Single slit of width a:
A bright central maximum of width $w = \frac{2\lambda L}{a}$ is flanked by weaker secondary maxima.
Dark fringes are located at angles such that $a \sin\theta_p = p\lambda$, p=1,2,3,...
If $\lambda/a \ll 1$, then from the small-angle approximation $\theta_p = \frac{p\lambda}{a}$, $y_p = \frac{p\lambda L}{a}$
C**ircular aperture** of diameter D:
A bright central maximum of diameter $w = \frac{2.44\lambda L}{D}$ is surrounded by circular secondary maxima.
The first dark fringe is located at $\theta_1 = \frac{1.22\lambda}{D}$, $y_1 = \frac{1.22\lambda L}{D}$

Double slit with separation d.
Equally spaced bright fringes are located at $\theta_m = \frac{m\lambda}{d}$, $y_m = \frac{m\lambda L}{d}$, m=0,1,2,3,...
The fringe spacing is $\Delta y = \frac{\lambda L}{d}$
Diffraction grating with slit spacing d:
Very bright and narrow fringes are located at angles and positions $d \sin\theta_m = m\lambda$, $y_m = L \tan\theta_m$

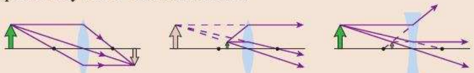
Law of reflection: $\theta_r = \theta_i$
Plane mirrors: A virtual image is formed at P' with $s' = s$.

Snells law of refraction: $n_i \sin\theta_i = n_r \sin\theta_r$
Index of refraction is $n = \frac{c}{v}$
If $n_r < n_i$, **total internal reflection** occurs when the angle of incidence $\theta_i \geq \theta_c = \sin^{-1}(n_r/n_i)$.

Spherical surface: Object and image distances are related by: $\frac{n_1}{s} + \frac{n_2}{s'} = \frac{n_2 - n_1}{R}$
Plane surface: $\left|\frac{s'}{s}\right| = \frac{n_2}{n_1}$

Ray tracing

3 special rays in 3 basic situations:



Converging lens Real image — Converging lens Virtual image — Diverging lens Virtual image

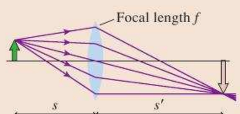
Magnification $m = -\frac{s'}{s}$

m is + for an upright image, − for inverted.
The height ratio is $h'/h = |m|$.

Thin lenses

The image and object distances are related by

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$



where the focal length is given by the lens maker's equation:

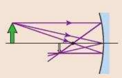
$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

R	+ for surface convex toward object	− for concave
f	+ for a converging lens	− for diverging
s'	+ for a real image	− for virtual

Spherical mirrors

The image and object distances are related by

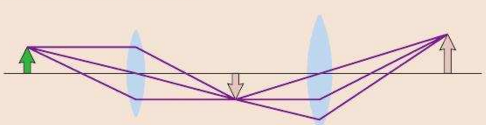
$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$



R, f	+ for concave mirror	− for convex
s'	+ for a real image	− for virtual

Focal length $f = R/2$

Lens Combinations

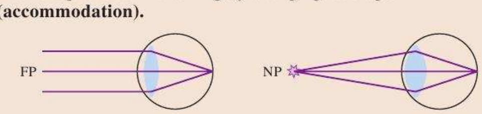


The image of the first lens acts as the object for the second lens.

Lens **power**: $P = \frac{1}{f}$ diopters, 1 D = 1 m^{-1}

Vision

Refraction at the cornea is responsible for most of the focusing. The lens provides fine-tuning by changing its shape **(accommodation).**



In normal vision, the eye can focus from a far point (FP) at ∞ (relaxed eye) to a near point (NP) at ≈ 25 cm (maximum accommodation).

- **Hyperopia** (farsightedness) is corrected with a converging lens.
- **Myopia** (nearsightedness) is corrected with a diverging lens.