BRAIN MAP

RAY OPTICS

Ray optics describes light propagation in terms of rays. The ray in ray optics is an abstraction or instrument, useful in approximating the paths along which light propagates. The entire field of ray optics deals with tracing back the rays to see their origin.

Formation of images by spherical mirrors

- Mirror formula, $\frac{1}{u}+\frac{1}{v}=\frac{1}{f}=\frac{2}{R}$.
- Magnification, $m=\frac{h_2}{h_1}=\frac{-v}{u}=\frac{f}{f-u}=\frac{f-v}{f}$
  m is negative for real image; m is positive for virtual image
  - f and R are negative for a concave mirror and positive for a convex mirror.
  - For a real object u is negative, v is negative for real image and positive for virtual image.

Refraction of light, lateral shift and real and apparent depth

- Refractive index, $\mu=\frac{c}{v}=\frac{\lambda}{\lambda'}$.
- When light travel from medium 1 to 2, ${}^1\mu_2=\frac{\sin i}{\sin r}=\frac{\mu_2}{\mu_1}$.
- $\mu=\frac{\text{Real depth }(x)}{\text{Apparent depth }(y)}$
- Normal shift of image $d=t\left(1-\frac{1}{\mu}\right)$
  where t is the thickness of medium
- Lateral shift $L=t\frac{(\sin(i-r))}{\cos r}$

Refraction from spherical surfaces

- When refraction occurs from rarer to denser medium,
  $$\frac{\mu_1}{-u}+\frac{\mu_2}{v}=\frac{\mu_2-\mu_1}{R}$$
- When refraction occurs from denser to rarer medium,
  $$\frac{\mu_2}{-u}+\frac{\mu_1}{v}=\frac{\mu_1-\mu_2}{R}$$
- First principal focal length, $f_1=-\frac{\mu_1 R}{\mu_2-\mu_1}$
- Second principal focal length, $f_2=-\frac{\mu_2 R}{\mu_2-\mu_1}$

Lens maker's formula and power of lens

- Lens maker's formula, $\frac{1}{f}=(\mu-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$
  where $\mu=\frac{\mu_2}{\mu_1}=\frac{\text{Refractive index of lens material}}{\text{Refractive index of medium}}$
- Power of lens, $P=\frac{1}{f\,(\text{in m})}=\frac{100}{f\,(\text{in cm})}$

Microscope

- Magnifying power of simple microscope when image is formed at infinity, $m=\frac{D}{f}$
- Magnifying power of simple microscope for image formed at D, $m=\left(1+\frac{D}{f}\right)$
- Magnifying power of a compound microscope when image is formed at least distance of distinct vision (D),
  $$m=m_0\times m_e=\frac{v_0}{-u_0}\left(1+\frac{D}{f_e}\right)$$

Combination of two lenses

- Focal length F of a combination of two lenses of focal length f_1 and f_2 separated by distance d is,
  $$\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1 f_2}$$
- If lenses are in contact, $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$
- Magnification of combination of lenses
  $m=m_1\times m_2\times m_3\ \ldots\ldots$
- Power of two lens separated by a distance d is,
  $P=P_1+P_2-d\,P_1P_2.$

Prism

Refraction through prism :

- For refraction through prism,
  - $A+\delta=i_1+e$
  - $r_1+r_2=A$
  - In case of minimum deviation $\delta=\delta_m$, $i_1=e$ and $r_1=r_2$

  $\therefore\quad i=\frac{A+\delta_m}{2}$ and $r=\frac{A}{2}$
- $$\mu=\frac{\sin\left(\frac{A+\delta_m}{2}\right)}{\sin\frac{A}{2}}$$
- Minimum deviation in case of thin prism $\delta=(\mu-1)A$.

Dispersion through prism :

- Angular dispersion $=\delta_V-\delta_R=(\mu_V-\mu_R)A$
- Dispersive power, $\omega=\frac{\delta_V-\delta_R}{\delta}=\frac{\mu_V-\mu_R}{\mu-1}$
- Mean deviation, $\delta=\frac{\delta_V-\delta_R}{2}$

Telescope

- Astronomical telescope :
  - In normal adjustment case, $m=-\frac{f_0}{f_e}$
  - When final image is at the least distance of distinct vision, $m=-\frac{f_0}{f_e}\left(1+\frac{f_e}{D}\right)$
- Terrestrial telescope :
  - In normal adjustment, $m=\frac{f_0}{f_e}$
  - Distance between objective and eye piece $=f_0+4f+f_e$
- Reflecting type telescope, $m=\frac{f_0}{f_e}=\frac{R/2}{f_e}$

Total internal reflection

- Critical angle (i_c) = angle of incidence in denser medium for which angle of refraction is 90° in rarer medium
- Refractive index of denser medium, $\mu=\frac{1}{\sin i_c}$
- Total internal reflection occur when $i>i_c$ and ray must travel from denser to rarer medium.