DRGP Institute

Chapter 9

Ray Optics and Optical Instrument

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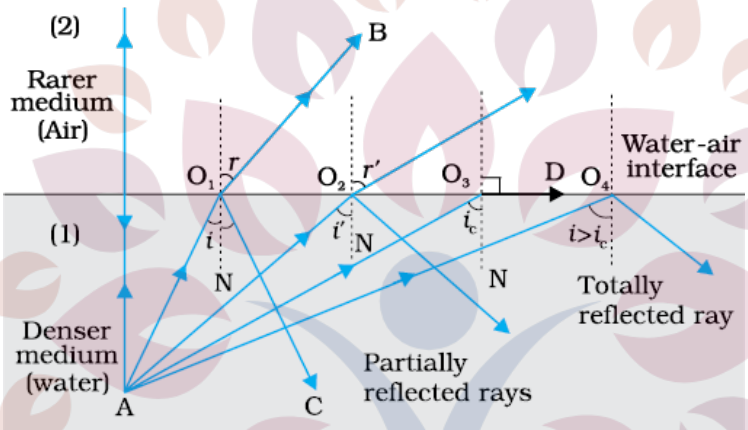
BOARD:- 2013

1. Define the phenomenon of Total internal reflection.

⇒ when light rays travels from denser to rare medium and angle of incident in denser medium is more than critical angle than light ray reflect back in same denser medium. This phenomena is called TIR.



2. Match the column-

	Column-1	Column-2
A.	$\angle i = \angle r$	Snell's Law
B.	$\mu = 1/\sin i_c$	Law of Reflection
C.	$\mu = \sin i/\sin r$	Prism
D.	$\mu = \dfrac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2}$	Total internal reflection

⇒ A. $\angle i = \angle r$ — Law of Reflection

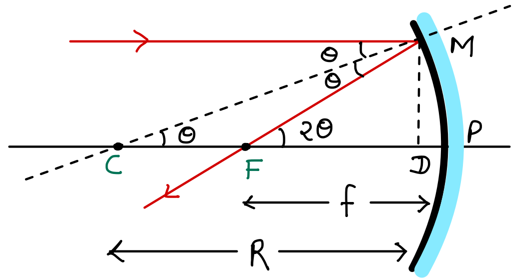
B. $\mu = \dfrac{1}{\sin i_c}$ — Total internal reflection

C. $\mu = \dfrac{\sin i}{\sin r}$ — Snell's Law

D. $\mu = \dfrac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin A/2}$ — Prism

3. Draw ray diagram for concave mirror and prove that focal length of the mirror is half the radius of curvature. write mirror equation for a concave mirror. when light enters from a rare medium to a denser medium, what will be effect on its wavelength & frequency?

⇒ a. Relation b/w f & R - Let C be the centre of curvature of the mirror. Consider a ray parallel to the principal axis striking the mirror at M.



In △MPF

$$\tan 2\theta = \frac{MP}{PF}$$

for small angle $\tan 2\theta \simeq 2\theta$

$$2\theta = \frac{MP}{PF} \quad \text{— ①}$$

Similiary in △MPC

$$\tan\theta \simeq \theta = \frac{MP}{PC} \quad \text{-②}$$

Put in eq^n -

$$2\left(\frac{MP}{PC}\right) = \frac{MP}{PF}$$

$$2PF = PC$$

$$2(-f) = -R$$

$$\boxed{f = R/2}$$

b. Mirror Equation -

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

f = focal length
v = distance of image
u = distance of object

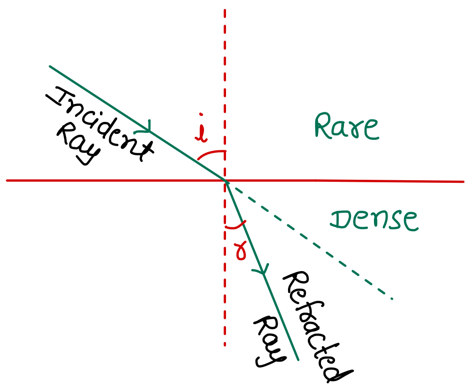
c. Effect on wavelength & frequency - when light enters from rarer to denser medium, there will be -

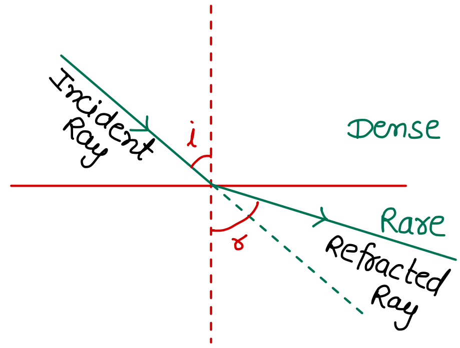
(i) No effect on frequency
(ii) Due to reduction in velocity, the wavelength of light also reduces.

BOARD - 2013 (Supp.)

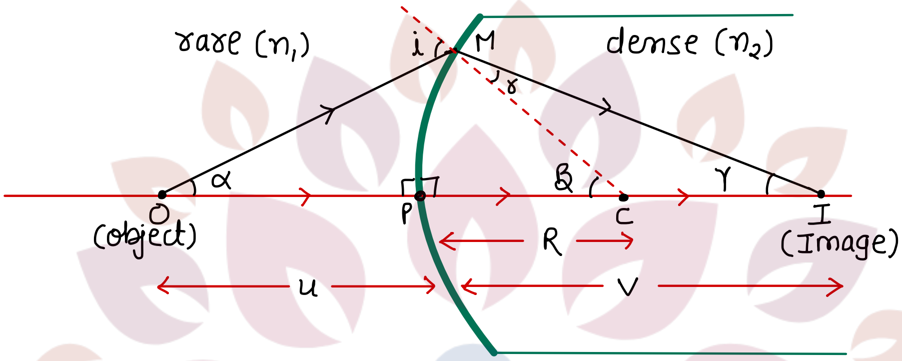
4. Define refraction of light. For the refraction from the curved spherical surface, establish the relation $\left[\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}\right]$ in terms of object and image distances, refractive index of the medium and radius of curvature. Draw necessary ray diagram.

⇒ Refraction - when a light ray travels from one transparent medium to another then speed of light changes and path of light also changes. This process is known as refraction of light.





Refraction by spherical surface -



Suppose rays are incident from a medium of refractive index n_1 to another of refractive index n_2. Aperture of surface is small, so small angle approximation take place.

In $\triangle MPO$ -

$$\tan\alpha \simeq \alpha = \frac{MP}{PO}$$

$$\alpha = \frac{MP}{-u} \quad -(1)$$

In $\triangle MPC$ - $\tan\beta \simeq \beta = \frac{MP}{PC}$

$$\beta = \frac{MP}{R} \quad -(2)$$

In $\triangle MPI$ - $\tan\gamma \simeq \gamma = \frac{MP}{PI}$

$$\gamma = \frac{MP}{v} \quad -(3)$$

Calculation of 'i' -

$$\text{ext.}\angle = \text{sum of int.}\angle$$

$$i = \alpha + \beta \quad -(4)$$

Calculation of 'r' -

$$\text{ext.}\angle = \text{sum of int.}\angle$$

$$\beta = r + \gamma$$

$$r = \beta - \gamma \quad -(5)$$

By Snell's Law -

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

$$n_2 \sin r = n_1 \sin i$$
$$n_2 r = n_1 i$$

{ for small angle - $\sin\theta \simeq \theta$ }

put values of r & i

$$n_2(\beta - \gamma) = n_1(\alpha + \beta)$$

$$n_2\left(\frac{MP}{R} - \frac{MP}{V}\right) = n_1\left(\frac{MP}{-u} + \frac{MP}{R}\right)$$

$$\frac{n_2}{R} - \frac{n_2}{V} = \frac{n_1}{R} - \frac{n_1}{u}$$

$$\frac{n_1}{u} - \frac{n_2}{V} = \frac{n_1}{R} - \frac{n_2}{R}$$

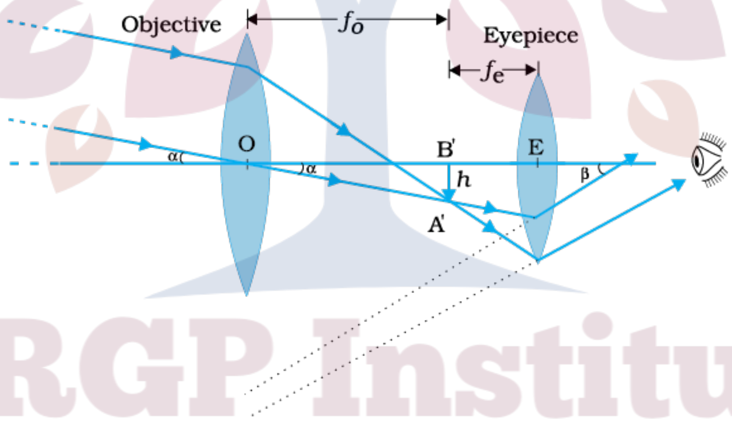
$$\boxed{\frac{n_1}{u} - \frac{n_2}{V} = \frac{n_1 - n_2}{R}}$$

BOARD:- 2014

5. Draw a labelled ray diagram of a refractive telescope. Deduce an expression of magnifying power of it. Write two main limitation of refractive type telescope over a reflecting type telescope. [4]

⇒

(a) Refractive Telescope -



(b) Magnifying power of Telescope -

object is placed at f_e so image is formed at ∞

$$\text{magnification} = \frac{\beta}{\alpha} \quad -①$$

'm' is ratio of angle β subtended at eye by final image to the angle α subtended at eye by object.

$$\tan\beta \simeq \beta = \frac{A'B'}{f_e}$$

$$\tan\alpha \simeq \alpha = \frac{A'B'}{f_o}$$

put in eq^n ①

$$m = \frac{A'B'}{f_e} \div \frac{A'B'}{f_o}$$

$$\boxed{m = \frac{f_o}{f_e}}$$

(c) Refractive v/s Reflecting -

Refracting Telescope	Reflecting Telescope
1. It has chromatic aberration	1. It has no chromatic aberration.
2. It has spherical aberration which can't be removed.	2. It has spherical aberration which can be removed with the help of parabolic mirror.
3. Image is faint and it is costly.	3. Image is bright & sharp and it is less costly.
4. Difficult to handle	4. Easy to handle.
5. Difficult to make lens of large aperature	5. Easy to make mirror of large aperature.

BOARD:- 2015

6. write the relation b/w the object distance u, image distance v and focal length f for a concave mirror?

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

7. what will be radius of curvature of a concave mirror of focal length 10 cm?

⇒ $f = -10cm$

$R = 2f = -20cm.$

8. Draw a ray diagram for refraction at a spherical surface separating two media. for refraction on a spherical surface, the relationship b/w object distance (u), image distance (v), refractive index of the medium (n_1, n_2) and radius of curvature (R).

$$\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$$

BOARD - 2016

9. The radius of curvature of a concave mirror is 40cm. Find its focal length.

⇒ $$f = \frac{R}{2} = \frac{-40}{2} = -20\,cm$$

10. (i) Why reflecting telescope better than refracting telescope?
(ii) The magnifying power of a telescope is 8. When it is adjusted for parallel rays. Then the distance b/w eyepiece & objective lens is 18 cm? find focal length of both the lenses?

⇒ (i) ✓
(ii)

$$m = 8$$
$$L = f_o + f_e = 18\,cm$$
$$f_o = ? \quad f_e = ?$$

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

$$f_o = mf_e$$
$$L = mf_e + f_e$$
$$18 = 8f_e + f_e$$
$$18 = 9f_e$$

$$\boxed{f_e = 2\,cm}$$

$$f_o = 16\,cm$$

11. Describe the structure of a compound microscope. Derive the formula for its total magnifying power through microscope. Draw the ray diagram.

⇒ Compound Microscope - A compound microscope contains two lenses -

(i) Object lens ⇓ - Lens nearest the object

(ii) eye piece lens ⇓ - Lens nearest to eye.

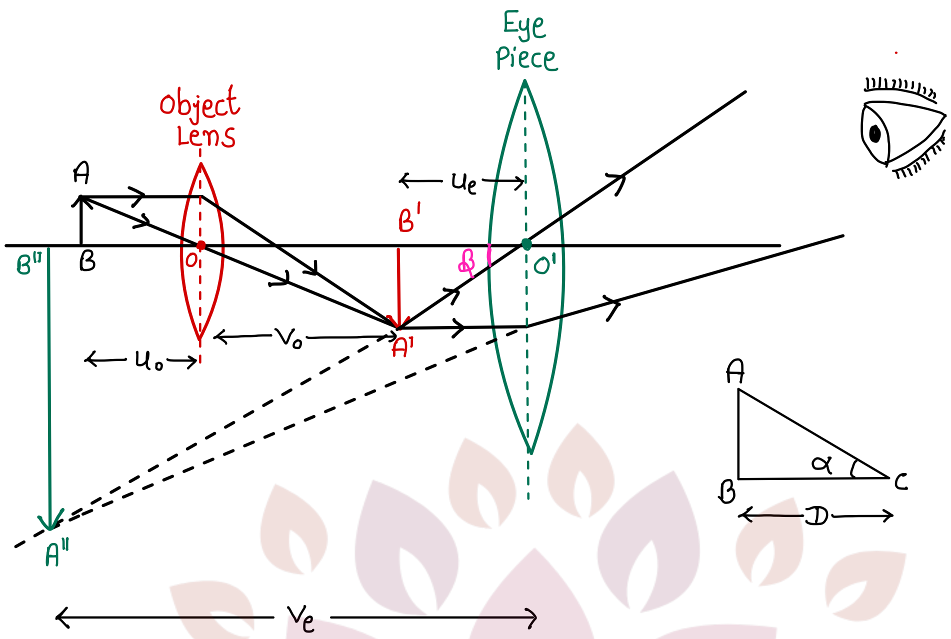
→ The image formed by object lens, serve as object for eyepiece Lens.

→ The aperture and focal length of eyepiece lens is greater than object lens.

→ Tube length $L = f_o + f_e$

Magnification -

$$m = \frac{\beta}{\alpha} \quad -①$$



in $\Delta A'B'O'$ $\quad \tan\beta \simeq \beta = \dfrac{A'B'}{u_e}$

in ΔABC $\quad \tan\alpha \simeq \alpha = \dfrac{AB}{D}$

Put in eq^n ①

$$m = \frac{A'B'}{u_e} \Big/ \frac{AB}{D}$$

$$m = \frac{A'B'}{AB} \times \frac{D}{u_e}$$

$\left\{ \dfrac{A'B'}{AB} = \text{magnification of objective lens} = m_o \right\}$

$$m = m_o \times \frac{D}{u_e}$$

$$m = -\frac{V_o}{u_o}\left(\frac{D}{u_e}\right) \quad - ②$$

if image is formed at D -

$$\frac{1}{f_e} = \frac{1}{V_e} - \frac{1}{u_e}$$

$U_e = -u_e$

$V_e = -D$

$$\frac{1}{f_e} = -\frac{1}{D} + \frac{1}{u_e}$$

multiply by D on both side

$$\frac{D}{f_e} = -\frac{D}{D} + \frac{D}{u_e}$$

$$\frac{D}{u_e} = \frac{D}{f_e} + 1$$

put in eqⁿ ②

$$m = \frac{-V_o}{u_o}\left(1 + \frac{D}{f_e}\right)$$

if image is formed ∞ -

$$\frac{1}{f_e} = \frac{1}{V_e} - \frac{1}{u_e}$$

$$\frac{1}{f_e} = \frac{1}{-\infty} - \frac{1}{-u_e}$$

$$f_e = u_e$$

put in eqⁿ ②

$$m = \frac{-V_o}{u_o}\left(\frac{D}{f_e}\right)$$

BOARD - 2017

12. Write the definition of refractive index of medium.

⇒ Ratio of speed of light in air and speed of light in medium is called the refractive index of medium.

$$\mu = \frac{c}{V}$$

13. The focal length of objective and eyepiece of a small telescope are 192 cm and 8 cm respectively. Find the distance b/w two lenses and m.

⇒ $f_o = 192$ cm

$f_e = 8$ cm

(i) $m = \frac{f_o}{f_e} = \frac{192}{8} = 24$

(ii) Distance b/w lenses - $L = f_o + f_e$

$L = 192 + 8 = 200$ cm

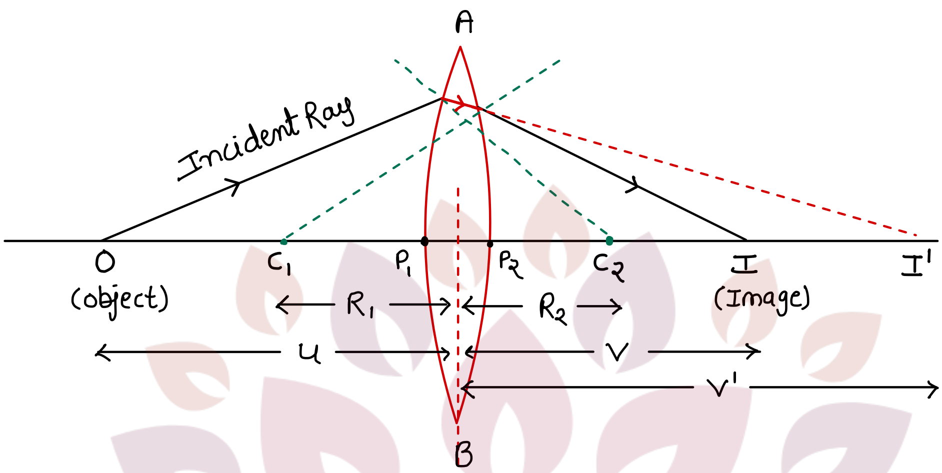
14. What is lateral displacement? Establish relationship b/w focal length & radius of curvature of a mirror.

⇒ (a) Lateral Displacement - when a ray of light travels through a rectangular slab, the ⊥ distance b/w the emergent ray and incident ray is called lateral displacement.

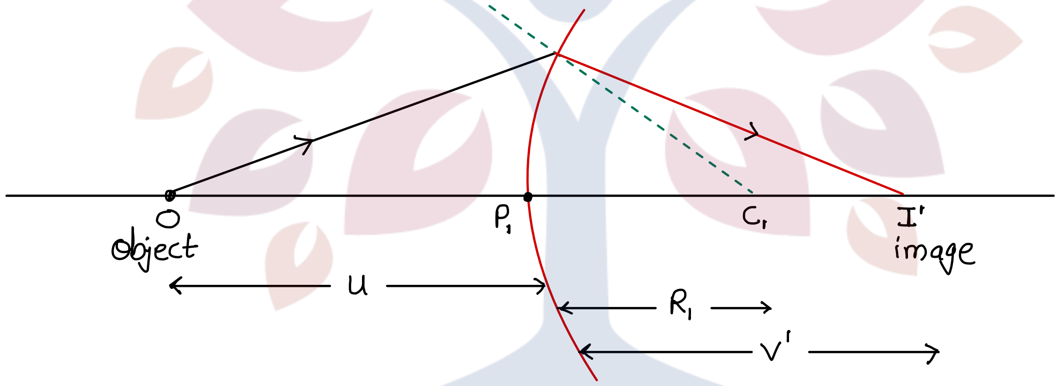
(b) Relation b/w R & f - ✓

15. Derive lens maker formula. The lower half of the concave mirror's reflecting surface is covered with opaque material. What will be the effect on the image formed by the mirror?

⇒ (a) Lens maker formula -



A. Refraction by AP_1B spherical surface -

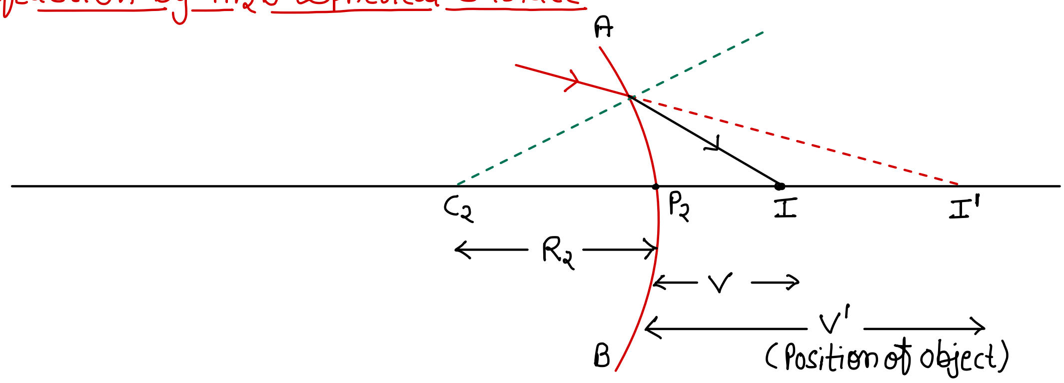


Refraction formula for rare to denser -

$$\frac{n_2}{\text{Position of image}} - \frac{n_1}{\text{Position of object}} = \frac{n_2 - n_1}{\text{Radius of curvature}}$$

$$\frac{n_2}{v'} - \frac{n_1}{u} = \frac{n_2 - n_1}{R_1} \quad \text{— (1)}$$

B. Refraction by AP_2B spherical surface



Refraction formula for denser to rare

$$\frac{n_1}{\text{Position of image}} - \frac{n_2}{\text{Position of object}} = \frac{n_1 - n_2}{\text{Radius of curvature}}$$

$$\frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_1 - n_2}{R_2} \quad — ①$$

eq^n ① + eq^n ②

$$\frac{n_2}{v'} - \frac{n_1}{u} + \frac{n_1}{v} - \frac{n_2}{v'} = \frac{n_2 - n_1}{R_1} + \frac{n_1 - n_2}{R_2}$$

$$n_1\left(\frac{1}{v} - \frac{1}{u}\right) = (n_2 - n_1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{v} - \frac{1}{u} = \frac{n_2 - n_1}{n_1}\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\frac{1}{f} = \left(\frac{n_2}{n_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

$$\boxed{\frac{1}{f} = (n_{21} - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)}$$

Lens maker's formula

BOARD - 2017 (Supp)

16. Two thin lens of power +5D and -3D are in contact. Find out the focal length of combination. Write the type of resultant lens. [2]

⇒

$P = P_1 + P_2 + \ldots$

$P = P_1 + P_2$

$P = 5 + (-3)$

$P = 2D$

↳ +ve, so lens is convex lens (converging Lens)

17. Write sign convention rule for mirrors & Lenses. Draw a ray diagram for image formation by concave mirror and establish a relation b/w u, v & f.

⇒ A. Sign convention rule -

(i) $u = -ve$

(ii) f = concave = -ve

convex = +ve

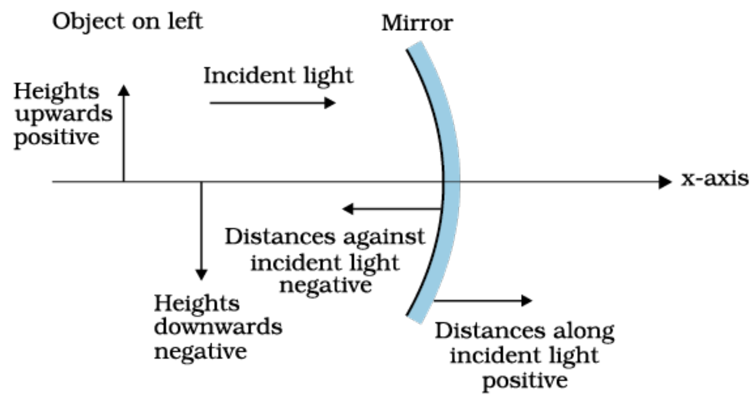
(iii) h = +ve

(iv) h' = virtual = +ve

Real = -ve

(v) v = virtual = +ve

Real = -ve



For lens –

(i) $u = -ve$

(ii) f = concave = $-ve$

convex = $+ve$

(iii) $h = +ve$

(iv) h' = virtual = $+ve$

Real = $-ve$

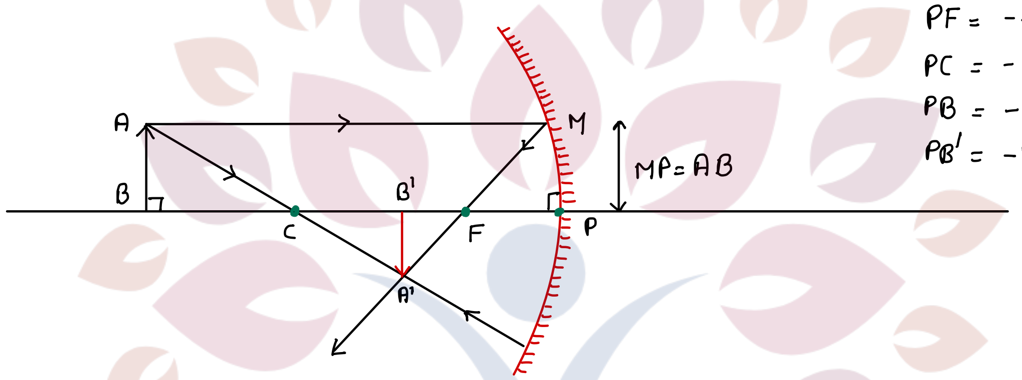
(v) v = virtual = $-ve$

Real = $+ve$

(vi) m = virtual = $+ve$

Real = $-ve$

B. Ray diagram for image formation by concave mirror –



$PF = -f$

$PC = -2f$

$PB = -u$

$PB' = -v$

$\triangle ABC \sim \triangle A'B'C$ by AA rule -

$$\frac{AB}{A'B'} = \frac{BC}{B'C'}$$

$$\frac{AB}{A'B'} = \frac{PB - PC}{PC - PB'} = \frac{-u-(-2f)}{-2f-(-v)}$$

$$\frac{AB}{A'B'} = \frac{-u+2f}{-2f+v} \quad \text{— ①}$$

$\triangle MPF \sim \triangle A'B'F$ by AA rule.

$$\frac{MP}{A'B'} = \frac{PF}{B'F}$$

$$\frac{AB}{A'B'} = \frac{PF}{PB' - PF} \qquad \{AB = MP\}$$

$$\frac{AB}{A'B'} = \frac{-f}{-v-(-f)}$$

$$\frac{AB}{A'B'} = \frac{-f}{f-v} \quad \text{— ②}$$

from ① & ②

$$\frac{-u+2f}{-2f+v} = \frac{-f}{f-v}$$

$$-uf + uv + 2f^2 - 2vf = +2f^2 - vf$$

$$-uf + uv - vf = 0$$

divide by uvf

$$-\frac{uf}{uvf} + \frac{uv}{uvf} - \frac{vf}{uvf} = 0$$

$$-\frac{1}{v} + \frac{1}{f} - \frac{1}{u} = 0$$

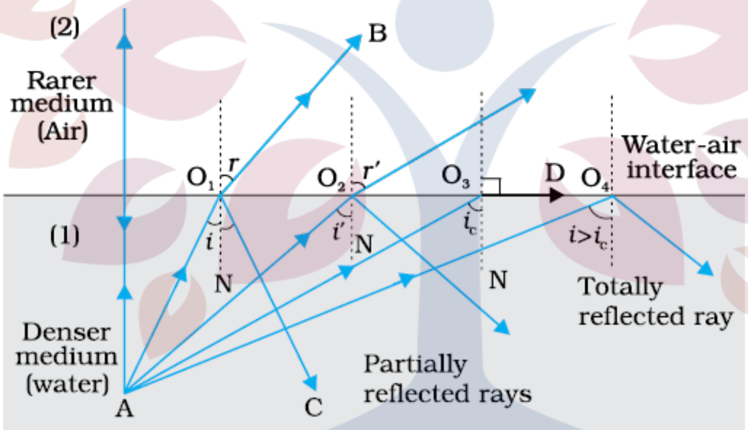
$$\boxed{\frac{1}{f} = \frac{1}{v} + \frac{1}{u}}$$

18. Define total internal reflection. write two conditions for it. Draw a graph b/w the angle of deviation (δ) and incident angle (i) for a prism. Derive

$$\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin(A/2)}$$

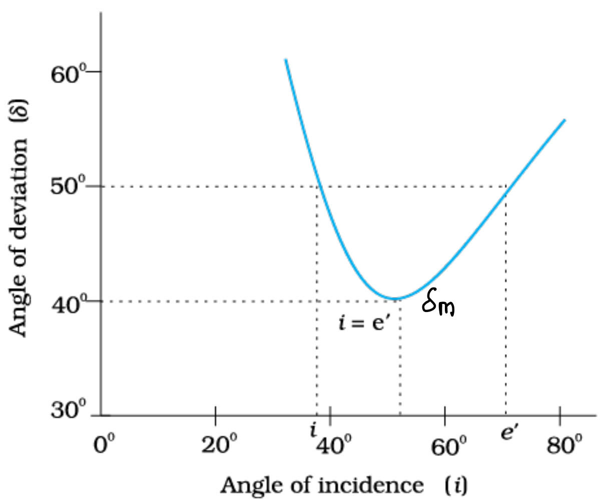
⇒ (A) Total internal reflection.

when light rays travels from denser to rare medium and angle of incident in denser medium is more than critical angle than light ray reflect back in same denser medium. This phenomena is called TIR.

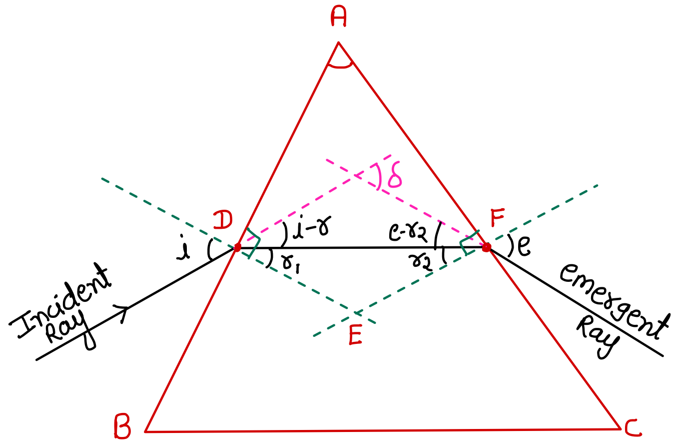


Conditions - 1. Light rays must travell from Denser to rarer medium.
2. $\angle i > \angle i_c$ (Critical angle).

(B) Graph b/w δ and i -



(C) Derivation -



$\angle A$ = Prism angle (angle b/w 2 refractive surface)
$\angle \delta$ = Angle b/w direction of incident ray & emergent ray is called angle of deviation.

W.K.T

According to Snell's Law -

$$n = \frac{\sin i}{\sin r} \quad \text{— (1)}$$

(A) Calculation of r

in □ ADEF

$$\angle A + \angle D + \angle E + \angle F = 360°$$
$$\angle A + 90° + \angle E + 90° = 360°$$
$$\angle A + \angle E + 180° = 360°$$
$$\angle A + \angle E = 180° \quad \text{— (2)}$$

in △ DEF

$$\angle r_1 + \angle r_2 + \angle E = 180° \quad \text{- (3)}$$

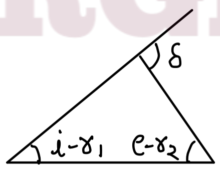
from (2) & (3)

$$\angle r_1 + \angle r_2 = \angle A \quad \text{- (4)}$$

By practical results $\angle r_1 + \angle r_2 = \angle r$

$$\angle r + \angle r = \angle A$$
$$\angle r = \angle A/2 \quad \text{- (5)}$$

(B) Calculation of i -



ext ∠ = Sum of int. ∠

$$\delta = \angle i - r_1 + \angle e - r_2$$
$$\delta = \angle i + \angle e - \angle(r_1 + r_2)$$
$$\delta = \angle i + \angle e - \angle A$$

at minimum angle of deviation -

$$\angle i = \angle e$$
$$\delta = \delta_{min}$$

$$\delta_{min} = \angle i + \angle i - \angle A$$
$$\angle i = \frac{\delta_{min} + \angle A}{2} \quad \text{— (6)}$$

put value of $\angle i$ & $\angle r$ in eq^n (1)

$$n = \frac{\sin\left(\frac{\delta_{min} + \angle A}{2}\right)}{\sin \angle A/2}$$

BOARD:- 2018

19. (a) what does mean by magnifying power of a microscope?
(b) An object is placed at 20 cm from a convex lens. If 3 times magnified real image is formed by the lens then find the focal length of lens.

⇒ (a) magnification-

$$m = \frac{\beta}{\alpha}$$

'm' is ratio of angle β subtended at eye by final image to the angle α subtended at eye by object.

(b) $u = -20\,cm$

$m = -3$

$f = ?$

$$m = \frac{v}{u}$$

$$-3 = \frac{v}{(-20)}$$

$$v = 60\,cm$$

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

$$\frac{1}{f} = \frac{1}{60} - \frac{1}{-20}$$

$$\frac{1}{f} = \frac{1+3}{60}$$

$$f = 15\,cm$$

BOARD:- 2019

20. write relation b/w power of lens & its focal length.

⇒ $$P = \frac{1}{f}$$

21. Total internal reflection.
22. Deduce expression for mirror equation. Draw necessary ray diagram.
23. Find focal length of a spherical mirror of radius of curvature 10 cm.

⇒ $$f = R/2 = 5\,cm$$

BOARD:- 2020

24. focal length of convex lens in air is 25 cm. If it is immersed in water then find the focal length of the lens. ($n_w = 4/3$, $n_g = 3/2$)

⇒

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

when lens is in air -

$$\frac{1}{f_1} = (n_{ga}-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{f_1} = \left(\frac{n_g}{n_a}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \quad -①$$

when placed in water -

$$\frac{1}{f_2} = (n_{gw}-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$$

$$\frac{1}{f_2} = \left(\frac{n_g}{n_w}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right) \quad -②$$

$eq^n ① / eq^n 2$

$$\frac{f_2}{f_1} = \frac{(n_g/n_a - 1)}{(n_g/n_w - 1)}$$

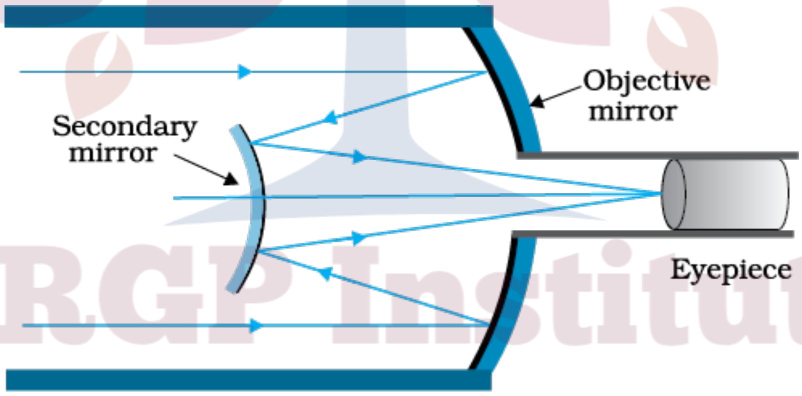
$$\frac{f_2}{25} = \frac{(3/2 \div 1 \ -1)}{(3/2 \div 4/3 - 1)}$$

$$f_2 = \frac{(1/2)}{(1/8)} \times 25$$

$$f_2 = \frac{8}{2} \times 25 = 100\, cm$$

25. Describe the structure and working of reflecting telescope. Make the necessary ray diagram.

⇒



→ In reflecting or cassegrain telescope we use a large parabolic concave mirror as objective.

→ There is another mirror which is used as 2° mirror.

→ There is hole in objective mirror, where eye piece lens is placed.

→ Due to all these arrangement -

1. No chromatic aberration
2. Image is bright & sharp
3. By use of parabolic mirror spherical aberration can be reduced.

BOARD- 2021

26. If image formed at ∞ by simple microscope, then formula for its magnifying power (M) will be-

⇒ $M = D/f$

27. The power of objective and eye-piece are 4D & 24D respectively in an astronomical telescope. If final image formed at ∞ then calculate the magnifying power of telescope.

⇒ Astronomical telescope –
(Refracting telescope)

$f_o = 1/P_o = 1/4 \text{ m}$

$f_e = 1/P_e = 1/24 \text{ m}$

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

$m = 1/4 \div 1/24$

$m = \frac{24}{4}$

$m = 6$

28. Derive

$$\eta = \frac{\sin\left(A+\delta m/2\right)}{\sin(A/2)}$$

BOARD- 2022

29. If refractive index of denser medium 1 with respect to rarer medium 2 is n_{12} and critical angle for this pair of media is i_c, then correct relation b/w n_{12} & i_c is -

A. $n_{12} = \sin i_c$ B. $n_{12} = \tan i_c$

C. $n_{12} = 1/\tan i_c$ D. $n_{12} = 1/\sin i_c$

⇒ $n_{21} = \frac{\sin i}{\sin r}$

when $i = i_c$ then $r = 90^\circ$

$$n_{12} = \frac{\sin r}{\sin i_c}$$

$$n_{12} = \frac{1}{\sin i_c}$$

30. Draw a graph b/w angle of incidence (i) and angle of deviation (δ) for a triangular prism.

31. prove that R = 2f for concave mirror.

32. If a concave lens of 25 cm focal length is placed in contact with convex lens of 20cm focal length, then calculate the power of the combined lens formed by this combination.

⇒ $f_1 = -25\,cm = -\frac{25}{100}\,m \Rightarrow P_1 = 1/f_1 = -4D$

$f_2 = +20\,cm = +\frac{20}{100}\,m \Rightarrow P_2 = 1/f_2 = +5D$

combined power ⇒

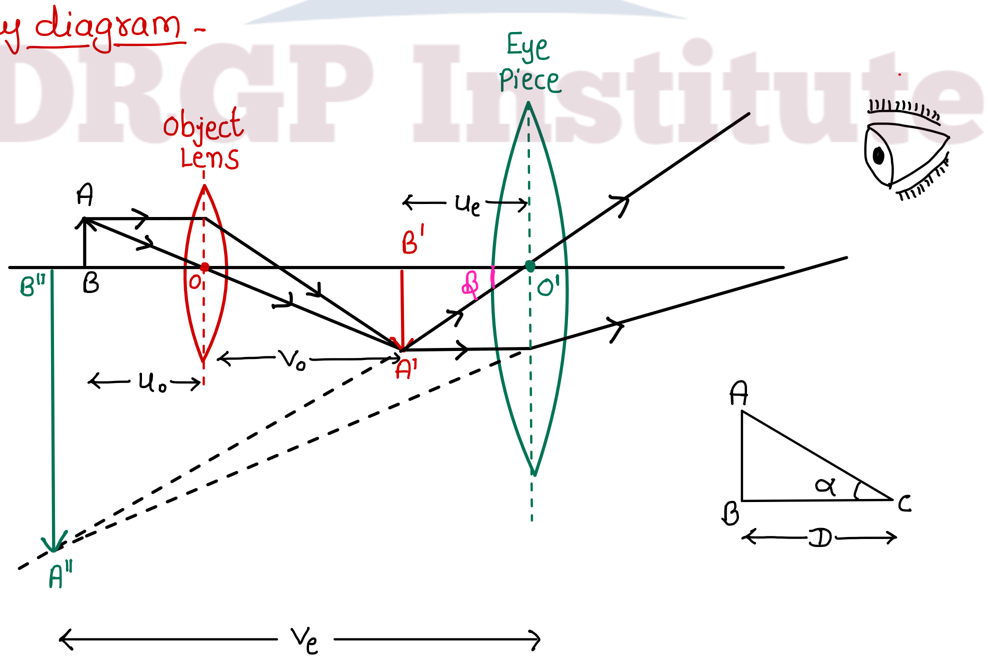
$P = P_1 + P_2 = -4 + 5 = 1D$

33. what is compound microscope? Draw a ray diagram of the formation of an image by a compound microscope. Briefly describe its working and derive formula for its magnification.

⇒ Compound Microscope - The microscope which has two coaxial lenses, one compounding the effect of other is known as compound microscope. Compound microscope -

(i) object lens
(ii) Eyepiece lens

Ray diagram -



Working - A compound microscope contains two lenses -

(i) Object lens
⇓
– Lens nearest the object

(ii) eye piece lens
⇓
– Lens nearest to eye.

→ The aperture and focal length of eyepiece lens is greater than object lens.

→ Object lens formed real inverted, large image.

→ The image formed by object lens, serve as object for eyepiece Lens.

→ Eyepiece lens further magnify and form very large, virtual image.

Derivation -

in $\Delta A'B'O'$ $\quad \tan\beta \simeq \beta = \dfrac{A'B'}{u_e}$

in ΔABC $\quad \tan\alpha \simeq \alpha = \dfrac{AB}{D}$

Put in eq^n ①

$$m = \frac{A'B'}{u_e} \Big/ \frac{AB}{D}$$

$$m = \frac{A'B'}{AB} \times \frac{D}{u_e}$$

$\left\{ \dfrac{A'B'}{AB} = \text{magnification of objective lens} = m_o \right\}$

$$m = m_o \times \frac{D}{u_e}$$

$$m = -\frac{V_o}{u_o}\left(\frac{D}{u_e}\right) \quad \text{– ②}$$

if image is formed at D -

$$\frac{1}{f_e} = \frac{1}{v_e} - \frac{1}{u_e}$$

$U_e = -u_e$
$V_e = -D$

$$\frac{1}{f_e} = -\frac{1}{D} + \frac{1}{u_e}$$

multiply by D on both side

$$\frac{D}{f_e} = -\frac{D}{D} + \frac{D}{u_e}$$

$$\frac{D}{u_e} = \frac{D}{f_e} + 1$$

put in eq^n (2)

$$m = \frac{-V_o}{u_o}\left(1 + \frac{D}{f_e}\right)$$

if image is formed ∞ -

$$\frac{1}{f_e} = \frac{1}{V_e} - \frac{1}{u_e}$$

$$\frac{1}{f_e} = \frac{1}{-\infty} - \frac{1}{-u_e}$$

$$f_e = u_e$$

put in eq^n (2)

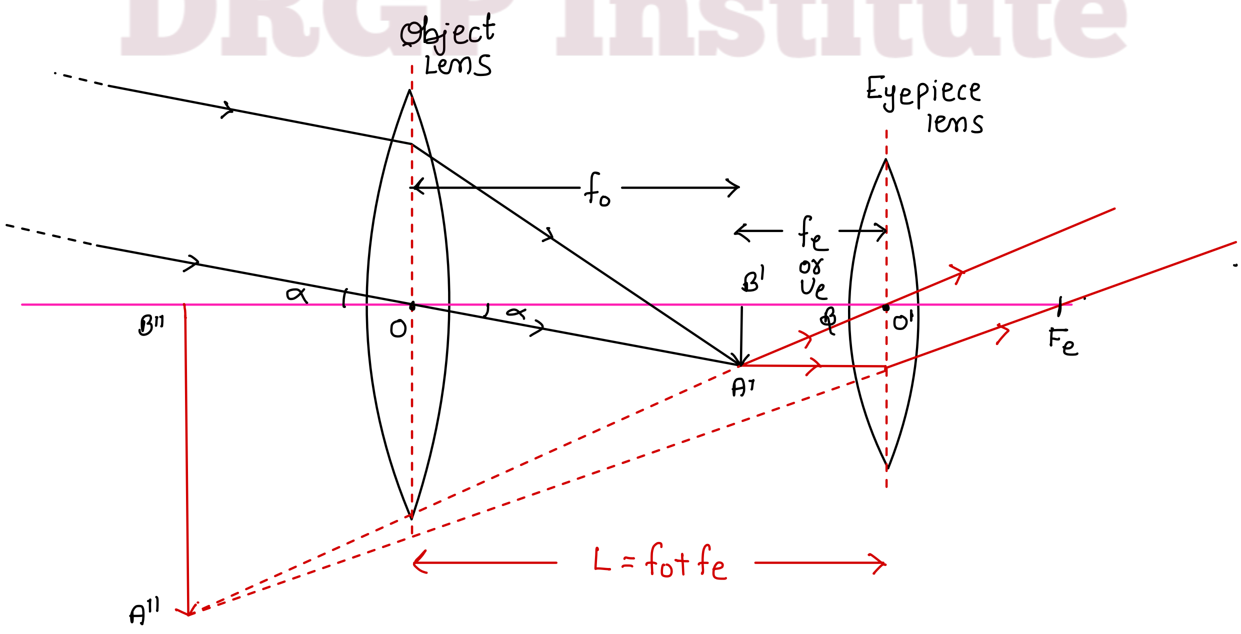
$$m = \frac{-V_o}{u_o}\left(\frac{D}{f_e}\right)$$

34. what is Telescope? Draw ray diagram of image formation by a refracting telescope. Describe working and derive formula of magnification.

⇒ Telescope - Telescope is an optical instrument which is used to see distant object.

Telescope
- Refracting (Astronomical Telescope)
- Reflecting (Cassegrain Telescope)

Refracting Telescope -



Working - In refracting telescope, we use 2 convex lens which are called objective & eye piece lens. Aperture and focal length of objective lens is large compare to eye piece. Object lens form small, real image at focus of object lens. This image serve as object for eye piece lens. Now eyepiece lens magnify this and form large virtual image at ∞.

Derivation -

$$m = \frac{\beta}{\alpha} \quad -(1)$$

in $\triangle A'B'O'$

$$\tan\beta \simeq \beta = \frac{A'B'}{u_e} \text{ or } \frac{A'B'}{f_e} \quad -(2)$$

in $\triangle A'B'O$

$$\tan\alpha \simeq \alpha = \frac{A'B'}{f_o} \quad -(3)$$

put in eq^n (1)

$$m = \frac{A'B'/f_e}{A'B'/f_o}$$

$$\boxed{m = \frac{f_o}{f_e}}$$

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35. What will be the focal length of a convex lens whose power is +2.5 D?

$\Rightarrow$ $f = 1/P = 1/2.5 = 0.4m = 40cm$

36. The radius of curvature of a concave mirror is 28 cm, what is the focal length.

$\Rightarrow$ $2f = R$ $\quad f = R/2$

$f = -28/2 = -14 \text{ cm}$

37. Mirror formula.

38. $$\mu = \frac{\sin\left(\frac{A+\delta m}{2}\right)}{\sin(A/2)}$$

BOARD - 2024

39. If the magnification of an optical instrument is negative then the image will always be formed -

$\Rightarrow$ Real & inverted.

40. If the magnification of objective and eyepiece in a compound microscope is 'm_o' and 'm_e' respectively. The total magnifying power (m) of the microscope will be -

⇒ $m = m_o m_e$

41. Radius of curvature of a concave mirror is 24 cm. The value of its focal length ________.

⇒ $f = \frac{R}{2} = \frac{-24}{2} = -12\,cm.$

42. The magnifying power of a small telescope is 9 and the length of tube is 100 cm. find focal length of object and eyepiece of Telescope.

⇒ $m = 9$

$L = 100\,cm$

$L = f_o + f_e = 100\,cm$ —(1)

$m = \frac{f_o}{f_e} = 9$

$f_o = 9 f_e$

put in eq^n (1)

$f_o + f_e = 100\,cm$

$9f_e + f_e = 100\,cm$

$f_e = 10\,cm$

and $f_o = 100 - 10 = 90\,cm.$

43. Total internal reflection & mirror formula.

44. Lateral displacement & Lens maker formula.