$$\varepsilon\mu_D = \frac{\mu_D}{\mu_E}$$

Ray optics – I

① Deviation of two successive Refⁿ

$$\delta_N = 2\pi - 2\theta$$

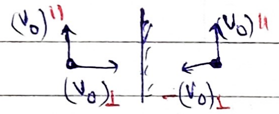
② No. of Images formed by inclined mirror.

a) ⇒ formula method.

n = even	n = odd	n = fraction
① (n−1) = no. of images	① no. of image (n−1) obj symmetry	used count
– symmetry or unsymm	② no. of image = (n) obj asymmetric	image method

$$n = 360/\theta$$

③ parallel & ⊥er both directions



① $\vec{V}_O = (V_{O\perp})\hat{i} + (V_O)_{\parallel}\hat{j}$

② $\vec{V}_I = -(V_{O\perp})\hat{i} + (V_O)_{\parallel}\hat{j}$

– valid only when mirror is at rest

⇒ when mirror moves (plane mirror)

$\vec{V}_{O/m} \rightarrow \vec{V}_{I/m} \rightarrow \vec{V}_I \rightarrow \vec{V}_{I/O}$

$\vec{V}_{O/m} = \vec{V}_O - \vec{V}_m$ (RT)

$-\vec{V}_{O/m}$ (SRT)

$\vec{V}_{I/m} = \vec{V}_I - \vec{V}_m$

$\vec{V}_I = \vec{V}_{I/m} + \vec{V}_m$ (RT)

$\vec{V}_{I/O} = \vec{V}_I - \vec{V}_O$ (RT)

④ spherical mirror ⇒ $f = R/2$ $\quad f = R - \frac{R}{2\cos i}$

⑤ $V = \frac{uf}{u-f}$

⑥ Transverse magnification

$$M_T = \frac{I}{O} = \frac{-v}{u} = \frac{f}{(f-u)}$$

⑦ Axial magnification

$$M_{axial} = (M_T)^2$$

⇒ Relative motion in spherical mirror.

$$V_{I/M} = -(M_T)^2 \times V_{O/M}$$

⑧ snell's law for multiple medium.

$\mu_1 \sin\theta = \mu_2 \sin\theta_2 = \mu_3 \sin\theta_3 \ldots$

$$\mu_1 \sin i = \mu_2 \sin r$$

⑨ when object is in denser medium and observer is in rarer medium

$$\mu = \frac{\text{real depth}}{\text{apparent depth}}$$

⑩ vice-versa

$$\mu = \frac{\text{app. depth}}{\text{real depth}}$$

shift = Real − Apparent $\quad s = h\left[1 - \frac{1}{\mu}\right]$

⑪ Thickness of glass slab.

$$t = \mu(V_1 + V_2)$$

⑫ multiple medium

$$X_{obj/observer} = \mu_{observer} \sum \frac{x}{\mu}$$

x = distance

⑬ shifting of obj. by glass slab

$$s = t\left[1 - \frac{1}{\mu}\right]$$

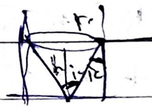
⇒ t = thickness of slab

⑭ critical angle

$$\sin i_c = \frac{\mu_E}{\mu_d}$$

⑮ Area of visible region.

$$\text{Area} = \frac{\pi h^2}{(\varepsilon\mu_D)^2 - 1}$$



⑯ minimum devⁿ

1) $\sin i = \mu \sin A/2$

2) $\delta_{min} = 2i - A$

⑰ silvering of prism

$$\sin i = \frac{\mu_2}{\mu_1} \sin A$$

⑱ Thin prism $\quad \theta < 10°$

$\delta_{min} = A(\mu - 1)$ $\quad$ devⁿ = min. devⁿ

Resolving limit $\propto \frac{1}{\text{Resolving power}} \propto (\lambda)$

(19) Angular dispersion

$$\theta = A(\mu_V - \mu_R) = \delta_V - \delta_R$$

(20) Dispersion power

$$\omega = \frac{\text{Angular disp}}{\text{Dev}^n \text{ of mean ray}} = \frac{[\mu_V - \mu_R]}{[\mu_y - 1]}$$

Lenses

① Lens maker's formula

a) equiconvex ⇒ $f = \frac{R}{2[(\mu_g) - 1]}$

b) equi cancave ⇒ $f = -\frac{R}{2(a\mu_g - 1)}$

c) Planoconvex ⇒

$$f_{planoconvex} = 2 f_{equiconvex}$$

d) comparison of focal length in (air) & (liq)

$$\frac{f_{air}}{f_{liq}} \neq \frac{(a\mu_g - 1)}{(a\mu_g - 1)}$$

⇒

$$f_{eq} = \frac{R}{2(\mu_1 - \mu_2)}$$

- f_{eq} काढण्यासाठी Powers add करणे not f add करणे.

silvering of lenses

a) equiconvex lens $f_{eq} = -\frac{R}{2(2\mu - 1)}$

b) planoconvex lens $f_{eq} = -\frac{R}{2(\mu - 1)} = \frac{f_{air}}{2}$

c)

$$f_{eq} = -\frac{R}{2\mu}$$

lens formula

$$M_T = \frac{I}{O} = \frac{v}{u} = \frac{f}{f+u}$$

To find out focal length, when lens is displaced (or) moving on a screen

$$f = \frac{D^2 - x^2}{4D}$$

x = displacement

D = obj. dist. from screen

Microscope

① simple microscope $m = \frac{\beta}{\alpha} = \frac{D}{u}$

a) Eye under relaxed state or Normal vision

$$M_{min} = \frac{D}{u_{max}} = \frac{D}{f}$$

b) Eye under strain

$$M_{max} = 1 + D/f$$

$$U_{min} = \frac{DF}{(D+F)}$$

② comp. microscope ⇒ Resolving limit $= \frac{1.22\lambda}{2\mu \sin\theta}$

(a) $L = V_0 + u_e$

(b) $m = -(m_0 \times m_e) = -\frac{V_0}{u_0} \times \frac{D}{u_e}$

i) Eye in Relaxed state ⇐

replace (u_e) by (f_e)

ii) Eye under strain ⇐ least distinct vision

$$L_{min} = V_0 + \frac{Df_e}{D + f_e}$$

$$M_{max} = -\frac{V_0}{u_0}\left[1 + \frac{D}{f_e}\right]$$

$$\frac{M_{N.A}}{M_{S.T}} = \frac{D}{D + f_e}$$ ★

③ Telescope

$$m_{min} = -\frac{f_0}{f_e}$$

$$m_{max} = -\frac{f_0}{f_e}\left[1 + \frac{f_e}{D}\right]$$

1) Resolving limit $= \frac{1.22\lambda}{a}$ Resolving Power $= \frac{a}{1.22\lambda}$

(a) Diameter of lens

$\mu \sin\theta$ = Numerical Aperture of Radius of Aperture