac{100}{P} = \frac{100}{0.66} = 151\ cm$

51. (c) A bifocal lens consist of both convex or concave lenses with lower part is convex.

52. (a) For lens u = wants to see = – 30 *cm*

and v = can see = – 10 *cm*

$\therefore \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \frac{1}{-10} - \frac{1}{(-30)} \Rightarrow f = -15\,cm$

53. (a) Focal length = – (far point)

54. (c) For lens u = wants to see = – 12 *cm*

v = can see = – 3 *m*

$\therefore P = \frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow P = \frac{1}{-3} - \frac{1}{(-12)} = -\frac{1}{4}D$

55. (d) $I_1 D_1^2 t_1 = I_2 D_2^2 t_2$

Here D is constant and $I = \frac{L}{r^2}$

So $\frac{L_1}{r_1^2} \times t_1 = \frac{L_2}{r_2^2} \times t_2 \Rightarrow \frac{60}{(2)^2} \times 10 = \frac{120}{(4)^2} \times t \Rightarrow 20\ sec$

56. (a) $f = -40\ cm$ and $P = \frac{100}{-40} = -2.5\ D$

57. (a) Focal length of the lens $f = \frac{100}{3} cm$

By lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\Rightarrow \frac{1}{+100/3} = \frac{1}{v} - \frac{1}{-25} \Rightarrow v = -100\ cm = -1\ m$

58. (d) This is the defect of hypermetropia.

59. (a) For large objects, large image is formed on retina.

60. (d) $v = -15cm,\ u = -300cm,$

From lens formula $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

$\Rightarrow \frac{1}{f} = \frac{1}{-15} - \frac{1}{-300} = \frac{-19}{300} \Rightarrow f = \frac{-300}{19} = -15.8\ cm$

and power $P = \frac{100}{f} cm = \frac{-100 \times 19}{300} = -6.33\ D.$

61. (d) Time of exposure $\propto \frac{1}{(\text{Aperture})^2}$

62. (a) Light gathering power ∝ Area of lens aperture or d

63. (b) Time of exposure $\propto (f.\text{number})^2 \Rightarrow \frac{t_2}{t_1} = \left(\frac{5.6}{2.8}\right)^2 = 4$

$t_2 = 4\,t_1 = 4 \times \frac{1}{200} = \frac{1}{50}\ sec = 0.02\ sec.$

64. (d)

65. (a)

Microscope and Telescope

1. (c) By using $m_\infty = \frac{(L_\infty - f_o - f_e).D}{f_o f_e}$

$\Rightarrow 45 = \frac{(L_\infty - 1 - 5) \times 25}{1 \times 5} \Rightarrow L_\infty = 15\,cm.$

2. (b) For a compound microscope $m \propto \frac{1}{f_o f_e}$

3. (b) For a compound microscope $f_{objective} < f_{eye\ piece}$

4. (b) In microscope final image formed is enlarged which in turn increases the visual angle.

5. (b)

6. (d) Magnification of a compound microscope is given by $m = -\frac{v_o}{u_o} \times \frac{D}{u_e} \Rightarrow |m| = m_o \times m_e.$

7. (c) Magnifying power of a microscope $m \propto \frac{1}{f}$

Since $f_{\text{violet}} < f_{\text{red}};\ \therefore m_{\text{violet}} > m_{\text{red}}$

8. (a) $L_\infty = v_o + f_e \Rightarrow 14 = v_o + 5 \Rightarrow v_o = 9\ cm$

Magnifying power of microscope for relaxed eye

$m = \frac{v_o}{u_o}.\frac{D}{f_e}$ or $25 = \frac{9}{u_o}.\frac{25}{5}$ or $u_o = \frac{9}{5} = 1.8\ cm$

9. (b) $m_\infty = -\frac{v_o}{u_o} \times \frac{D}{f_e}$

From $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$\Rightarrow \frac{1}{(+1.2)} = \frac{1}{v_o} - \frac{1}{(-1.25)} \Rightarrow v_o = 30\ cm$

$\therefore |m_\infty| = \frac{30}{1.25} \times \frac{25}{3} = 200$

10. (b) For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$\Rightarrow \frac{1}{(+4)} = \frac{1}{v_o} - \frac{1}{(-4.5)} \Rightarrow v_o = 36\ cm$

$\therefore |m_D| = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = \frac{36}{4.5}\left(1 + \frac{24}{8}\right) = 32$

11. (a) For a microscope $|m| = \frac{v_o}{u_o} \times \frac{D}{u_e}$ and $L = v_o + u_e$

For a given microscope, with increase in L, u will increase and hence magnifying power (m) will decrease.

12. (b) In compound microscope objective forms real image while eye piece forms virtual image.

13. (b) $m = 1 + \frac{D}{f}$

Smaller the focal length, higher the magnifying power.

14. (a) In electron microscope, electron beam $(\lambda \approx 1 \mathring{A})$ is used so it's $R.P.$ is approx. 5000 times more than that of ordinary microscope $(\lambda \approx 5000 \mathring{A})$.

15. (c) If nothing is said then it is considered that final image is formed at infinite and $m_\infty = \frac{(L_\infty - f_o - f_e).D}{f_o f_e} \simeq \frac{LD}{f_0 f_e}$

$\Rightarrow 400 = \frac{20 \times 25}{0.5 \times f_e} \Rightarrow f_e = 2.5\ cm.$

16. (d) $m_{\max} = 1 + \frac{D}{f} = 1 + \frac{25}{2.5} = 11$.

17. (a)

18. (b) $m = 1 + \frac{D}{f} = 1 + DP$ (m increases with P)

19. (b)

20. (b) Like Gallilean telescope.

21. (a) $|m| \propto \frac{1}{f_o f_e}$

22. (d) A microscope consists of lens of small focal lengths. A telescope consists of objective lens of large focal length.

23. (c) $m = m_o \times m_e = 25 \times 6 = 150$

24. (a) When final image is formed at infinity,

length of the tube $= v_o + f_e$

$\Rightarrow 15 = v_o + 3 \Rightarrow v_o = 12\ cm$

For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$\Rightarrow \frac{1}{(+2)} = \frac{1}{(+12)} - \frac{1}{u_o} \Rightarrow u_o = -2.4\ cm$

25. (d) R.P. of microscope $= \frac{2\mu \sin\theta}{\lambda}$

26. (c) $m = m_o \times m_e \Rightarrow m = m_o \times \left(1 + \frac{D}{f_e}\right)$

$\Rightarrow 100 = 10 \times \left(1 + \frac{25}{f_e}\right) \Rightarrow f_e = \frac{25}{9}\ cm$

27. (c) A simple microscope is just a convex lens with object lying between optical centre and focus of the lens.

28. (d) In general, the simple microscope is used with image at D, hence

$m = 1 + \frac{D}{f} = 1 + \frac{25}{5} = 6$

29. (d)

30. (b) Resolving power of microscope $\propto \frac{1}{\lambda}$

31. (a) Cross wire arrangement is used to make measurements.

32. (d) $L = v_o + u_e = \frac{u_o f_o}{(u_o - f_o)} + \frac{f_e D}{f_e + D}$

$\Rightarrow L = \frac{2 \times 1.5}{(2 - 1.5)} + \frac{6.25 \times 25}{(6.25 + 25)} = 11\ cm$

33. (d) $m \simeq \frac{LD}{f_o f_e} \Rightarrow m = \frac{10 \times 25}{0.5 \times 1} = 500$.

34. (c) Intermediate image means the image formed by objective, which is real, inverted and enlarged.

35. (d) $m \propto \frac{1}{f_o f_e}$

36. (b) R.P. $\propto \frac{1}{\lambda}$; $\lambda_{Blue} < \lambda_{Red}$ so $(R.P.)_{Blue} > (R.P.)_{Red}$

37. (a) $m = 1 + \frac{D}{f} \Rightarrow 6 = 1 + \frac{25}{f} \Rightarrow f = 5\ cm = 0.05\ m$

38. (a) Resolving limit

$x \propto \lambda \Rightarrow \frac{x_1}{x_2} = \frac{\lambda_1}{\lambda_2} \Rightarrow \frac{0.1}{x_2} = \frac{6000}{4800} \Rightarrow x_2 = 0.08\ mm$

39. (b) $m = m_o \times m_e \Rightarrow 100 = 5 \times m_e \Rightarrow m_e = 20$

40. (d) $m \propto \frac{1}{f} \propto P$

41. (d) R.P. $\propto \frac{1}{\lambda} \Rightarrow \frac{(R.P.)_1}{(R.P.)_2} = \frac{\lambda_2}{\lambda_1} = \frac{5}{4}$

42. (b) Resolving limit (minimum separation) $\propto \lambda$

$\Rightarrow \frac{P_A}{P_B} = \frac{2000}{3000} \Rightarrow P_A < P_B$

43. (d) Similar to Q.No. 34

44. (a) For achromatic telescope objective lens, convergent of crown and divergent of flint is the best combination because $\mu_{crown} < \mu_{flint}$

45. (c)

46. (b) Magnifying power of telescope is $\frac{f_o}{f_e}$, so as $\frac{1}{f_e}$ increases, magnifying power increases.

47. (b) Since $m = \frac{f_o}{f_e}$

Also $m = \frac{\text{Anglesubtended by the image}}{\text{Anglesubtended by the object}}$

$\therefore \frac{f_o}{f_e} = \frac{\alpha}{\beta} \Rightarrow \alpha = \frac{f_o \times \beta}{f_e} = \frac{60 \times 2}{5} = 24^o$

48. (d) Resolving power $= \frac{d}{1.22\,\lambda} = \frac{0.1}{1.22 \times 6000 \times 10^{-10}}$

$\cong 1.36 \times 10^5\, radian$

49. (b) Because size of the aperture decreases.

50. (d) Resolving power $\propto$ aperture.

51. (c) Telescope is used to see the distant objects. More magnifying power means more nearer image.

52. (a) When the final image is at the least distance of distinct vision, then

$m = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = \frac{200}{5}\left(1 + \frac{5}{25}\right) = \frac{200 \times 6}{5 \times 5} = -48$

When the final image is at infinity, then

$m = \frac{-f_o}{f_e} = \frac{200}{5} = -40$

53. (a) In terrestrial telescope erecting lens absorbs a part of light, so less constant image. But binocular lens gives the proper three dimensional image.

54. (a) By formula $m = \frac{f_o}{f_e}$

55. (b) In telescope $f_o >> f_e$ as compared to microscope.

56. (a) Because magnification in this case becomes reciprocal of initial magnification.

57. (d) $m = \frac{f_o}{f_e} \Rightarrow \frac{80}{f_e} = 20 \Rightarrow f_e = 4\ cm$

Hence length of terrestrial telescope

$= f_o + f_e + 4f = 80 + 4 + 4 \times 20 = 164\ cm$

58. (d) In this case $|m| = \frac{f_o}{f_e} = 5$ .... (i)

and length of telescope $= f_o + f_e = 36$ .... (ii)

Solving (i) and (ii), we get $f_e = 6$ cm, $f_o = 30\,cm$.

59. (c) $|m| = \frac{f_o}{f_e} = \frac{180}{6} = 30$

60. (c) Same as Q. No. 58.

61. (c) $f_o = \frac{1}{1.25} = 0.8\,m$ and $f_e = \frac{1}{-20} = -0.05\,m$

$\therefore |L_\infty| = |f_o| - |f_e| = 0.8 - 0.05 = 0.75\,m = 75\,cm$

and $|m_\infty| = \frac{f_o}{f_e} = \frac{0.8}{0.05} = 16$

62. (a) For greater aperture of lens, light passing through lens is more and so intensity of image increases.

63. (b)

64. (a) Same as Q. No. 58.

65. (b) $m = \frac{f_o}{f_e} = \frac{60}{10} = 6$.

66. (a) $f_o + f_e = 54$ and $\frac{f_o}{f_e} = m = 8 \Rightarrow f_o = 8f_e$

$\Rightarrow 8f_e + f_e = 54 \Rightarrow f_e = \frac{54}{9} = 6$

$\Rightarrow f_o = 8f_e = 8 \times 6 = 48$

67. (a) $f_o - f_e = 9\ cm$ and $f_e = f_o - 9 = 15 - 9 = 6\ cm$

$\Rightarrow m = \frac{f_o}{f_e} = \frac{15}{6} = 2.5$

68. (c) $f_o + f_e = 80$ and $\frac{f_o}{f_e} = 19 \Rightarrow f_o = 76$ and $f_e = 4$ cm.

69. (a)

70. (b) $R.P. \propto \frac{D}{\lambda}$

71. (c) $m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right)$

72. (b) Resolving power $\propto$ Aperture

73. (a) If final image is formed at infinity, then the distance between the two lenses of telescope is equal to length of tube $= f_o + f_e = 0.3 + 0.05 = 0.35\ m$

74. (a) Limit of resolution $= \frac{1.22\,\lambda}{a} \times \frac{180}{\pi}$ (in degree)

$= \left(\frac{1.22 \times (6000 \times 10^{-10})}{5} \times \frac{180}{\pi}\right)^o = 0.03\ sec$

75. (b) Final image formed by astronomical telescope is inverted not erect.

76. (d)

77. (c)

78. (b) For normal vision (relaxed eye), the image is formed at infinity. Hence the magnifying power of Gallilean telescope $= \frac{f_o}{f_e} = \frac{200}{2} = 100$.

79. (a) $m = -\frac{f_o}{f_e} = -\frac{100}{2} = -50$.

80. (c)

81. (b) Magnifying power of astronomical telescope

$m = -\frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = -\frac{200}{5}\left(1 + \frac{5}{25}\right) = -48$.

82. (b) $m \propto \frac{1}{f_e}$

83. (b) $f_0 > f_e$ for telescope.

84. (a) $m = -\frac{f_0}{f_e}$.

85. (b) $|m| = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = \frac{100}{5}\left(1 + \frac{5}{25}\right) = 24$

86. (a, b, c, d)

87. (a) $|m| = \frac{f_o}{f_e} = 20$ and $L = f_o + f_e = 105 \Rightarrow f_o = 100\ cm$

88. (a) Total length $L = f_o + f_e$ and both lenses are convex.

89. (b) $L = f_o + f_e = 44$ and $|m| = \frac{f_o}{f_e} = 10$

This gives $f_o = 40\ cm$

90. (c) In case of a telescope if object and final image are at infinity then $m = \frac{f_o}{f_e}$

91. (b) Three lenses are $\to$ objective, eye piece and erecting lens.

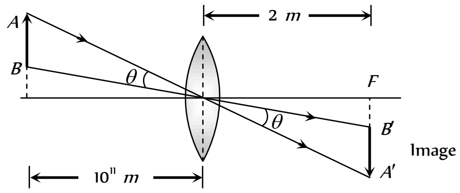
92. (d) Length of the telescope when final image is formed at least distance of distinct vision is

$$L = f_o + u_e = f_o + \frac{f_e D}{f_e + D} = 50 + \frac{5 \times 25}{5 + 25} = \frac{325}{6}\ cm$$

93. (c) $\frac{\beta}{\alpha} = \frac{f_o}{f_e} \Rightarrow \frac{\beta}{0.5^o} = \frac{100}{2} \Rightarrow \beta = 25^o$

94. (d)

95. (c) $\theta = \frac{AB}{10^{11}} = \frac{A'B'}{2} \Rightarrow A'B' = \frac{2 \times 1.4 \times 10^9}{10^{11}} = 2.8\ cm$



96. (c) $m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) \Rightarrow m = \frac{90}{6}\left(1 + \frac{6}{30}\right) \Rightarrow m = 18$

97. (d) Resolving power of telescope $= \frac{d}{1.22\ \lambda}$

98. (a) For largest magnification focal length of eye lens should be least.

99. (b) $m = \frac{f_o}{f_e}\left(1 + \frac{f_e}{D}\right) = \frac{150}{6}\left(1 + \frac{6}{25}\right) = 30$.

100. (d) To make telescope of higher magnifying power, f_o should be large and f_e should be least.

101. (c) $f_o = 50\ cm,\ f_e = 5\ cm,\ D = 25\ cm$ and $u_o = 200\ cm$.

Separation between the objective and the eye lens is

$$L = \frac{u_o f_o}{(u_o - f_o)} + \frac{f_e D}{(f_e + D)} = \frac{200 \times 50}{(200 - 50)} + \frac{5 \times 25}{(5 + 25)} = 71\ cm$$

102. (b) Resolving power $= \frac{d}{1.22\ \lambda} = \frac{1.22}{1.22 \times 5000 \times 10^{-10}} = 2 \times 10^6$

103. (a)

104. (b) By using $m = \frac{f_o}{f_e} \Rightarrow f_e = \frac{100}{50} = 2\ cm$

Also $L = f_o - f_e = 100 - 2 = 98\ cm$

105. (b) $m = \frac{f_o}{f_e} \Rightarrow 10 = \frac{f_o}{20} \Rightarrow f_o = 200\ cm$

106. (c) Minimum angular separation $\Delta\theta = \frac{1}{R.P.} = \frac{1.22\ \lambda}{d}$

$$= \frac{1.22 \times 5000 \times 10^{-10}}{2} = 0.3 \times 10^{-6}\ rad$$

107. (c) $m = 1 + \frac{D}{f_e} \Rightarrow 10 = 1 + \frac{25}{f_e} \Rightarrow f_e = \frac{25}{9} \simeq 25\ mm$

108. (a) $\frac{D}{F}$ or $\frac{25}{F}$

109. (c) $L = v_0 + u_e$ and $v_0 >> f_0,\ u_e \simeq f_e$

110. (c) Magnification will be done by compound microscope only when $f_o < f_e$

111. (d) Angular resolution $d\theta = \frac{1.22\ \lambda}{a}$

$$= \frac{1.22 \times 5000 \times 10 \times 10^{-10}}{10 \times 10^{-2}} = 6.1 \times 10^{-6}\ rad.$$

112. (a) Resolving power $= \frac{a}{1.22\ \lambda}$

113. (d) $M = \frac{f_o}{f_e} = \frac{P_e}{P_o} = \frac{20}{0.5} = 40$.

114. (a) Radio, waves can pass through dust, clouds, fog, etc, in a radio, telescope. It can detect very faint radio signal due to enormous size of its reflector. So it can be used at night and even in cloudy weather.

115. (a) Resolving limit

$$d\theta = \frac{1.22\ \lambda}{a} = \frac{1.22 \times 4538 \times 10^{-10}}{1} = 5.54 \times 10^{-7}\ rad.$$

116. (a) Magnification of objective lens $m = \frac{I}{O} = \frac{v_0}{u_0} = \frac{f_0}{u_0}$

$\Rightarrow \frac{I}{50} = \frac{200 \times 10^{-2}}{2 \times 10^3} \Rightarrow I = 5 \times 10^{-2}\ m = 5\ cm.$

117. (b) $m = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = m_o\left(1 + \frac{D}{f_e}\right)$

$\Rightarrow 30 = m_o\left(1 + \frac{25}{5}\right) = m_0 \times 6 \Rightarrow m_o = 5$.

118. (a)

119. (a) $m = \frac{f_o}{f_e} \Rightarrow \frac{100}{f_e} = 50 \Rightarrow f_e = 2\ cm$

Normal distance $f_o - f_e = 100 - 2 = 98\ cm.$

120. (a) For objective lens $\frac{1}{f_o} = \frac{1}{v_o} - \frac{1}{u_o}$

$\Rightarrow \frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o} = \frac{1}{4} + \frac{1}{-5} = \frac{1}{20} \Rightarrow v_o = 20cm$

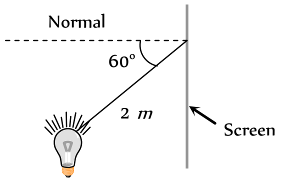
Now $M = \frac{v_o}{u_o}\left(1 + \frac{D}{f_e}\right) = \frac{20}{5}\left(1 + \frac{20}{10}\right) = 12.$

Photometry

1. (d) Luminous flux $= 4\pi\ L = 4 \times 3.14 \times 42 = 528$ *Lumen*

Power of lamp $= \frac{\text{Luminous flux}}{\text{Luminous efficiency}} = \frac{528}{2} = 264\ W$

2. (b) $I = \dfrac{L\cos\theta}{r^2}$



$\Rightarrow L = \dfrac{I \times r^2}{\cos\theta}$

$= \dfrac{5\times10^{-4}\times10^4\times2^2}{\cos 60°} = 40\ Candela$

3. (d) $I = \dfrac{L}{r^2} \Rightarrow \dfrac{dI}{I} = -\dfrac{2dr}{r}$ ($\because$ L = constant)

$\Rightarrow \dfrac{dI}{I}\times100 = -\dfrac{2\times dr}{r}\times100 = -2\times1 = -2\%$

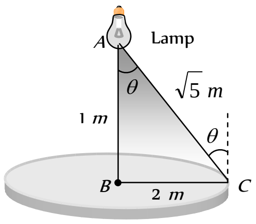
4. (c) For equal fogging $I_2 \times t_2 = I_1 \times t_1$

$\Rightarrow \dfrac{L_2}{r_2^2}\times t_2 = \dfrac{L_1}{r_1^2}\times t_1 \Rightarrow \dfrac{16}{4}\times t_2 = \dfrac{20}{1}\times10$

$\Rightarrow t_2 = 50\ \text{sec}.$

5. (d) The illuminance at B

$I_B = \dfrac{L}{1^2}$ ....(i)



and illuminance at point C

$I_C = \dfrac{L\cos\theta}{(\sqrt{5})^2} = \dfrac{L}{(\sqrt{5})^2}\times\dfrac{1}{\sqrt{5}}$

$\Rightarrow I_C = \dfrac{L}{5\sqrt{5}}$ ...... (ii)

From equation (i) and (ii) $I_B = 5\sqrt{5}\ I_0$

6. (b) $I \propto \dfrac{1}{r^2}$ so,

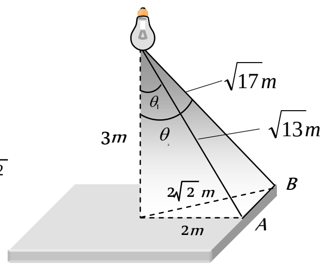
$\dfrac{\text{Illuminance on slide}}{\text{Illuminance on screen}} = \dfrac{(\text{Length of image on screen})^2}{(\text{Length of object on slide})^2}$

$= \left(\dfrac{3.5\ m}{35\ mm}\right)^2 = 10^4 : 1$

7. (a) The illuminance at A is

$I_A = \dfrac{L}{(\sqrt{13})^2}\times\cos\theta_1 = \dfrac{L}{13}\times\dfrac{3}{\sqrt{13}} = \dfrac{3L}{(13)^{3/2}}$

The illuminance at B is



$I_B = \dfrac{L}{(\sqrt{17})^2}\times\cos\theta_2$

$= \dfrac{L}{17}\times\dfrac{3}{\sqrt{17}} = \dfrac{3L}{(17)^{3/2}}$

$\therefore \dfrac{I_A}{I_B} = \left(\dfrac{17}{13}\right)^{3/2}$

8. (b)

9. (c) Luminous intensity $L = \dfrac{\phi}{4\pi} \Rightarrow 1 = \dfrac{\phi}{4\pi} \Rightarrow \phi = 4\pi$.

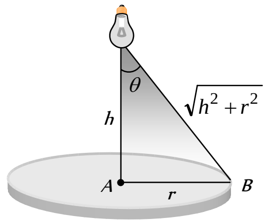
10. (c) $\phi = 4\pi L = 4\times3.14\times100 = 1256$ *lumen.*

11. (a) $I = \dfrac{L}{r^2} \Rightarrow L = I.r^2 = 22\times2^2 = 100$

Now $\phi = 4\pi L = 4\times3.14\times100 = 1256$ *lumen.*

12. (c) Illuminance at A,

$I_A = \dfrac{L}{h^2}$



Illuminance at B,

$I_B = \dfrac{L}{\sqrt{(h^2+r^2)^2}}\cos\theta$

$= \dfrac{Lh}{(r^2+h^2)^{3/2}}$

$\therefore \dfrac{I_A}{I_B} = \left(1+\dfrac{r^2}{h^2}\right)^{3/2} = \left(1+\dfrac{8^2}{8^2}\right)^{3/2} = 2^{3/2} = 2\sqrt{2} : 1$

13. (c) $I = \dfrac{L}{r^2}$

14. (c) Efficiency of light source

$\eta = \dfrac{\phi}{p}$ ..... (i)

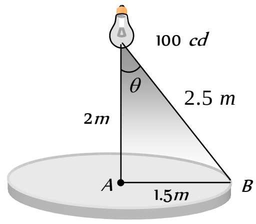
and $L = \dfrac{\phi}{4\pi}$ ..... (ii)

From equation (i) and (ii)

$\Rightarrow p = \dfrac{4\pi L}{\eta} = \dfrac{4\pi\times35}{5} \approx 88\ W$.

15. (a) Case I

$I_A = \dfrac{100}{2^2} = 25\ cd$

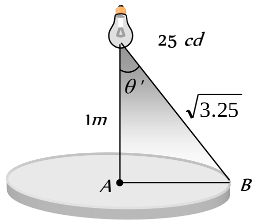


and $I_B = \dfrac{100}{(2.5)^2}\cos\theta$

$= \dfrac{100}{2.5^2}\times\dfrac{2}{2.5} = \dfrac{200}{(2.5)^3}$

Case II,

$I'_B = X\,I_B = \dfrac{25}{(3.25)^{3/2}}$



so $\dfrac{I'_B}{I_B} = \dfrac{25}{200}\times\dfrac{(2.5)^3}{(3.25)^{3/2}}$

$\Rightarrow X = 1/3$

16. (a) $I \propto \dfrac{1}{r^2} \Rightarrow \dfrac{I_2}{I_1} = \dfrac{r_1^2}{r_2^2} = \dfrac{60^2}{180^2} = \dfrac{1}{9}$

17. (b)

18. (b) $I \propto \dfrac{1}{r^2}$

19. (c) To develop a print a fix amount of energy is required. Total light energy incident on photo print

$I\times A\,t = \dfrac{L}{r^2}A\,t \Rightarrow \dfrac{L_1}{r_1^2}A_1t_1 = \dfrac{L_2}{r_2^2}A_2t_2$

$\Rightarrow \dfrac{t_1}{r_1^2} = \dfrac{t_2}{r_2^2}$ ($\because L_1 = L_2$ and $A_1 = A_2$)

$\Rightarrow t_2 = \frac{r_2^2}{r_1^2}.t_1 = \left(\frac{0.40}{0.25}\right) 2\times 5 = 12.8$ *sec.*

20. (b) $\frac{I_{centre}}{I_{edge}} = \frac{(r^2+h^2)^{3/2}}{h^3} = \frac{\left(1+\frac{1}{4}\right)^{3/2}}{1^3} = \left(\frac{5}{4}\right)^{3/2}$

21. (c) $I = \frac{L}{r^2} \Rightarrow \frac{L_1}{r_1^2} = \frac{L_2}{r_2^2}$ (I is same)

$\Rightarrow \frac{L_1}{L_2} = \frac{r_1^2}{r_2^2} = \left(\frac{1}{10}\right)^2 = 1:100$.

22. (c) $I_\theta = I_o \cos\theta = I_o \cos 60^o = \frac{I_o}{2}$

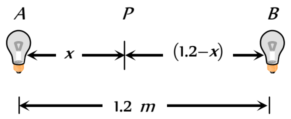
23. (a)

24. (b) $\phi = 4\pi L = 200\ \pi$ *lumen.*

so $I = \frac{\phi}{100\,A} = \frac{200\,\pi}{100\times\pi r^2} = \frac{2}{(0.1)^2} = 200$ *lux.*

25. (b,c) According to the problem

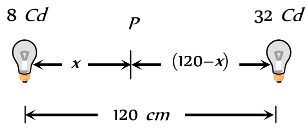
$\frac{I_A}{x^2} = 4\frac{I_B}{(1.2-x)^2}$



$\Rightarrow \frac{1}{x^2} = \frac{4}{(1.2-x)^2}$

$\Rightarrow \frac{1}{x} = \frac{2}{1.2-x} \Rightarrow x = 0.4\,m$ and $1.2 - x = 0.8\,m$.

26. (c) $I = \frac{L}{r^2} \Rightarrow \frac{L_1}{L_2} = \frac{r_1^2}{r_2^2}$



or $\frac{8}{x^2} = \frac{32}{(120-x)^2}$

Solving it we get $x = 40\,cm$.

27. (d) $\frac{I_{center}}{I_{edge}} = \frac{(r^2+h^2)^{3/2}}{h^3}$

$\Rightarrow 8 = \frac{(r^2+h^2)^{3/2}}{h^3} \Rightarrow 2h = (r^2+h^2)^{1/2}$

$\Rightarrow 4h^2 = r^2 + h^2 \Rightarrow 3h^2 = r^2 \Rightarrow h = \frac{r}{\sqrt{3}}$

28. (b) $I = \frac{L}{r^2} = \frac{100}{5^2} = 4$ *Lux.*

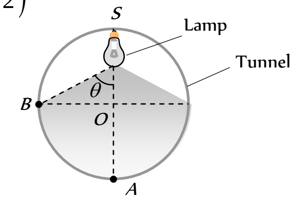
29. (d) $I_1 = \frac{L}{r_1^2} = \frac{L}{1600}$ and $I_2 = \frac{L}{2500}$

$\therefore$ % decease in illuminance

$= \frac{I_1 - I_2}{I_1}\times 100 = \left(1 - \frac{1600}{2500}\right)\times 100 = \frac{900}{2500}\times 100 = 36$

30. (b)

31. (d) $I_A = \frac{L}{(2r)^2}$ and $I_B = \frac{L}{\left(r\sqrt{2}\right)^2}\cos\theta$



$= \frac{L}{2r^2}.\frac{r}{r\sqrt{2}} = \frac{L}{2\sqrt{2}\,r^2}$

$\therefore \frac{I_A}{I_B} = \frac{2\sqrt{2}}{4} = \frac{1}{\sqrt{2}}$

32. (a) $I = \frac{L}{r^2} \Rightarrow L = 1.57\times 10^5 \times (1.5\times 10^{11})^2 = 3.53\times 10^{27}$ *Cd*

33. (d) $\phi = 4\pi L = 4\times 3.14\times 3.53\times 10^{27} = 4.43\times 10^{28}$ *lumen.*

34. (d) $\phi = \frac{3}{1.5\times 10^{-3}}\times 0.685 = 1.37\times 10^3$ *lumen*

35. (a) $\phi_{surface} = \frac{3000}{6} = 500$ *lumen.*

36. (c) Rotation of area about incident light doesn't change the inclination of the light ray on the area.

37. (c) $I = \frac{Lh}{r^3}$

38. (d) By the symmetry of the rays and location of the points.

39. (d) If η is the luminous efficiency of the bulb then.

luminous flux by 120 *watt* at 555 *nm* $= \eta\times 120$

Let bulb of P watt at 600 *nm* produces the same luminous flux as by 120 *watt* at 555 *nm* then

$\eta\times 120 = \eta P\times 0.6 \Rightarrow P = \frac{120}{0.6} = 200$ *watt.*

40. (c) Illuminance produce by the sun $= \frac{L}{(1.5\times 10^{11})^2}$

Illuminance produce by the bulb $= \frac{10000}{(0.3)^2}$

According to problem $\frac{L}{(1.5\times 10^{11})^2} = \frac{10000}{(0.3)^2}$

$\Rightarrow L = \frac{2.25\times 10^{22}\times 10^4}{9\times 10^{-2}} = 25\times 10^{26}$ *Cd*

41. (c) $I_1 = \frac{L}{r_1^2} = \frac{L}{16}$ and $I_2 = \frac{L}{r_2^2} = \frac{L}{9}$

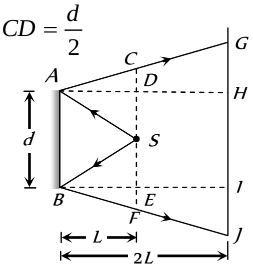
% increase in illuminance

$= \frac{I_2 - I_1}{I}\times 100 = \left(\frac{16}{9} - 1\right)\times 100 \approx 78\%$

Critical Thinking Questions

1. (d) According to the following ray diagram $HI = AB = d$

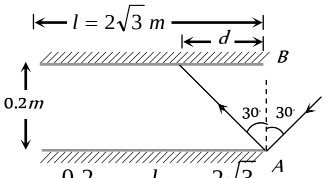
and $DS = CD = \frac{d}{2}$



$\because AH = 2AD \Rightarrow GH = 2CD = \dfrac{2d}{2} = d$

Similarly $IJ = d$ so $GJ = GH + HI + IJ = d + d + d = 3d$

2. (b) From the following ray diagram

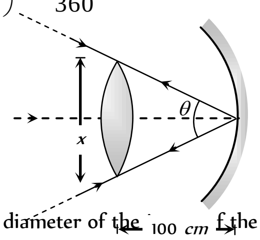


$d = 0.2\tan 30° = \dfrac{0.2}{\sqrt{3}} \Rightarrow \dfrac{l}{d} = \dfrac{2\sqrt{3}}{0.2/\sqrt{3}} = 30$

Therefore maximum number of reflections are 30.

3. (b) The angle subtended by the image of the sun at the mirror

$= 30' = \left(\dfrac{1}{2}\right)^{o} = \dfrac{\pi}{360}\ rad$



If x be the diameter of the image of the sun, then

$\dfrac{\text{Arc}}{\text{Radius}} = \dfrac{x}{100} = \dfrac{1}{2}.\dfrac{2\pi}{360} = \dfrac{\pi}{360} \Rightarrow x = \dfrac{100\pi}{360} = 0.87\ cm$

4. (a) $m = \dfrac{I}{O} = \dfrac{f}{u-f} = \dfrac{10}{25-10} = \dfrac{10}{15} = \dfrac{2}{3}$

$m^2 = \dfrac{A_i}{A_o} \Rightarrow A_i = m^2 \times A_o = \left(\dfrac{2}{3}\right)^2 \times (3)^2 = 4\ cm^2$

5. (d) From mirror formula $\dfrac{1}{f} = \dfrac{1}{v} + \dfrac{1}{u}$ .....(i)

Differentiating equation (i), we obtain

$0 = -\dfrac{1}{v^2}dv - \dfrac{1}{u^2}du \Rightarrow dv = -\left(\dfrac{v}{u}\right)^2 du$ .....(ii)

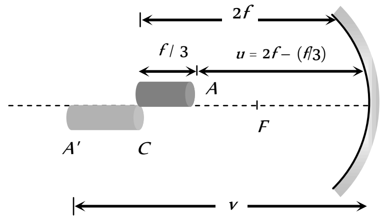
Also from equation (i) $\dfrac{v}{u} = \dfrac{f}{u-f}$ .....(iii)

From equation (ii) and (iii) we get $dv = -\left(\dfrac{f}{u-f}\right)^2 . l$

Therefore size of image is $\left(\dfrac{f}{u-f}\right)^2 l.$

6. (b) If end A of rod acts an object for mirror then it's image will be A' and if

$$u = 2f - \frac{f}{3} = \frac{5f}{3} \text{ so by using } \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

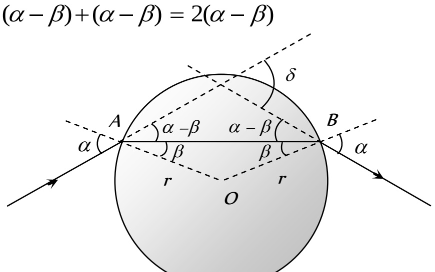


$$\Rightarrow \frac{1}{-f} = \frac{1}{v} + \frac{1}{\frac{-5f}{3}} \Rightarrow v = -\frac{5}{2}f$$

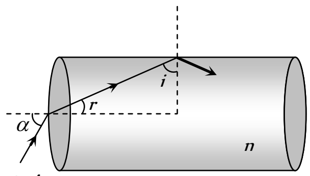
$$\therefore \text{ Length of image } = \frac{5}{2}f - 2f = \frac{f}{2}$$

7. (b) From the following ray diagram it is clear that

$$\delta = (\alpha - \beta) + (\alpha - \beta) = 2(\alpha - \beta)$$



8. (a) From the following figure



$r + i = 90° \Rightarrow i = 90° - r$

For ray not to emerge from curved surface $i > C$

$\Rightarrow \sin i > \sin C \Rightarrow \sin(90° - r) > \sin C \Rightarrow \cos r > \sin C$

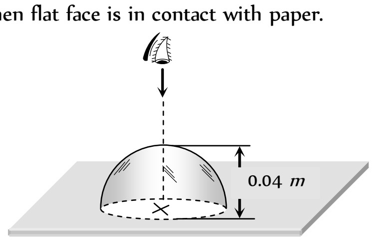
$$\Rightarrow \sqrt{1 - \sin^2 r} > \frac{1}{n} \qquad \left\{\because \sin C = \frac{1}{n}\right\}$$

$$\Rightarrow 1 - \frac{\sin^2\alpha}{n^2} > \frac{1}{n^2} \Rightarrow 1 > \frac{1}{n^2}(1 + \sin^2\alpha)$$

$$\Rightarrow n^2 > 1 + \sin^2\alpha \Rightarrow n > \sqrt{2} \qquad \{\sin i \to 1\}$$

$\Rightarrow$ Least value $= \sqrt{2}$

9. (b) **Case (i)** When flat face is in contact with paper.



$$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \text{ where}$$

μ_2 = *R. I.* of medium in which light rays are going = 1

μ_1 = *R. I.* of medium from which light rays are coming = 1.6

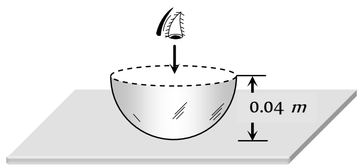
u = distance of object from curved surface = – 0.04 m

R = – 0.04 m.

$$\therefore \frac{1}{v} - \frac{1.6}{(-0.04)} = \frac{1 - 1.6}{(-0.04)} \Rightarrow v = -0.04\, m$$

i.e. the image will be formed at the same position of cross.

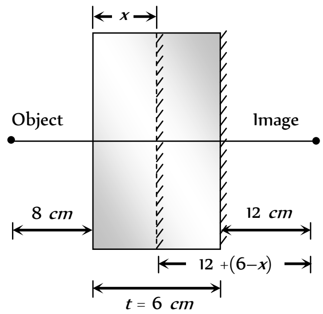
Case (ii) When curved face is in contact with paper



$$\mu = \frac{\text{Real depth } (h)}{\text{Apparent depth } (h')}$$

$$\Rightarrow 1.6 = \frac{0.04}{h'} \Rightarrow h' = 0.025\, m \qquad \text{(Below the flat face)}$$

10. (c) Let x be the apparent position of the silvered surface.

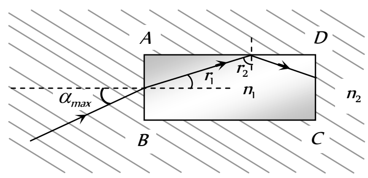


According to property of plane mirror

$x + 8 = 12 + 6 - x \Rightarrow x = 5$ cm

$$\text{Also } \mu = \frac{t}{x} \Rightarrow \mu = \frac{6}{5} = 1.2$$

11. (a) Ray comes out from CD, means rays after refraction from AB get, total internally reflected at AD



$$\frac{n_1}{n_2} = \frac{\sin\alpha_{\max}}{\sin r_1} \Rightarrow \alpha_{\max} = \sin^{-1}\left[\frac{n_1}{n_2}\sin r_1\right] \qquad \text{...(i)}$$

$$\text{Also } r_1 + r_2 = 90^o \Rightarrow r_1 = 90 - r_2 = 90 - C$$

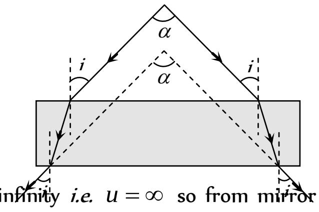
$$\Rightarrow r_1 = 90 - \sin^{-1}\left(\frac{1}{{}_2\mu_1}\right) \Rightarrow r_1 = 90 - \sin^{-1}\left(\frac{n_2}{n_1}\right) \qquad \text{...(ii)}$$

Hence from equation (i) and (ii)

$$\alpha_{\max} = \sin^{-1}\left[\frac{n_1}{n_2}\sin\left\{90 - \sin^{-1}\frac{n_2}{n_1}\right\}\right]$$

$$= \sin^{-1}\left[\frac{n_1}{n_2}\cos\left(\sin^{-1}\frac{n_2}{n_1}\right)\right]$$

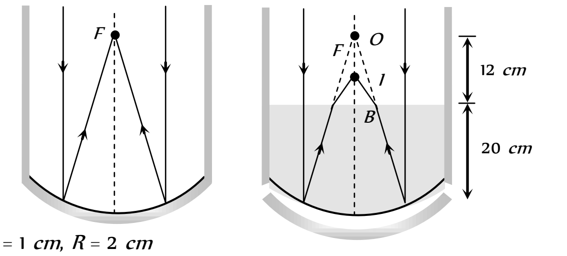
12. (b) Since rays after passing through the glass slab just suffer lateral displacement hence we have angle between the emergent rays as α.



13. (b) Sun is at infinity *i.e.* $u = \infty$ so from mirror formula we have $\frac{1}{f} = \frac{1}{-32} + \frac{1}{(-\infty)} \Rightarrow f = -32\ cm$.

When water is filled in the tank upto a height of 20 *cm*, the image formed by the mirror will act as virtual object for water surface. Which will form it's image at I such that $\frac{\text{Actual height}}{\text{Apperant height}} = \frac{\mu_w}{\mu_a}$ *i.e.* $\frac{BO}{BI} = \frac{4/3}{1}$

$\Rightarrow BI = BO \times \frac{3}{4} = 12 \times \frac{3}{4} = 9\ cm$.



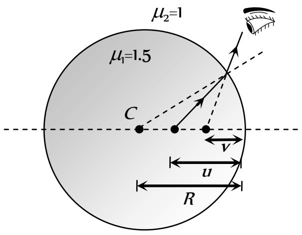
14. (a) $v = 1\ cm,\ R = 2\ cm$

By using

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$\frac{1}{-1} - \frac{1.5}{u} = \frac{1 - 1.5}{-2}$

$\Rightarrow u = -1.2\,cm$

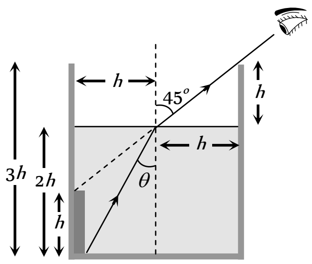


15. (b) The line of sight of the observer remains constant, making an angle of 45° with the normal.

$\sin\theta = \frac{h}{\sqrt{h^2 + (2h)^2}} = \frac{1}{\sqrt{5}}$

$\mu = \frac{\sin 45^o}{\sin\theta}$

$= \frac{1/\sqrt{2}}{1/\sqrt{5}} = \sqrt{\left(\frac{5}{2}\right)}$



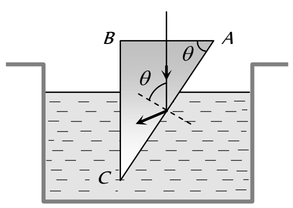
16. (b) For *glass-water* interface ${}_g\mu_w = \frac{\sin i}{\sin r}$ ...(i)

For *water-air* interface ${}_w\mu_a = \frac{\sin r}{\sin 90^o}$ ...(ii)

$\Rightarrow {}_g\mu_w \times {}_w\mu_a = \frac{\sin i}{\sin r} \times \frac{\sin r}{\sin 90^o} = \sin i$

$\Rightarrow \frac{\mu_w}{\mu_g} \times \frac{\mu_a}{\mu_w} = \sin i \Rightarrow \mu_g = \frac{1}{\sin i}$

17. (a) For TIR at AC



$\theta > C$

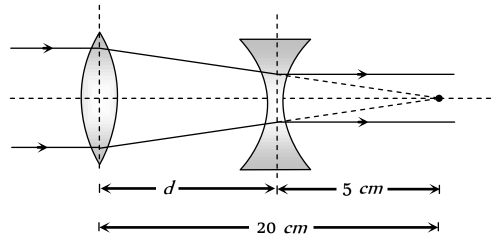
$\Rightarrow \sin\theta \geq \sin C$

$\Rightarrow \sin\theta \geq \frac{1}{{}_w\mu_g}$

$\Rightarrow \sin\theta \geq \frac{\mu_w}{\mu_g} \Rightarrow \sin\theta \geq \frac{8}{9}$

18. (b) From figure it is clear that separation between lenses

$d = 20 - 5 = 15\,cm$



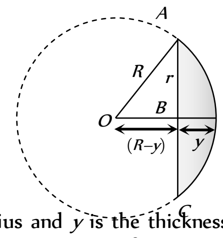
19. (c) According to lens formula $\frac{1}{f} = (\mu - 1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

The lens is plano-convex *i.e.*, $R_1 = R$ and $R_2 = \infty$

Hence $\frac{1}{f} = \frac{\mu - 1}{R} \Rightarrow f = \frac{R}{\mu - 1}$

Speed of light in medium of lens $v = 2 \times 10^8\ m/s$

$\Rightarrow \mu = \frac{c}{v} = \frac{3 \times 10^8}{2 \times 10^8} = \frac{3}{2} = 1.5$



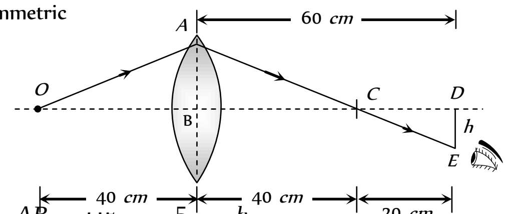
If r is the radius and y is the thickness of lens (at the centre), the radius of curvature R of its curved surface in accordance with the figure is given by

$R^2 = r^2 + (R - y)^2 \Rightarrow r^2 + y^2 - 2Ry = 0$

Neglecting y^2; we get $R = \frac{r^2}{2y} = \frac{(6/2)^2}{2 \times 0.3} = 15\ cm$

Hence $f = \frac{15}{1.5 - 1} = 30\ cm$

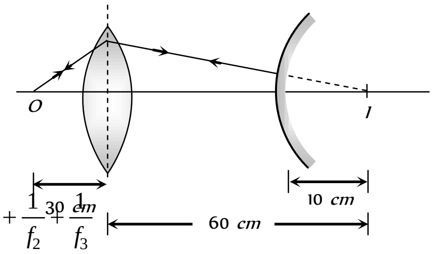
20. (c) In the following ray diagram $\Delta's$, ABC and CDE are symmetric



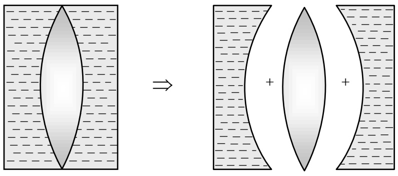
So, $\frac{AB}{BC} = \frac{DE}{CD} \Rightarrow \frac{5}{40} = \frac{h}{20} \Rightarrow h = 2.5\ cm$

21. (c) For lens $u = 30\,cm,\ f = 20\,cm$, hence by using $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{+20} = \frac{1}{v} - \frac{1}{-30} \Rightarrow v = 60\ cm$

The final image will coincide the object, if light ray falls normally on convex mirror as shown. From figure it is seen clear that separation between lens and mirror is 60 – 10 = 50 *cm*.



22. (d) $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}$



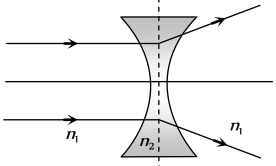
$$\frac{1}{f_1}=(1.6-1)\left(\frac{1}{\infty}-\frac{1}{20}\right)=-\frac{0.6}{20}=-\frac{3}{100} \quad \text{...(i)}$$

$$\frac{1}{f_2}=(1.5-1)\left(\frac{1}{20}-\frac{1}{-20}\right)=\frac{1}{20} \quad \text{...(ii)}$$

$$\frac{1}{f_3}=(1.6-1)\left(\frac{1}{-20}-\frac{1}{\infty}\right)=-\frac{3}{100} \quad \text{...(iii)}$$

$$\Rightarrow \frac{1}{F}=-\frac{3}{100}+\frac{1}{20}-\frac{3}{100}\Rightarrow F=-100\ cm$$

23. (d) $\frac{1}{f}=\left(\frac{n_2}{n_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ where n_2 and n_1 are the refractive indices of the material of the lens and of the surroundings respectively. For a double concave lens, $\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ is always negative.



Hence f is negative only when $n_2>n_1$

24. (a, d) For a lens $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}\Rightarrow\frac{1}{v}=\frac{1}{u}+\frac{1}{f}$ .....(i)

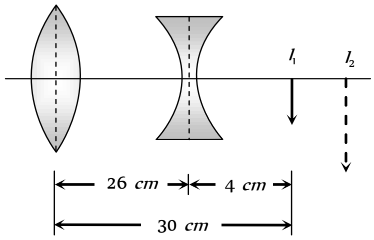
Also $m=\frac{f-v}{f}=1-\frac{v}{f}\Rightarrow m=\left(-\frac{1}{f}\right)v+1$ ....(ii)

On comparing equations (i) and (ii) with $y=mx+c$.

It is clear that relationship between $\frac{1}{v}$ *vs* $\frac{1}{u}$ and *m vs v* is linear.

25. (c) The dispersion produced by a spherical surface depends on it's radius of curvature. Hence, a lens will not exhibit dispersion only if it's two surfaces have equal radii, with one being convex and the other concave.

26. (b) Convex lens will form image I_1 at it's focus which acts like a virtual object for concave lens.



Hence for concave lens $u=+4\ cm$, $f=20\ cm$. So by lens formula $\frac{1}{-20}=\frac{1}{v}-\frac{1}{4}\Rightarrow v=5\,cm$ *i.e.* distance of final image (I_2) from concave lens $v=5\,cm$ by using $\frac{v}{u}=\frac{I}{O}\Rightarrow\frac{5}{4}=\frac{I}{2}\Rightarrow(I_2)=2.5\,cm$

27. (d) For achromatic combination $\omega_C=-\omega_F$

$[(\mu_v-\mu_r)A]_C=-[(\mu_v-\mu_r)A]_F$

$\Rightarrow[\mu_rA]_C+[\mu_rA]_F=[\mu_vA]_C+[\mu_vA]_F$

$=1.5\times19+6\times1.66=38.5$

Resultant $\delta=[(\mu_r-1)Al]_C+[(\mu_r-1)A]_F$

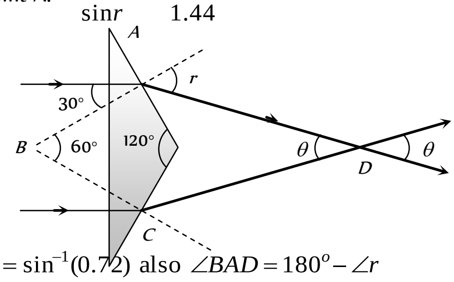
$=[\mu_rA]_C+[\mu_rA]_F-(A_C+A_F)=38.5-(19+6)=13.5^o$

28. (d) By using $\mu=\frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}\Rightarrow\cot\frac{A}{2}=\frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}$

$$\Rightarrow\frac{\cos\frac{A}{2}}{\sin\frac{A}{2}}=\frac{\sin\frac{A+\delta_m}{2}}{\sin\frac{A}{2}}$$

$$\Rightarrow\sin\left(90^\circ-\frac{A}{2}\right)=\sin\left(\frac{A+\delta_m}{2}\right)\Rightarrow\delta_m=180-2A$$

29. (d) At point A. $\frac{\sin30^o}{\sin r}=\frac{1}{1.44}$



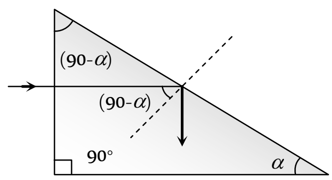
$\Rightarrow r=\sin^{-1}(0.72)$ also $\angle BAD=180^o-\angle r$

In rectangle *ABCD*, ∠ *A* + ∠ *B* + ∠ *C* + ∠ *D* = 360°

$\Rightarrow(180^\circ-r)+60^\circ+(180^\circ-r)+\theta=360^\circ$

$\Rightarrow\theta=2[\sin^{-1}(0.72)-30^o]$

30. (d) If α = maximum value of base angle for which light is totally reflected form hypotenuse.



$(90° - \alpha) = C$ = minimum value of angle of incidence at hypotenuse for total internal reflection

$$\sin(90° - \alpha) = \sin C = \frac{1}{\mu} \Rightarrow \cos\alpha = \frac{1}{\mu} \Rightarrow \alpha = \cos^{-1}\left(\frac{1}{\mu}\right)$$

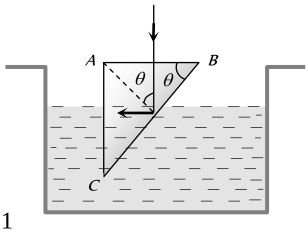
31. (b) For total internal reflection from surface BC

$\theta \geq C \Rightarrow \sin\theta \geq \sin C$

$\Rightarrow \sin\theta \geq \left(\frac{1}{{}_l\mu_g}\right)$

$\Rightarrow \sin\theta \geq \left(\frac{\mu_{\text{Liquid}}}{\mu_{\text{Prism}}}\right)$

$\sin\theta \geq \left(\frac{1.32}{1.56}\right) \Rightarrow \sin\theta \geq \frac{11}{13}$



32. (a) $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R} \Rightarrow \frac{1.5}{+OQ} - \frac{1}{(-OP)} = \frac{(1.5-1)}{+R}$

On putting $OQ = OP,\ OP = 5R$

33. (d) Here $\frac{1}{F} = \frac{2}{f} + \frac{1}{f_m}$

Plano-convex lens silvered on plane side has $f_m = \infty$.

$\therefore \frac{1}{F} = \frac{2}{f} + \frac{1}{\infty} \Rightarrow \frac{1}{30} = \frac{2}{f} \Rightarrow f = 60\ cm$

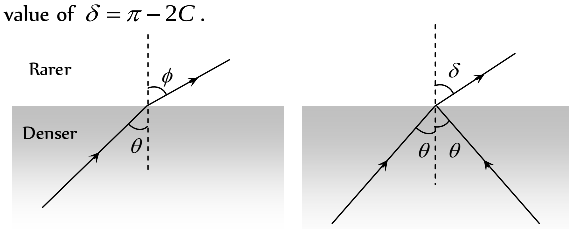
Plano-convex lens silvered on convex side has $f_m = \frac{R}{2}$

$\therefore \frac{1}{F} = \frac{2}{f} + \frac{2}{R} \Rightarrow \frac{1}{10} = \frac{2}{60} + \frac{2}{R} \Rightarrow R = 30\ cm$

Now using $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R}\right)$, we get $\mu = 1.5$

34. (c) When the ray passes into the rarer medium, the deviation is $\delta = \phi - 0$. This can have a maximum value of $\left(\frac{\pi}{2} - C\right)$ for $\theta = C$ and $\phi = \frac{\pi}{2}$.

When total internal reflection occurs, the deviation is $\delta = \pi - 2$, the minimum value of θ being C. The maximum value of $\delta = \pi - 2C$.



35. (c) $\frac{}{r} = \frac{}{d} \to x = \frac{}{d}$

$= \frac{1.22 \times 500 \times 10^{-9} \times 400 \times 10^3}{5 \times 10^{-3}} = 50\ m$

36. (d) Resolving power $= \frac{1.22\ \lambda}{a} = \frac{1.22 \times 6000 \times 10^{-10}}{5}$

Also resolving power $= \frac{d}{D} = \frac{d}{38.6 \times 10^7}$

$\therefore \frac{1.22 \times 6 \times 10^{-7}}{5} = \frac{d}{38.6 \times 10^7}$

$\Rightarrow d = \frac{1.22 \times 6 \times 10^{-7} \times 38.6 \times 10^7}{5} m = 56.51\ m$

37. (a) As limit of resolution

$\Delta\theta = \frac{1}{\text{Resolving Power(RP)}}$; and if x is the distance between points on the surface of moon which is at a distance r from the telescope.

$\Delta\theta = \frac{x}{r}$

So $\Delta\theta = \frac{1}{RP} = \frac{x}{r}$ i.e. $x = \frac{r}{RP} = \frac{r}{d/1.22\ \lambda} \Rightarrow x = \frac{1.22\ \lambda r}{d}$

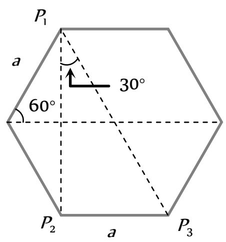
$= \frac{1.22 \times 5500 \times 10^{-10} \times (3.8 \times 10^8)}{500 \times 10^{-2}} = 51\ m$

38. (b) $I_{\text{edge}} = \frac{L\cos\theta}{(h^2 + r^2)} = \frac{Lh}{(h^2 + r^2)^{3/2}}$

For maximum extensity $\frac{dI}{dh} = 0$

Applying this condition have get $h = \frac{r}{\sqrt{2}}$

39. (a) From the geometry of the figure



$p_1p_2 = 2a\sin 60^o$

so, $I_{P_2} = \frac{L}{p_1p_2^2}$

$= \frac{L}{(2a\sin 60^o)^2} = \frac{L}{3a^2}$

and $I_{P_3} = \frac{L}{(P_1P_2^2 + a^2)}\cos 30^o$

$= \frac{L}{[(2a\sin 60^o)^2 + a^2]}\frac{\sqrt{3}}{2} = \frac{\sqrt{3}\ L}{8\ a^2}$

$\Rightarrow I_{P_3} = \frac{3\sqrt{3}}{8} I_{P_2} = \frac{3\sqrt{3}}{8} I_0$

All options are wrong.

40. (c) Distance of object from mirror

$= 15 + \frac{33.25}{4} \times 3 = 39.93\ cm$

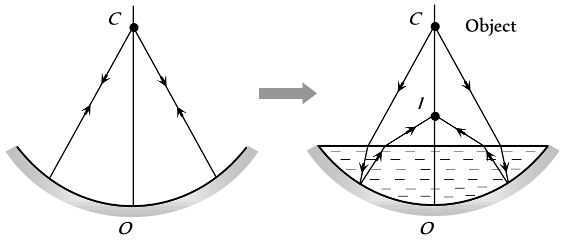
Distance of image from mirror $= 15 + \frac{25}{4} \times 3 = 33.75$

For mirror, $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\Rightarrow \frac{1}{-33.75} - \frac{1}{39.93} = \frac{1}{f} \Rightarrow f \approx -18.3\ cm.$

41. (c) $v_i = -\left(\frac{f}{f-u}\right)^2 . v_o = -\left(\frac{-24}{-24-(-60)}\right)^2 \times 9 = 4\ cm/sec.$

42. (d) From the following figures it is clear that real image (I) will be formed between C and O



Initially Finally

43. (b) $|m| = \frac{f_o}{f_e} = \frac{400}{10} = 40$

Angle subtented by moon on the objective of telescope

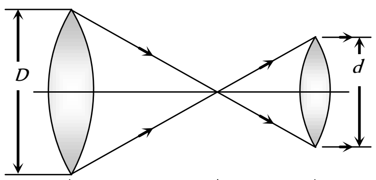
$\propto = \frac{3.5\times10^3}{3.8\times10^3} = \frac{3.5}{3.8}\times10^{-2} rad$

Also $|m| = \frac{\beta}{\alpha} \Rightarrow$ Angular size of final image

$\beta = |m|\times\alpha = 40\times\frac{3.5}{3.8}\times10^{-2}$ = 0.36 *rad*

$= 0.3\times\frac{180}{\pi} \approx 21^o$

44. (a) Full use of resolving power means whole aperture of objective in use. And for relaxed vision.



$\frac{f_o}{f_e} = \frac{D}{d} \Rightarrow \frac{300}{f_e} = \frac{5}{0.3} \Rightarrow f_e = 6\ cm$

45. (b) Wave length of the electron wave be $10\times10^{-12} m$,

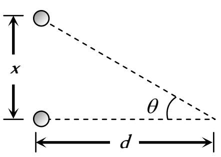
Using $\lambda = \frac{h}{\sqrt{2mE}} \Rightarrow E = \frac{h^2}{\lambda^2\times 2m}$

$= \frac{(6.63\times10^{-34})^2}{(10\times10^{-12})^2\times2\times9.1\times10^{-31}} Joule$

$= \frac{(6.63\times10^{-34})^2}{(10\times10^{-12})^2\times2\times9.1\times10^{-31}\times1.6\times10^{-19}} eV$

= 15.1 *KeV*.

46. (c) $\theta = \frac{x}{d} = \frac{1.22\lambda}{a}$



$\Rightarrow x = \frac{1.22\times d}{a}$

$= \frac{1.22\times5000\times10^{-10}\times10^3}{10\times10^{-2}}$ = 6.1 *mm*

i.e. order will be 5 *mm*.

47. (c) $\frac{1.22\lambda}{a} = \frac{x}{d} \Rightarrow d = \frac{x\times a}{1.22\lambda} = \frac{1\times10^{-3}\times3\times10^{-3}}{1.22\times500\times10^{-9}}$ = 5*m*

48. (c) Let distance between lenses be x. As per the given condition, combination behaves as a plane glass plate, having focal length ∞.

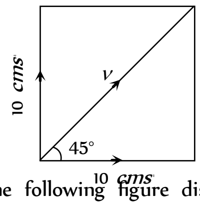
So by using $\frac{1}{F} = \frac{1}{f_1}+\frac{1}{f_2}-\frac{x}{f_1f_2}$

$\Rightarrow \frac{1}{\infty} = \frac{1}{+30}+\frac{1}{-10}-\frac{x}{(+30)(-10)} \Rightarrow x = 20\ cm$

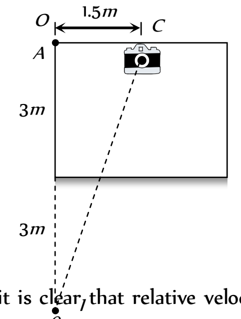
49. (a) When plane mirror rotates through an angle θ, the reflected ray rotates through an angle 2θ. So spot on the screen will make $2n$ revolution per second.

50. (d) $v\cos45° = 10 \quad v = 10\sqrt{2}\ cms$

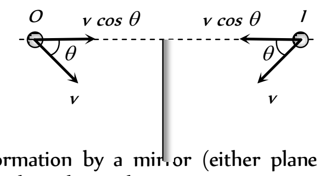
In the ceiling mirror the original velocity will be seen.



51. (d) According to the following figure distance of image I from camera $= \sqrt{(6)^2+(1.5)^2} = 6.18\,m$



52. (c) From figure it is clear that relative velocity between object and it's image = $2v\cos\theta$



53. (b) Image formation by a mirror (either plane or spherical) does not depend on the medium.

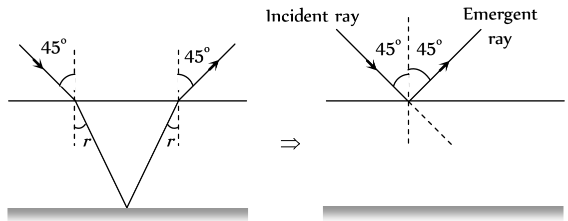
The image of P will be formed at a distance h below the mirror. If d = depth of liquid in the tank.

Apparent depth of $P = x_1 = \frac{d-h}{\mu}$

Apparent depth of the image of $P = x_2 = \frac{d+h}{\mu}$

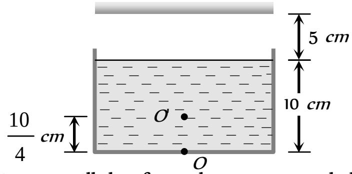
$\therefore$ Apparent distance between P and it's image $= x_2 - x_1 = \frac{2h}{\mu}$

54. (a) From the figure it is clear that the angle between incident ray and the emergent ray is 90°.



55. (b) From figure it is clear that object appears to be raised by $\frac{10}{4} cm \, (2.5 \, cm)$

Hence distance between mirror and $O' = 5 + 7.5 = 12.5 \, cm$



So final image will be formed at 12.5 cm behind the plane mirror.

56. (d) Velocity of approach of man towards the bicycle = $(u - v)$

Hence velocity of approach of image towards man is $2(u - v)$.

57. (c) For A

Total number of waves = $\frac{(1.5)t}{\lambda}$ ....(i)

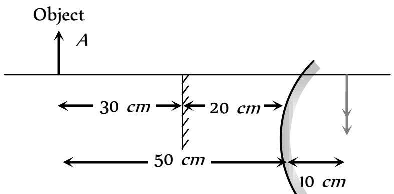
$\because \left(\begin{matrix}\text{Total number} \\ \text{of waves}\end{matrix}\right) = \left(\frac{\text{optical path length}}{\text{wavelength}}\right)$

For B and C

Total number of waves = $\frac{n_B\left(\frac{t}{3}\right)}{\lambda} + \frac{(1.6)\left(\frac{2t}{3}\right)}{\lambda}$ ....(ii)

Equating (i) and (ii) $n_B = 1.3$

58. (b) Since there is no parallex, it means that both images (By plane mirror and convex mirror) coinciding each other.



According to property of plane mirror it will form image at a distance of 30 cm behind it. Hence for convex mirror $u = -50 \, cm$, $v = +10 \, cm$

By using $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\Rightarrow \frac{1}{f} = \frac{1}{+10} + \frac{1}{-50} = \frac{4}{50}$

$\Rightarrow f = \frac{25}{2} cm$ $\Rightarrow R = 2f = 25cm.$

59. (d) For surface P, $\frac{1}{v_1} = \frac{1}{f} - \frac{1}{u} = 1 - \frac{1}{3} = \frac{2}{3} \Rightarrow v_1 = \frac{3}{2} m$

For surface Q, $\frac{1}{v_2} = \frac{1}{f} - \frac{1}{u} = 1 - \frac{1}{5} = \frac{4}{5} \Rightarrow v_2 = \frac{5}{4} m$

$\therefore v_1 - v_2 = 0.25m$

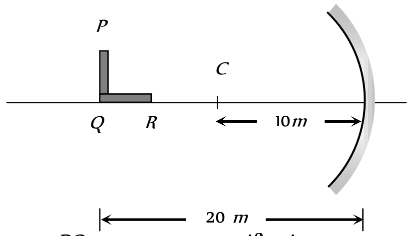
Magnification of $P = \frac{v_1}{u} = \frac{3/2}{3} = \frac{1}{2}$

$\therefore$ Height of $P = \frac{1}{2} \times 2 = 1m$

Magnification of $Q = \frac{v_2}{u} = \frac{5/4}{5} = \frac{1}{4}$

$\therefore$ Height of $Q = \frac{1}{4} \times 2 = 0.5m$

60. (b) Focal length of mirror $f = \frac{R}{2} = \frac{10}{2} = 5cm$



For part PQ : transverse magnification

length of image $L = \left(\frac{f}{f-u}\right) \times L_0$

$= \left(\frac{-5}{-5-(-20)}\right) \times L_0 = \frac{-L_0}{3}$

For part QR : longitudinal magnification

Length of image $L_2 = \left(\frac{f}{f-u}\right)^2 L_0$

$= \left(\frac{-5}{-5-(-20)}\right)^2 \times L_0 = \frac{L_0}{9} \Rightarrow \frac{L_1}{L_2} = \frac{3}{1}$

61. (d) The two slabs will shift the image a distance

$d = 2\left(1 - \frac{1}{\mu}\right)t = 2\left(1 - \frac{1}{1.5}\right)(1.5) = 1 \, cm$

Therefore, final image will be 1 cm above point P.

62. (a) Here optical distance between fish and the bird is

$s = y' + \mu y$

Differentiating $w.r.t$ t we get $\frac{ds}{dt} = \frac{dy'}{dt} + \frac{\mu dy}{dt}$

$\Rightarrow 9 = 3 + \frac{4}{3}\frac{dy}{dt} \Rightarrow \frac{dy}{dt} = 4.5 \, m/\text{sec}$

63. (a) The real depth $= \mu$ (apparent depth)

$\Rightarrow$ In first case, the real depth $h_1 = \mu(b - a)$

Similarly in the second case, the real depth $h_2 = \mu(d - c)$

Since $h_2 > h_1$, the difference of real depths $= h_2 - h_1 = \mu(d - c - b + a)$

Since the liquid is added in second case, $h_2 - h_1 = (d - b)$

$\Rightarrow \mu = \frac{(d-b)}{(d-c-b+a)}$

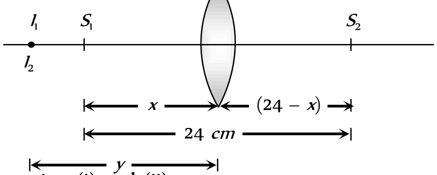
64. (a) The given condition will be satisfied only if one source (S) placed on one side such that $u < f$ (*i.e.* it lies under the focus). The other source (S) is placed on the other side of the lens such that $u > f$ (*i.e.* it lies beyond the focus).

If S_1 is the object for lens then $\frac{1}{f} = \frac{1}{-y} - \frac{1}{-x}$

$\Rightarrow \frac{1}{y} = \frac{1}{x} - \frac{1}{f}$ .....(i)

If S_2 is the object for lens then

$\frac{1}{f}=\frac{1}{+y}-\frac{1}{-(24-x)} \Rightarrow \frac{1}{y}=\frac{1}{f}-\frac{1}{(24-x)}$ .....(ii)



From equation (i) and (ii)

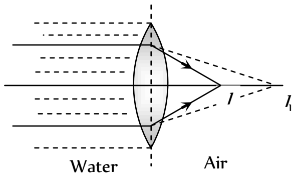
$$\frac{1}{x}-\frac{1}{f}=\frac{1}{f}-\frac{1}{(24-x)} \Rightarrow \frac{1}{x}+\frac{1}{(24-x)}=\frac{2}{f}=\frac{2}{9}$$

$\Rightarrow x^2-24x+108=0$. After solving the equation $x = 18\ cm$, $6\ cm$.

65. (c) Consider the refraction of the first surface *i.e.* refraction from rarer medium to denser medium

$$\frac{\mu_2-\mu_1}{R}=\frac{\mu_1}{-u}+\frac{\mu_2}{v_1} \Rightarrow \frac{\left(\frac{3}{2}\right)-\left(\frac{4}{3}\right)}{R}=\frac{\frac{4}{3}}{\infty}+\frac{\frac{3}{2}}{v_1} \Rightarrow v_1=9R$$

Now consider the refraction at the second surface of the lens *i.e.* refraction from denser medium to rarer medium



$$\frac{1-\frac{3}{2}}{-R}=-\frac{\frac{3}{2}}{9R}+\frac{1}{v_2} \Rightarrow v_2=\left(\frac{3}{2}\right)R$$

The image will be formed at a distance of $\frac{3}{2}R$. This is equal to the focal length of the lens.

66. (c) $\delta_{Prism}=(\mu-1)A=(1.5-1)4^o=2^o$

$\therefore\ \delta_{Total}=\delta_{Prism}+\delta_{Mirror}$

$=(\mu-1)A+(180-2i)=2^o+(180-2\times 2)=178^o$

67. (b) Here the requirement is that $i > c$

$\Rightarrow \sin i > \sin c \ \Rightarrow \sin i > \frac{\mu_2}{\mu_1}$ .....(i)

From Snell's law $\mu_1=\frac{\sin\alpha}{\sin r}$ ....(ii)

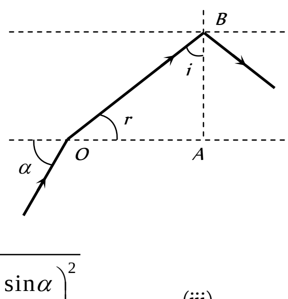
Also in ΔOBA

$r+i=90^o \ \Rightarrow r=(90-i)$

Hence from equation (ii)

$\sin\alpha=\mu_1\sin(90-i)$

$\Rightarrow \cos i=\frac{\sin\alpha}{\mu_1}$



$\sin i=\sqrt{1-\cos^2 i}=\sqrt{1-\left(\frac{\sin\alpha}{\mu_1}\right)^2}$ ....(iii)

From equation (i) and (iii) $\sqrt{1-\left(\frac{\sin\alpha}{\mu_1}\right)^2}>\frac{\mu_2}{\mu_1}$

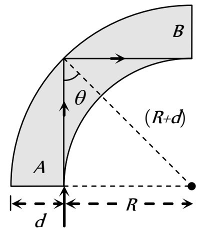
$\Rightarrow \sin^2\alpha<(\mu_1^2-\mu_2^2) \Rightarrow \sin\alpha<\sqrt{\mu_1^2-\mu_2^2}$

$\alpha_{max}=\sin^{-1}\sqrt{\mu_1^2-\mu_2^2}$

68. (b) Consider the figure if smallest angle of incidence θ is greater than critical angle then all light will emerge out of B

$\Rightarrow \theta \ge \sin^{-1}\left(\frac{1}{\mu}\right) \Rightarrow \sin\theta \ge \frac{1}{\mu}$

from figure $\sin\theta=\frac{R}{R+d}$

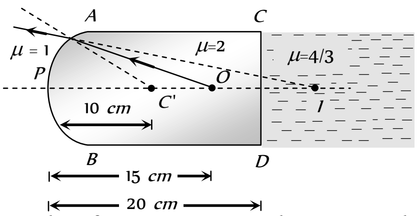


$\Rightarrow \frac{R}{R+d}\ge\frac{1}{\mu}\Rightarrow\left(1+\frac{d}{R}\right)\le\mu$

$\Rightarrow \frac{d}{R}\le\mu-1\Rightarrow\left(\frac{d}{R}\right)_{max}=0.5$

69. (b) In case of refraction from a curved surface, we have

$\frac{\mu_2}{v}-\frac{\mu_1}{u}=\frac{\mu_2-\mu_1}{R}\Rightarrow\frac{1}{v}-\frac{2}{(-15)}=\frac{(1-2)}{-10}\Rightarrow v=-30\ cm.$

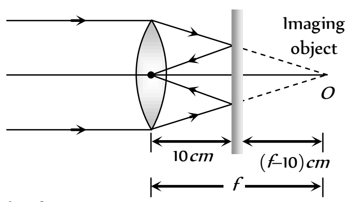


i.e. the curved surface will form virtual image I at distance of 30 *cm* from *P*. Since the image is virtual there will be no refraction at the plane surface *CD* (as the rays are not actually passing through the boundary), the distance of final image I from *P* will remain 30 *cm*.

70. (d) As $\mu_2>\mu_1$, the upper half of the lens will become diverging.

As $\mu_1>\mu_3$, the lower half of the lens will become converging

71. (b)



From the figure,

Using property of plane mirror

Image distance = Object distance

$f-10=10 \Rightarrow f=20\ cm$

72. (d) If initially the objective (focal length *F*) forms the image at distance *v* then $v_o=\frac{u_o f_o}{u_o-f_o}=\frac{3\times 2}{3-2}=6\ cm$

Now as in case of lenses in contact

$$\frac{1}{F_o}=\frac{1}{f_1}+\frac{1}{f_2}+\frac{1}{f_3}+.....=\frac{1}{f_1}+\frac{1}{F_o'}$$

$$\left\{\text{where } \frac{1}{F_o'}=\frac{1}{f_2}+\frac{1}{f_3}+.....\right\}$$

So if one of the lens is removed, the focal length of the remaining lens system

$$\frac{1}{F_o'}=\frac{1}{F_0}-\frac{1}{f_1}=\frac{1}{2}-\frac{1}{10} \Rightarrow F_o'=2.5\,cm$$

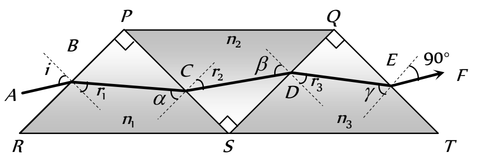
This lens will form the image of same object at a distance v_o' such that $v_o'=\frac{u_o F_o'}{u_o-F_o'}=\frac{3\times 2.5}{(3-2.5)}=15\,cm$

So to refocus the image, eye-piece must be moved by the same distance through which the image formed by the objective has shifted *i.e.* 15 – 6 = 9 *cm*.

73. (b) By using $m_\infty=\frac{(L_\infty-f_o-f_e)D}{f_o f_e}$

$$=\frac{(16-0.4-2.5)\times 25}{0.4\times 2.5}=327.5$$

74. (d)



α = 90 – r_1 β = 90 – r_2 γ = 90 – r_3

At B

$$\sin i=n_1\sin r_1 \Rightarrow \sin^2 i=n_1^2\sin^2 r_1 \quad .... (i)$$

At C

$$n_1\sin(90-r_1)=n_2\sin r_2 \Rightarrow n_2^2\sin^2 r_2=n_1^2\cos^2 r_1 \quad ....(ii)$$

At D

$$n_2\sin(90-r_2)=n_3\sin r_3 \Rightarrow n_2^2\cos^2 r_2=n_3^2\sin^2 r_3 \quad ....(iii)$$

At E

$$n_3\sin(90-r_3)=(1)\sin(90-1) \Rightarrow \cos^2 i=n_3^2\cos^2 r_3 \quad ....(iv)$$

Adding (i), (ii), (iii) and (iv) we get $1+n_2^2=n_1^2+n_3^2$

75. (a) $L_D=v_o+u_e$ and for objective lens $\frac{1}{f_o}=\frac{1}{v_o}-\frac{1}{u_o}$

Putting the values with proper sign convention.

$$\frac{1}{+2.5}=\frac{1}{v_o}-\frac{1}{(-3.75)} \Rightarrow v_o=7.5\,cm$$

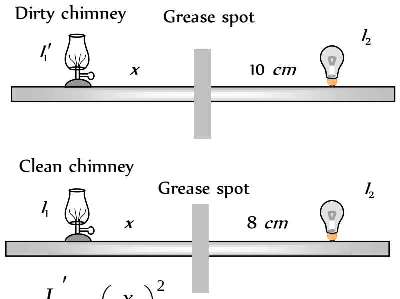
For eye lens $\frac{1}{f_e}=\frac{1}{v_e}-\frac{1}{u_e}$

$$\Rightarrow \frac{1}{+5}=\frac{1}{(-25)}-\frac{1}{u_e} \Rightarrow u_e=-4.16\,cm$$

$$\Rightarrow |u_e|=4.16\,cm$$

Hence $L_D=7.5+4.16=11.67\,cm$

76. (c) The actual luminous intensity of the lamp is I_1 whereas the intensity is I_1' in the dirty state.

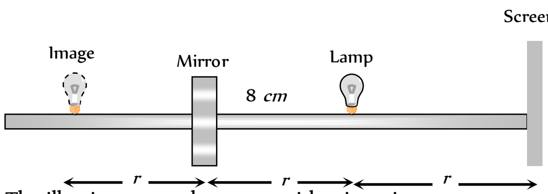


I position, $\frac{I_1'}{I_2}=\left(\frac{x}{10}\right)^2$

II position, $\frac{I_1}{I_2}=\left(\frac{x}{8}\right)^2 \quad \Rightarrow \frac{I_1'}{I_1}=0.64$

$\Rightarrow I_1'=0.64\,I_1$. Thus, % of light absorbed = 36%.

77. (c) The illuminance on the screen without mirror is $I_1=\frac{L}{r^2}$

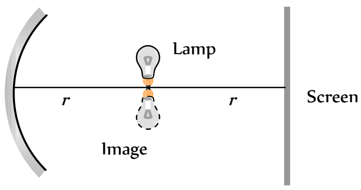


The illuminance on the screen with mirror is

$$I_2=\frac{L}{r^2}+\frac{L}{(3r)^2}=\frac{10}{9}\times\frac{L}{r^2}$$

$$\therefore \frac{I_2}{I_1}=\frac{10}{9}=10:9$$

78. (b) Illuminance on the screen without mirror is $I_1=\frac{L}{r^2}$



Illuminance on the screen with mirror

$$I_2=\frac{L}{r^2}+\frac{L}{r^2}=\frac{2L}{r^2} \Rightarrow \frac{I_2}{I_1}=2:1$$

79. (b) Apparent depth $h'=\frac{h}{{}_{air}\mu_{liquid}}$

$$\Rightarrow \frac{dh'}{dt}=\frac{1}{{}_a\mu_w}=\frac{1}{{}_a\mu_w}\frac{dh}{dt} \Rightarrow x=\frac{1}{{}_a\mu_w}\frac{dh}{dt} \Rightarrow \frac{dh}{dt}={}_a\mu_w\,x$$

Now volume of water $V=\pi R^2 h$

$$\Rightarrow \frac{dV}{dt}=\pi R^2\frac{dh}{dt}=\pi R^2.\,{}_a\mu_w\,x$$

$$={}_a\mu_w\pi R^2 x=\frac{\mu_w}{\mu_a}\pi R^2 x=\left(\frac{n_2}{n_1}\right)\pi R^2 x$$

Graphical Questions

1. (c) As $u\to f,\ v\to\infty$; $u\to\infty,\ v\to f$

2. (a) At $u = f$, $v = \infty$

At $u = 0$, $v = 0$ (*i.e.* object and image both lies at pole)

Satisfying these two conditions, only option (a) is correct.

3. (b, c) From graph $\tan 30^o = \frac{\sin r}{\sin i} = \frac{1}{{}_1\mu_2}$

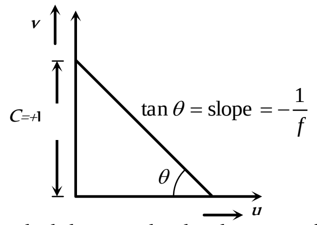
$\Rightarrow {}_1\mu_2 = \sqrt{3} \Rightarrow \frac{\mu_2}{\mu_1} = \frac{v_1}{v_2} = 1.73 \Rightarrow v_1 = 1.73 v_2$

Also from $\mu = \frac{1}{\sin C} \Rightarrow \sin C = \frac{1}{{}_{Rarer}\mu_{Denser}}$

$\Rightarrow \sin C = \frac{1}{{}_1\mu_2} = \frac{1}{\sqrt{3}}$.

4. (c) For a lens $m = \frac{f - v}{f} \Rightarrow m = \left(-\frac{1}{f}\right)v + 1$

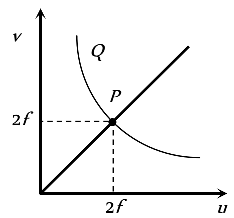
Comparing this equation with $y = mx + c$ (equation of straight line)



5. (c) At P, $u = v$ which happened only when $u = 2f$

At another point Q on the graph (above P)

$v > 2f$



6. (d) For a lens $m = \frac{f - v}{f} = -\frac{1}{f}v + 1$

Comparing it with $y = mx + c$

Slope $= m = -\frac{1}{f}$

From graph, slope of the line $= \frac{b}{c}$

Hence $-\frac{1}{f} = \frac{b}{c} \Rightarrow |f| = \frac{c}{b}$

7. (a) $\mu = A + \frac{B}{\lambda^2}$

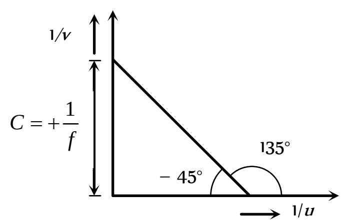
8. (a) Since $\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{v} = -\frac{1}{u} + \frac{1}{f}$

Putting the sign convention properly

$\frac{1}{(-v)} = \frac{-1}{(-u)} + \frac{1}{(-f)} \Rightarrow \frac{1}{v} = -\frac{1}{u} + \frac{1}{f}$

Comparing this equation with $y = mx + c$

Slope $= m = \tan\theta = -1 \Rightarrow \theta = 135°$ or $-45°$ and intercept $C = +\frac{1}{f}$



9. (a) As u goes from 0 to $-\infty$, v goes from $+0$ to $+f$

10. (a) For convex lens (for real image) $u + v \geq 4f$

For $u = 2f$, v is also equal to $2f$

Hence $u + v = 4f$

11. (d) For concave mirror $m = \frac{f}{f - u}$

For real image $m = -\frac{f}{(u - f)} = -\frac{f}{x}$

$= -\frac{f}{(\text{Distance of object from focus})} \Rightarrow m \propto \frac{1}{x}$.

12. (a) For a prism, as the angle of incidence increases, the angle of deviation first decreases, goes to a minimum value and then increases.

13. (b) From Newton's formula $xy = f^2$. This is the equation of a rectangular hyperbola.

14. (a, c) At P, $\delta = 0 = A(\mu - 1) \Rightarrow \mu = 1$.

Also $\delta_m = (\mu - 1)A = A\mu_m - A$

Comparing it with $y = mx + c$

Slope of the line $= m = A$

15. (b) From graph, slope $= \tan\left(\frac{2\pi}{10}\right) = \frac{\sin r}{\sin i}$

Also ${}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r} = \frac{1}{\tan\left(\frac{2\pi}{10}\right)} = \frac{4}{3} \Rightarrow \mu_2 > \mu_1$

It means that medium 2 is denser medium. So total internal reflection cannot occur.

16. (d) From graph it is clear that $\tan 30^o = \frac{\sin r}{\sin i}$

$\Rightarrow \frac{1}{\sqrt{3}} = \frac{\sin r}{\sin i} = \frac{1}{\mu} \Rightarrow \mu = \sqrt{3}$

Also $v = \frac{c}{\mu} = nc \Rightarrow n = \frac{1}{\mu} = \frac{1}{\sqrt{3}} = (3)^{-1/2}$

17. (b) In concave mirror, if virtual images are formed, u can have values zero and f

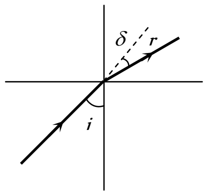
At $u = 0$, $m = \frac{f}{f - u} = \frac{f}{f} = 1$

At $u = f$, $m = \frac{f}{f - u} = -\frac{f}{-f - (-f)} = \infty$

18. (a) The ray of light is refracted at the plane surface. However, since the ray is travelling from a denser to a rarer medium, for an angle of incidence (i) greater then the critical angle (c) the ray will be totally internally reflected.

For $i < c$; deviation $\delta = r - i$ with

$$\frac{1}{\mu} = \frac{\sin i}{\sin r}$$

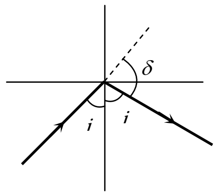


Hence $\delta = \sin^{-1}(\mu \sin i) - i$

This is a non-linear relation. The

maximum value of δ is $\delta_1 = \frac{\pi}{2} - c$; where $i = c$ and

$$\mu = \frac{1}{\sin c}$$



For $i > c$, deviation $\delta = \pi - 2i$

δ decreases linearly with i

$\delta = \pi - 2c = 2\delta$

19. (d) For a lens $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

If $u = \infty$, $v = f$ and if $u = f$, $v = \infty$

20. (d)

Assertion and Reason

1. (b)
2. (b) The stars twinkle while the planets do not. It is due to variation in density of atmospheric layer. As the stars are very far and giving light continuously to us. So, the light coming from stars is found to change their intensity continuously. Hence they are seen twinkling. Also stars are much bigger in size than planets but it has nothing to deal with twinkling phenomenon.
3. (c) Owls can move freely during night, because they have large number of cones on their retina which help them to see in night.
4. (c) Shining of air bubble in water is on account of total internal reflection.
5. (c) After the removal of stimulus the image formed on retina is sustained up to 1/6 second.
6. (a) Because of smallest wavelength of blue colour it is scattered to large extent than other colours, so the sky appears blue.
7. (e) For total internal reflection the angle of incidence should be greater than the critical angle. As critical angle is approximately 35°. Therefore, total internal reflection is not possible. So, assertion is not true but reason is true.
8. (c) The sun and its surroundings appears red during sunset or sunrise because of scattering of light. The amount of scattered light is inversely proportional to the fourth power of wavelength of light *i.e.* $I \propto \frac{1}{\lambda^4}$
9. (a) Focal length of lens immersed in water is four times the focal length of lens in air. It means

$$f_w = 4 f_a = 4 \times 10 = 40\, cm$$

10. (e) The velocity of light of different colours (all wavelengths) is same in vacuum and $\mu \propto \frac{1}{\lambda}$.
11. (a) The red glass absorbs the radiations emitted by green flowers; so flower appears black.
12. (a) Magnification produced by mirror $m = \frac{I}{O} = \frac{f}{f-u} = \frac{f}{x}$

x is distance from focus.

13. (e) Apparent shift for different coloured letter is $d = h\left(1 - \frac{1}{\mu}\right)$

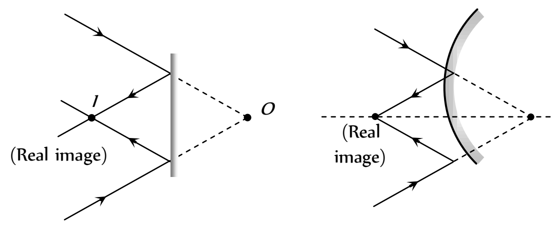
$\Rightarrow \lambda_R > \lambda_V$ so $\mu_R < \mu_V$

Hence $d_R < d_V$ *i.e.* red coloured letter raised least.

14. (a) The efficiency of fluorescent tube is about 50 *lumen/watt*, whereas efficiency of electric bulb is about 12 *lumen/watt*. Thus for same amount of electric energy consumed, the tube gives nearly 4 times more light than the filament bulb.
15. (c) Polar caps receives almost the same amount of radiation as the equatorial plane. For the polar caps angle between sun rays and normal (to polar caps) tends to 90°. As per Lambert's cosine law, $E \propto \cos\theta$, therefore E is zero. For the equatorial plane, θ = 0°, therefore E is maximum. Hence polar caps of earth are so cold. (where E is radiation received).
16. (b) At noon, rays of sun light fall normally on earth. Therefore θ = 0°. According to Lambert's cosine law, $E \propto \cos\theta$, when θ = 0°, cos θ = cos 0° = 1 = max. Therefore, E is maximum.
17. (d) When an object is placed between two plane parallel mirrors, then infinite number of images are formed. Images are formed due to multiple reflections. At each reflection, a part of light energy is absorbed. Therefore, distant images get fainter.
18. (c) In search lights, we need an intense parallel beam of light. If a source is placed at the focus of a concave spherical mirror, only paraxial rays are rendered parallel. Due to large aperture of mirror, marginal rays give a divergent beam.

But in case of parabolic mirror, when source is at the focus, beam of light produced over the entire cross-section of the mirror is a parallel beam.

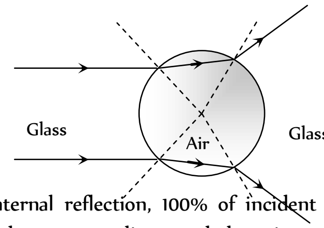
19. (d) The size of the mirror does not affect the nature of the image except that a bigger mirror forms a brighter image.
20. (a) When the sun is close to setting, refraction will effect the top part of the sun differently from the bottom half. The top half will radiate its image truly, while the bottom portion will send an apparent image. Since the bottom portion of sun is being seen through thicker, more dense atmosphere. The bottom image is being bent intensely and gives the impression of being squashed or "flattened" or elliptical shape.
21. (c) $\mu \propto \frac{1}{\lambda} \propto \frac{1}{C}$. λ_V is least so C is also least. Also the greatest wavelength is for red colour.
22. (e) We can produce a real image by plane or convex mirror.



Focal length of convex mirror is taken positive.

23. (d) The colour of glowing red glass in dark will be green as red and green are complimentary colours.

24. (d) The air bubble would behave as a diverging lens, because refractive index of air is less than refractive index of glass. However, the geometrical shape of the air bubble shall resemble a double convex lens.



25. (a) In total internal reflection, 100% of incident light is reflected back into the same medium, and there is no loss of intensity, while in reflection from mirrors and refraction from lenses, there is always some loss of intensity. Therefore images formed by total internal reflection are much brighter than those formed by mirrors or lenses.

26. (d) Focal length of the lens depends upon it's refractive index as $\frac{1}{f} \propto (\mu - 1)$. Since $\mu_b > \mu_r$ so $f_b < f_r$

Therefore, the focal length of a lens decreases when red light is replaced by blue light.

27. (b) After refraction at two parallel faces of a glass slab, a ray of light emerges in a direction parallel to the direction of incidence of white light on the slab. As rays of all colours emerge in the same direction (of incidence of white light), hence there is no dispersion, but only lateral displacement.

28. (d) It is not necessary for a material to have same colour in reflected and transmitted light. A material may reflect one colour strongly and transmit some other colour. For example, some lubricating oils reflect green colour and transmit red. Therefore, in reflected light, they will appear green and in transmitted light, they will appear red.

29. (d) Dispersion of light cannot occur on passing through air contained in a hollow prism. Dispersion take place because the refractive index of medium for different colour is different. Therefore when white light travels from air to air, refractive index remains same and no dispersion occurs.

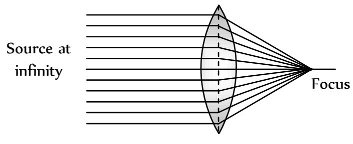
30. (b) The light gathering power (or brightness) of a telescope $\propto$ $(\text{diameter})^2$. So by increasing the objective diameter even far off stars may produce images of optimum brightness.

31. (c) Very large apertures gives blurred images because of aberrations. By reducing the aperture the clear image is obtained and thus the sensitivity of camera increases.

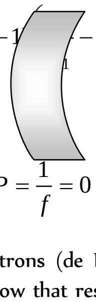
Also the focussing of object at different distance is achieved by slightly altering the separation of the lens from the film.

32. (d) We cannot interchange the objective and eye lens of a microscope to make a telescope. The reason is that the focal length of lenses in microscope are very small, of the order of *mm* or a few *cm* and the difference $(f_o - f_e)$ is very small, while the telescope objective have a very large focal length as compared to eye lens of microscope.

33. (a) Image formed by convex lens



34. (a) The focal length of a lens is given by $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

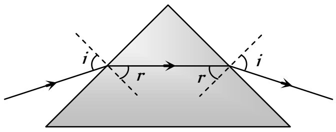


For, goggle, $R_1 = R_2$

$\therefore \ \frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0$. Therefore, $P = \frac{1}{f} = 0$

35. (c) The wavelength of wave associated with electrons (de Broglie waves) is less than that of visible light. We know that resolving power is inversely proportional to wavelength of wave used in microscope. Therefore the resolving power of an electron microscope is higher than that of an optical microscope.

36. (a) In case of minimum deviation of a prism $\angle i = \angle e$ so $\angle r_1 = \angle r_2$



37. (b) The velocity of light in a material medium depends upon it's colour (wavelength). If a ray of white light incident on a prism, then on emerging, the different colours are deviated through different angles.

Also dispersive power $\omega = \frac{(\mu_V - \mu_R)}{(\mu_Y - 1)}$

i.e. ω depends upon only μ.

38. (c) The ray of light incident on the water air interface suffers total internal reflections, in that case the angle of incidence is greater than the critical angle. Therefore, if the tube is viewed from suitable direction (so that the angle of incidence is greater than the critical angle), the rays of light incident on the tube undergoes total internal reflection. As a result, the test tube appears as highly polished *i.e.* silvery.

39. (a) In wide beam of light, the light rays of light which travel close to the principal axis are called paraxial rays, while the rays which travel quite away from the principal axis is called marginal rays. In case of lens having large aperture, the behaviour of the paraxial and marginal rays are markedly different from each other. The two types of rays come to focus at different points on the principal axis of the lens, thus the spherical aberration occur. However in case of a lens with small aperture, the two types of rays come to focus quite close to each other.

40. (e)

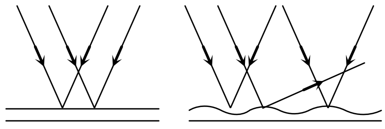
41. (b)

42. (b)

43. (c)

44. (a) Resolving power $= \frac{a}{1.22\lambda}$.

45. (c) When glass surface is made rough then the light falling on it is scattered in different direction due to which its transparency decreases.



46. (b) Diamond glitters brilliantly because light enters in diamond suffers total internal reflection. All the light entering in it comes out of diamond after number of reflections and no light is absorb by it.

47. (c) The clouds consist of dust particles and water droplets. Their size is very large as compared to the wavelength of the incident light from the sun. So there is very little scattering of light. Hence the light which we receive through the clouds has all the colours of light. As a result of this, we receive almost white light. Therefore, the cloud are generally white.

Ray Optics

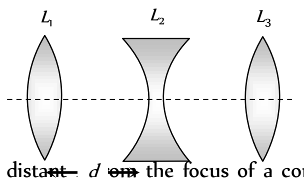
SET Self Evaluation Test - 29

1. In an astronomical telescope in normal adjustment, a straight black line of length L is drawn on the objective lens. The eyepiece forms a real image of this line. The length of this image is l. The magnification of the telescope is

(a) $\frac{L}{l}$ (b) $\frac{L}{l}+1$

(c) $\frac{L}{l}-1$ (d) $\frac{L+l}{L-l}$

2. Three lenses L_1, L_2, L_3 are placed co-axially as shown in figure. Focal length's of lenses are given 30 *cm*, 10 *cm* and 5 *cm* respectively. If a parallel beam of light falling on lens L_1 emerging L_3 as a convergent beam such that it converges at the focus of L_3. Distance between L_1 and L_2 will be



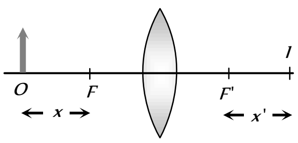
(a) 40 *cm*

(b) 30 *cm*

(c) 20 *cm*

(d) 10 *cm*

3. An object is placed at a point distant d cm the focus of a convex lens and its image is formed at I as shown in the figure. The distances x, x' satisfy the relation



(a) $\frac{x+x'}{2}=f$

(b) $f=xx'$

(c) $x+x'\le 2f$

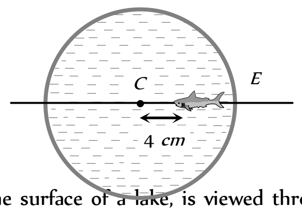
(d) $x+x'\ge 2f$

4. The diameter of the eye-ball of a normal eye is about 2.5 *cm*. The power of the eye lens varies from

(a) 2 *D* to 10 *D* (b) 40 *D* to 32 *D*

(c) 9 *D* to 8 *D* (d) 44 *D* to 40 *D*

5. In a thin spherical fish bowl of radius 10 *cm* filled with water of refractive index 4/3 there is a small fish at a distance of 4 *cm* from the centre C as shown in figure. Where will the image of fish appears, if seen from E



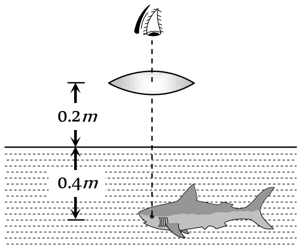
(a) 5.2 *cm*

(b) 7.2 *cm*

(c) 4.2 *cm*

(d) 3.2 *cm*

6. A small fish 0.4 *m* below the surface of a lake, is viewed through a simple converging lens of focal length 3 *m*. The lens is kept at 0.2 *m* above the water surface such that fish lies on the optical axis of the lens. The image of the fish seen by observer will be at $\left(\mu_{water}=\frac{4}{3}\right)$



(a) A distance of 0.2 *m* from the water surface

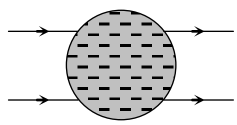
(b) A distance of 0.6 *m* from the water surface

(c) A distance of 0.3 *m* from the water surface

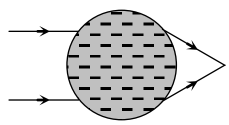
(d) The same location of fish

7. A water drop in air refractes the light ray as

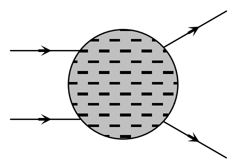
(a)



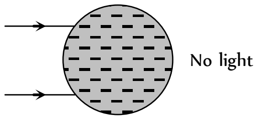
(b)



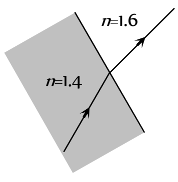
(c)



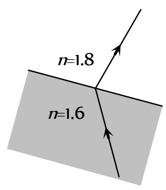
(d)



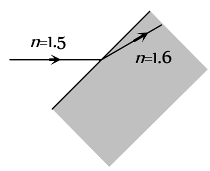
8. Which of the following ray diagram show physically possible refraction



(i)



(ii)

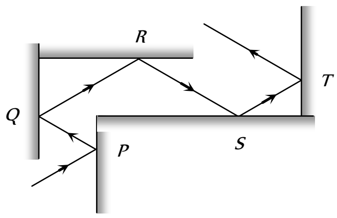


(iii)

(a) (i) (b) (ii)

(c) (iii) (d) None of these

9. Following figure shows the multiple reflections of a light ray along a glass corridor where the walls are either parallel or perpendicular to one another. If the angle of incidence at point P is 30°, what are the angles of reflection of the light ray at points Q, R, S and T respectively



(a) 30°, 30°, 30°, 30°

(b) 30°, 60°, 30°, 60°

(c) 30°, 60°, 60°, 30°

(d) 60°, 60°, 60°, 60°

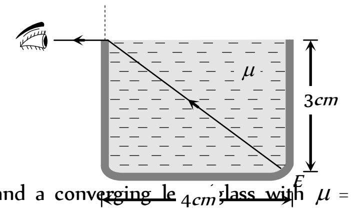
10. When the rectangular metal tank is filled to the top with an unknown liquid, as observer with eyes level with the top of the tank can just see the corner *E*; a ray that refracts towards the observer at the top surface of the liquid is shown. The refractive index of the liquid will be

(a) 1.2

(b) 1.4

(c) 1.6

(d) 1.9



11. A concave mirror and a converging lens (glass with μ = 1.5) both have a focal length of 3 *cm* when in air. When they are in water $\left(\mu = \frac{4}{3}\right)$, their new focal lengths are

(a) f_{Lens} = 12 *cm*, f_{Mirror} = 3*cm*

(b) f_{Lens} = 3 *cm*, f_{Mirror} = 12*cm*

(c) f_{Lens} = 3 *cm*, f_{Mirror} = 3*cm*

(d) f_{Lens} = 12 *cm*, f_{Mirror} = 12*cm*

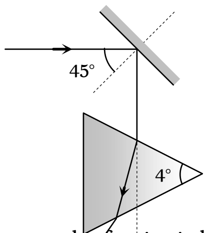
12. A ray of light strikes a plane mirror *M* at an angle of 45° as shown in the figure. After reflection, the ray passes through a prism of refractive index 1.5 whose apex angle is 4°. The total angle through which the ray is deviated is

(a) 90°

(b) 91°

(c) 92°

(d) 93°



13. A slab of glass, of thickness 6 *cm* and refractive index 1.5, is placed in front of a concave mirror, the faces of the slab being perpendicular to the principal axis of the mirror. If the radius of curvature of the mirror is 40 *cm* and the reflected image coincides with the object, then the distance of the object from the mirror is

(a) 30 *cm* (b) 22 *cm*

(c) 42 *cm* (d) 28 *cm*

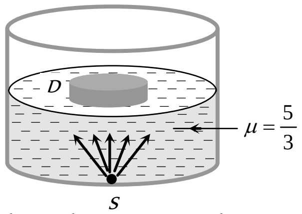
14. A point source of light *S* is placed at the bottom of a vessel containing a liquid of refractive index 5/3. A person is viewing the source from above the surface. There is an opaque disc *D* of radius 1 *cm* floating on the surface of the liquid. The centre of the disc lies vertically above the source *S*. The liquid from the vessel is gradually drained out through a tap. The maximum height of the liquid for which the source cannot be seen at all from above is

(a) 1.50 *cm*

(b) 1.64 *cm*

(c) 1.33 *cm*

(d) 1.86 *cm*



15. A point object is placed mid-way between two plane mirrors distance '*a*' apart. The plane mirror forms an infinite number of images due to multiple reflection. The distance between the *n*th order image formed in the two mirrors is

(a) *na* (b) 2*na*

(c) *na*/2 (d) *n a*

16. A convergent beam of light is incident on a convex mirror so as to converge to a distance 12 *cm* from the pole of the mirror. An inverted image of the same size is formed coincident with the virtual object. What is the focal length of the mirror

(a) 24 *cm* (b) 12 *cm*

(c) 6 *cm* (d) 3 *cm*

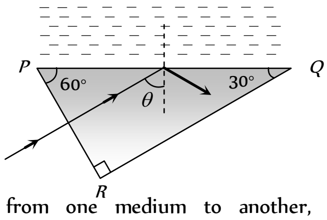
17. *PQR* is a right angled prism with other angles as 60° and 30°. Refractive index of prism is 1.5. *PQ* has a thin layer of liquid. Light falls normally on the face *PR*. For total internal reflection, maximum refractive index of liquid is

(a) 1.4

(b) 1.3

(c) 1.2

(d) 1.6



18. When a ray is refracted from one medium to another, the wavelength changes from 6000 Å to 4000 Å. The critical angle for the interface will be

(a) $\cos^{-1}\left(\frac{2}{3}\right)$ (b) $\sin^{-1}\left(\frac{2}{\sqrt{3}}\right)$

(c) $\sin^{-1}\left(\frac{2}{3}\right)$ (d) $\cos^{-1}\left(\frac{2}{\sqrt{3}}\right)$

19. Two thin lenses, when in contact, produce a combination of power + 10 *D*. When they are 0.25 *m* apart, the power reduces to + 6*D*. The focal lengths of the lenses (in *m*) are

(a) 0.125 and 0.5 (b) 0.125 and 0.125

(c) 0.5 and 0.75 (d) 0.125 and 0.75

20. The plane faces of two identical plano convex lenses, each with focal length *f* are pressed against each other using an optical glue to form a usual convex lens. The distance from the optical centre at which an object must be placed to obtain the image same as the size of object is

(a) $\frac{f}{4}$ (b) $\frac{f}{2}$

(c) *f* (d) 2 *f*

21. A parallel beam of light emerges from the opposite surface of the sphere when a point source of light lies at the surface of the sphere. The refractive index of the sphere is

(a) $\frac{3}{2}$ (b) $\frac{5}{3}$

(c) 2 (d) $\frac{5}{2}$

22. A ray of light makes an angle of 10° with the horizontal above it and strikes a plane mirror which is inclined at an angle θ to the horizontal. The angle θ for which the reflected ray becomes vertical is

(a) 40° (b) 50°

(c) 80° (d) 100°

23. A thin rod of $5cm$ length is kept along the axis of a concave mirror of $10cm$ focal length such that its image is real and magnified and one end touches the rod. Its magnification will be

(a) 1 (b) 2

(c) 3 (d) 4

24. A telescope using light having wavelength 5000 Å and using lenses of focal 2.5 and 30 *cm*. If the diameter of the aperture of the objective is 10 *cm*, then the resolving limit and magnifying power of the telescope is respectively

(a) $6.1\times10^{-6} rad$ and 12

(b) $5.0\times10^{-6} rad$ and 12

(c) $6.1\times10^{-6} rad$ and 8.3×10^{-2}

(d) $5.0\times10^{-6} rad$ and 8.3×10^{-2}

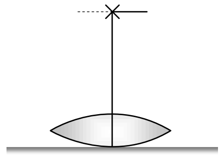
25. A lens when placed on a plane mirror then object needle and its image coincide at 15 *cm*. The focal length of the lens is

(a) 15 *cm*

(b) 30 *cm*

(c) 20 *cm*

(d) ∞



Answers and Solutions

(SET -29)

1. (a) Here we treat the line on the objective as the object and the eyepiece as the lens.

Hence $u = -(f_o + f_e)$ and $f = f_e$

Now $\frac{1}{v} - \frac{1}{-(f_o+f_e)} = \frac{1}{f_e}$

Solving we get $v = \frac{(f_o+f_e)f_e}{f_o}$

Magnification $= \left|\frac{v}{u}\right| = \frac{f_e}{f_o} = \frac{\text{Image size}}{\text{Object size}} = \frac{l}{L}$

∴ Magnification of telescope in normal adjustment

$= \frac{f_o}{f_e} = \frac{L}{l}$

2. (c) According to the problem, combination of L_1 and L_2 act a simple glass plate. Hence according to formula $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$

$\frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2} = 0 \Rightarrow \frac{1}{f_1} + \frac{1}{f_2} = \frac{d}{f_1 f_2}$

$\Rightarrow \frac{1}{30} - \frac{1}{10} = \frac{d}{30 \times -10} \Rightarrow \frac{-20}{30 \times 10} = -\frac{d}{30 \times 10}$

$\Rightarrow d = 20\,cm$

3. (d) From the figure for real image formation

$x + x' + 2f \geq 4f \Rightarrow x + x' \geq 2f.$

4. (d) An eye sees distant objects with full relaxation

So $\frac{1}{2.5 \times 10^{-2}} - \frac{1}{-\infty} = \frac{1}{f}$ or $P = \frac{1}{f} = \frac{1}{25 \times 10^{-2}} = 40D$

An eye sees an object at 25 *cm* with strain

So $\frac{1}{2.5 \times 10^{-2}} - \frac{1}{-25 \times 10^{-2}} = \frac{1}{f}$

or $P = \frac{1}{f} = 40 + 4 = 44D$

5. (a) By using $\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

where $\mu_1 = \frac{4}{3}$, $\mu_2 = 1$, $u = -6\,cm$, $v = ?$

On putting values $v = -5.2\,cm$

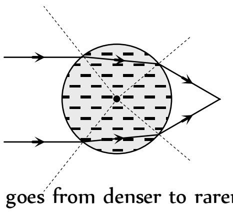
6. (d) Apparent distance of fish from lens $u = 0.2 + \frac{h}{\mu}$

$= 0.2 + \frac{0.4}{4/3} = 0.5\,m$

From $\frac{1}{f} = \frac{1}{v} - \frac{1}{u} \Rightarrow \frac{1}{(+3)} = \frac{1}{v} - \frac{1}{(-0.5)}$ $v = -0.6\,m$

The image of the fish is still where the fish is 0.4 *m* below the water surface.

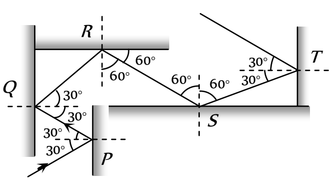
7. (b) A water drop in air behaves as converging lens.



8. (a) When light ray goes from denser to rarer medium (*i.e.* more μ to less μ) it deviates away from the normal while if light ray goes from rarer to denser medium (*i.e.* less μ more μ) it bend towards the normal.

This property is satisfying by the ray diagram (i) only.

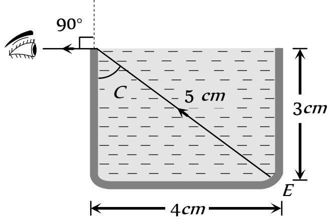
9. (c)



10. (a) Light ray is going from liquid (Denser) to air (Rarer) and angle of refraction is 90^o, so angle of incidence must be equal to critical angle

from figure

$\sin C = \frac{4}{5}$



Also $\mu = \frac{1}{\sin C} = \frac{5}{4} = 1.2$

11. (a) Focal length of lens will increase by four times (*i.e.* 12 *cm*) while focal length of mirror will not affected by medium.

12. (c) $\delta_{net} = \delta_{mirror} + \delta_{prism}$

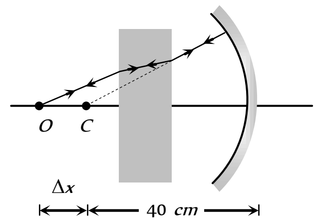
$= (180 - 2i) + (\mu - 1)A$

$= (180 - 2 \times 45) + (1.5 - 1) \times 4 = 92^o$

13. (c) $\Delta x = \left(1 - \frac{1}{\mu}\right)t$

$= \left(1 - \frac{1}{1.5}\right) \times 6$

= 2 *cm.*



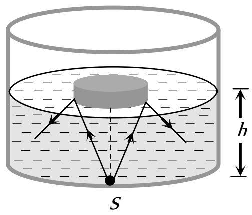
Distance of object from mirror = 42 *cm.*

14. (c) Suppose the maximum height of the liquid is h for which the source is not visible.

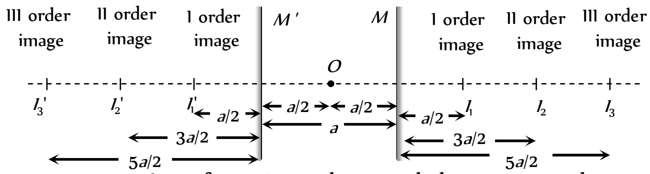
Hence radius of the disc

$r = \frac{h}{\sqrt{\mu^2 - 1}}$

$1 = \frac{h}{\sqrt{\left(\frac{5}{3}\right)^2 - 1}} \Rightarrow h = 1.33\,cm$



15. (b)

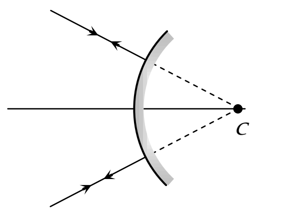


From above figure it can be proved that separation between *n*th order image formed in the two mirrors = $2na$

16. (c) Here object and image are at the same position so this position must be centre of curvature

$\therefore$ R = 12 *cm*

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



17. (b) For *TIR* at PQ; $\theta < C$

From geometry of figure $\theta = 60$ *i.e.* $60 > C$

$\Rightarrow \sin 60 > \sin C$

$\Rightarrow \frac{\sqrt{3}}{2} > \frac{\mu_{Liquid}}{\mu_{Prism}} \Rightarrow \mu_{Liquid} < \frac{\sqrt{3}}{2} \times \mu_{Prism}$

$\Rightarrow \mu_{Liquid} < \frac{\sqrt{3}}{2} \times 1.5 \Rightarrow \mu_{Liquid} < 1.3$.

18. (c) ${}_1\mu_2 = \frac{1}{\sin C} \Rightarrow \frac{\mu_2}{\mu_1} = \frac{\lambda_1}{\lambda_2} = \frac{1}{\sin C}$

$\Rightarrow \frac{6000}{4000} = \frac{1}{\sin C} \Rightarrow C = \sin^{-1}\left(\frac{2}{3}\right)$

19. (a) When lenses are in contact

$P = \frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} \Rightarrow 10 = \frac{1}{f_1} + \frac{1}{f_2}$ ..... (i)

When they are distance d apart

$P' = \frac{1}{F'} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2} \Rightarrow 6 = \frac{1}{f_1} + \frac{1}{f_2} - \frac{0.25}{f_1 f_2}$ ..... (ii)

From equation (i) and (ii) $f_1 f_2 = \frac{1}{16}$ ..... (iii)

From equation (i) and (iii) $f_1 + f_2 = \frac{5}{8}$ ..... (iv)

Also $(f_1 - f_2)^2 = (f_1 + f_2)^2 - 4 f_1 f_2$

Hence $(f_1 - f_2)^2 = \left(\frac{5}{8}\right)^2 - 4 \times \frac{1}{16} = \frac{9}{64}$

$\Rightarrow f_1 - f_2 = \frac{3}{8}$ ..... (v)

On solving (iv) and (v) $f_1 = 0.5\,m$ and $f_2 = 0.125\,m$

20. (c) Two plano-convex lens of focal length f, when combined will give rise to a convex lens of focal length $f/2$.

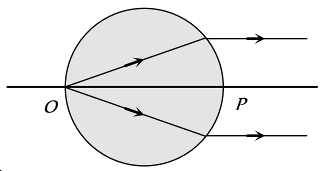
The image will be of same size if object is placed at $2f$ *i.e.* at a distance f from optical centre.

21. (c) Considering pole at P, we have

$\frac{\mu_2}{v} - \frac{\mu_1}{u} = \frac{\mu_2 - \mu_1}{R}$

$\Rightarrow \frac{1}{\infty} - \frac{\mu}{(-2R)} = \frac{1-\mu}{(-R)}$

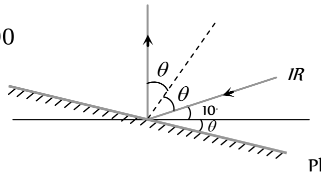
$\Rightarrow \frac{\mu}{2R} = \frac{1-\mu}{(-R)} \Rightarrow \mu = 2$



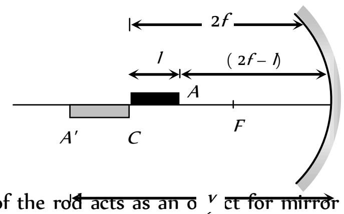
22. (a) From figure

$\theta + \theta + 10 = 90$

$\Rightarrow \theta = 40^o$



23. (b)



End A of the rod acts as an object for mirror and A' will be its image so $u = 2f - l = 20 - 5 = 15\,cm$

$\because \frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{-10} = \frac{1}{v} - \frac{1}{15} \Rightarrow v = -30\,cm$.

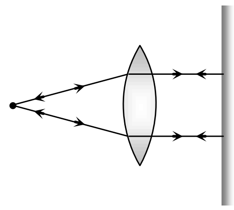
Now $m = \frac{\text{Length of image}}{\text{Length of object}} = \frac{(30-20)}{5} = 2$

24. (a) $m = \frac{f_0}{f_e} = \frac{30}{2.5} = 12$

Resolving limit $= \frac{1.22\,\lambda}{a} = \frac{1.22 \times (5000 \times 10^{-10})}{0.1}$

$= 6.1 \times 10^{-6}\,rad$

25. (a) When the object is placed at focus the rays are parallel. The mirror placed normal sends them back. Hence image is formed at the object itself as illustrated in figure.



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