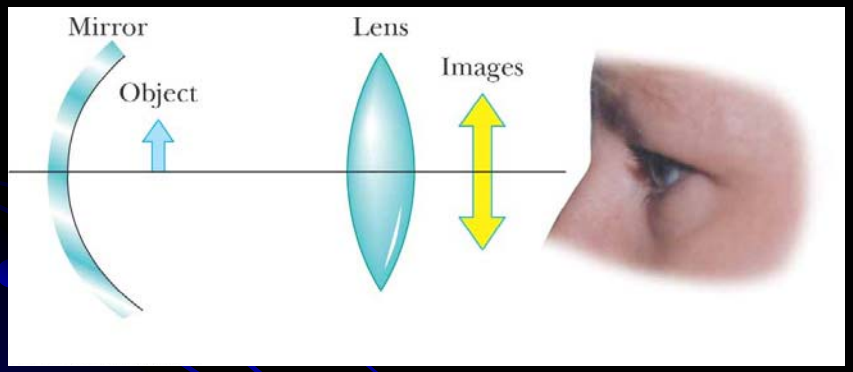
5) Combination of thin lenses :

(1) The image formed by the 1st lens acts as a *real object* for the 2nd lens.

(2) The image formed by the 1st lens acts as a *virtual object* for the 2nd lens.

(3) Two lenses in contact $\Rightarrow$ $\boxed{1/f' = 1/f_1 + 1/f_2}$

6) Mirror-Lens Combination :



- Sign convention for mirrors :

	p	q	f, R	M (= −q/p)
+	real object	real image	concave	upright
−	virtual object	virtual image	convex	inverted

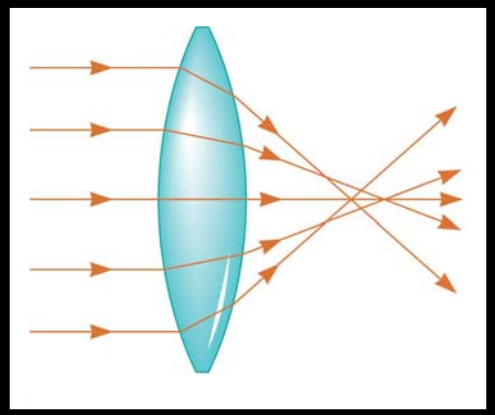
- Sign conventions for thin lenses :

	p	q	R_1 & R_2	f
+	real object (*front of lens*)	real image (*back of lens*)	C is in back of lens	converging
−	virtual object (*back of lens*)	virtual image (*front of lens*)	C is in front of lens	diverging

36.5 Lens aberrations

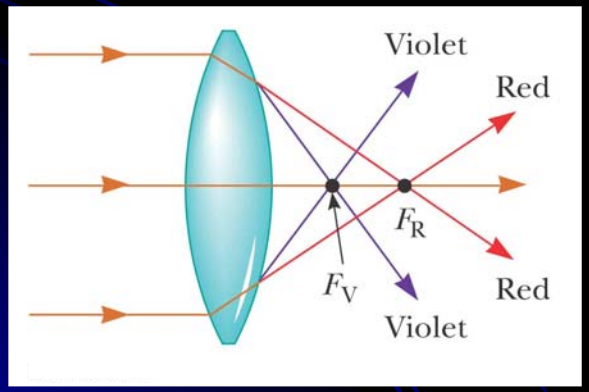
Aberrations : the departures of actual images from the ideal.

(a) Spherical aberrations [*cf.* Paraxial rays]



- This results from the focal points of light rays far from the principal axis being different from the focal points of rays passing near the axis

(b) Chromatic aberrations [*cf.* Dispersion $n(\lambda)$]

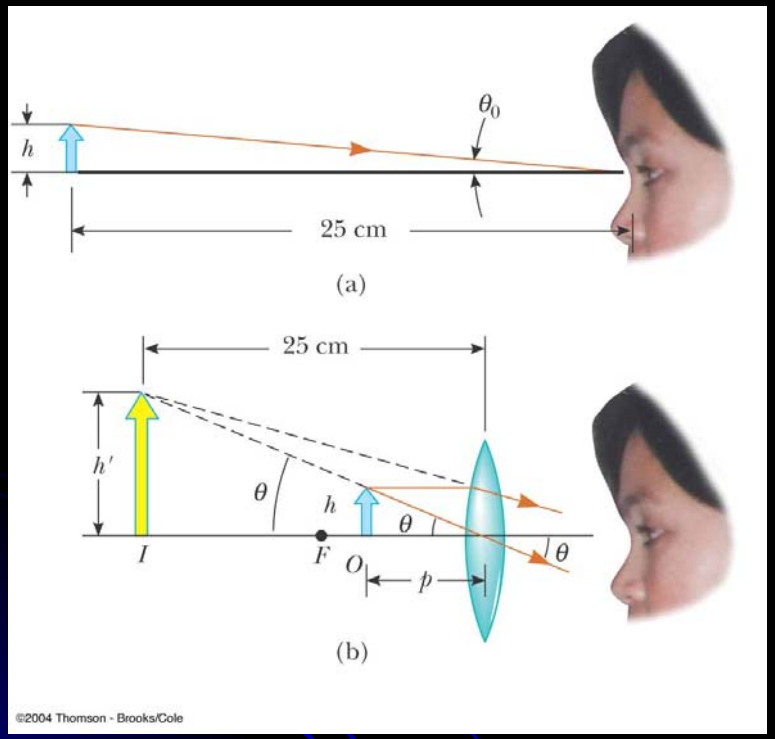


- Different wavelengths of light refracted by a lens focus at different points.
- Chromatic aberration can be minimized by the use of a combination of converging and diverging lenses made of different materials.

36.6 Optical instruments

1) The eye.

2) Simple magnifier : (consists of a single converging lens).



- **<u>Angular magnetification *m*</u>** :

$$m = \theta / \theta_o$$

$\Rightarrow$ the ratio of the angle an object subtends when seen through a lens to the angle subtended when it's at the 25-cm near point and viewed with the naked eye.

- $m = \theta / \theta_o = 25\ \text{cm} / f$ (simple magnifier)

3) Microscope :

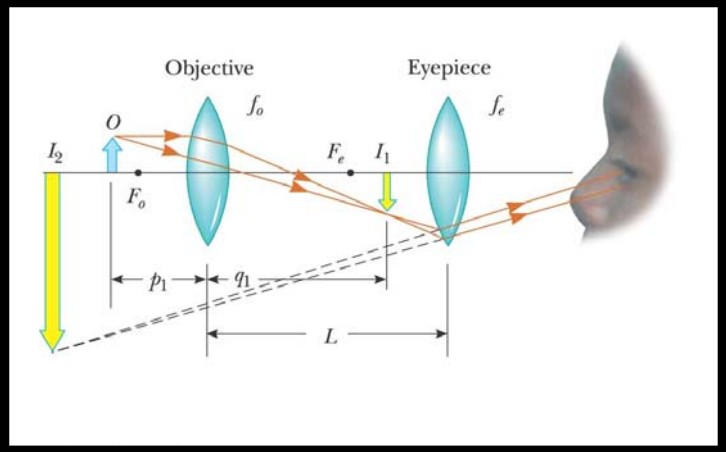


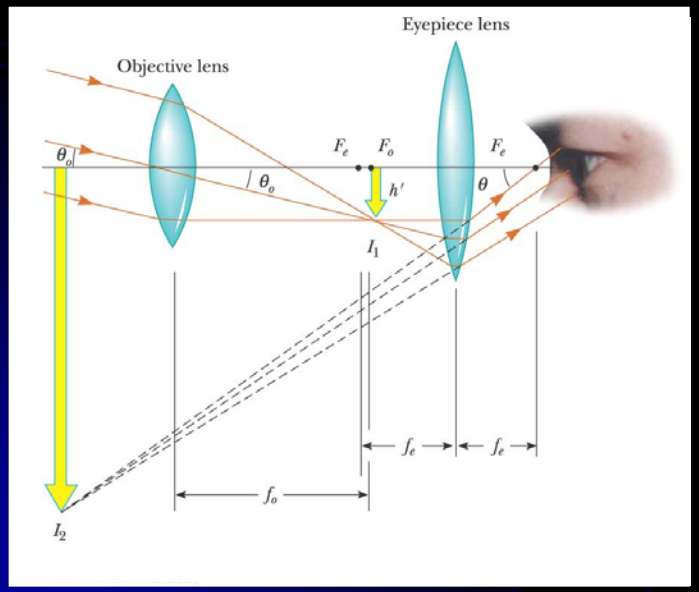
Diagram of a compound microscope, which consists of an *objective lens* and an *eyepiece lens*.

I_1 : real, inverted image.

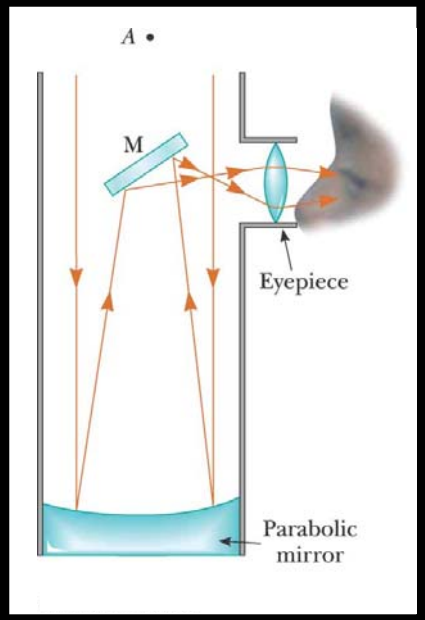
$I_1 = O_2$: real object.

I_2 : virtual, inverted image.

4) Telescope : (*i*) Refracting telescope (A combination of lenses).
(*ii*) Reflecting telescope (A curved mirror and a lens).



Lens arrangement in a refracting telescope, with the object at infinity.



A Newtonian-focus reflecting telescope.

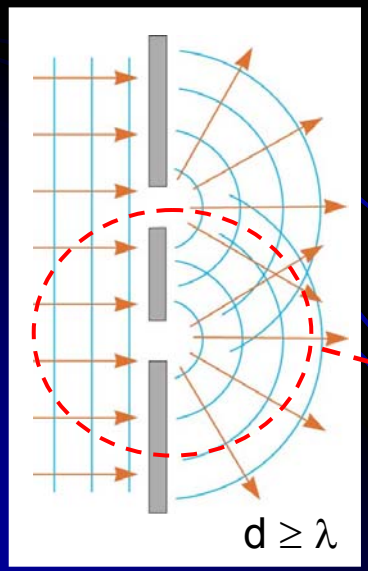
Ch. 37 Interference of light waves

37.1 Interference

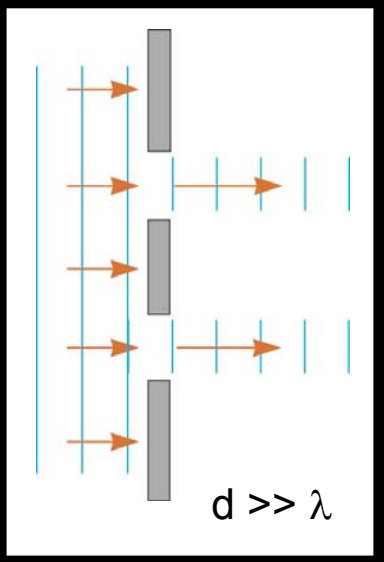
- Conditions for interference :

  1) The sources must be coherent, *i.e.* constant phase relationship.

  2) The sources must be monochromatic, *i.e.*, a single λ .

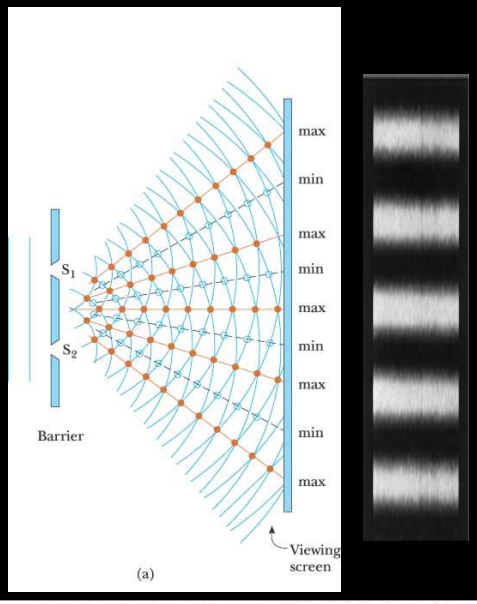


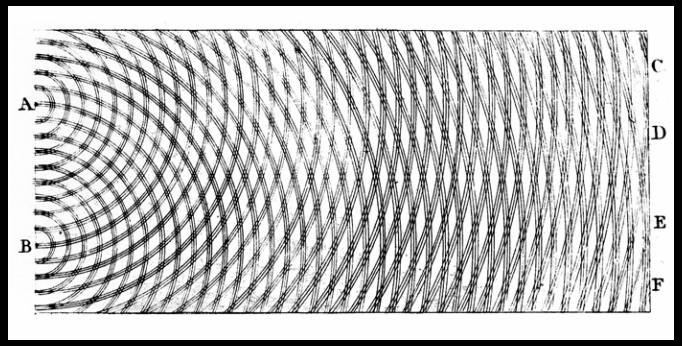
The light waves from the two slits overlap as they spread out, filling what we expect to be shadowed regions with light and producing interference fringes on a screen placed to the right of the slits.



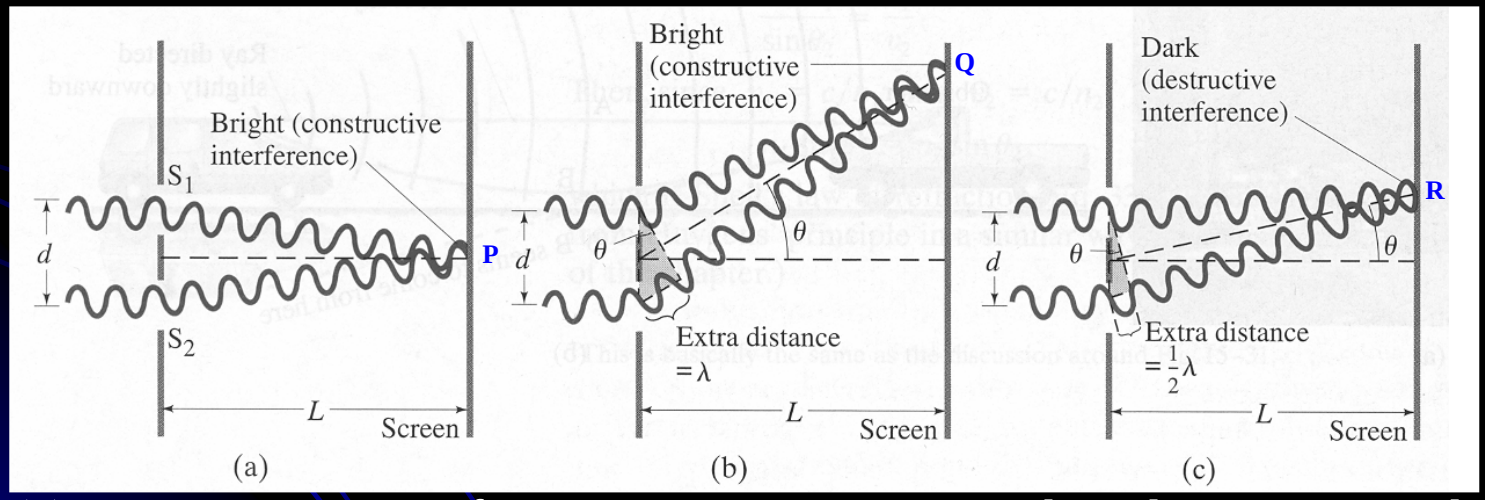
- Diffraction : the divergence of light from its initial line of travel (more detail in Ch. 38).

37.2 Young's double-slit experiment





Thomas Young's sketch of double-slit experiment. Young presented the results of this experiment to the Royal Society in 1803. ⇒ *Proof of the wave nature of light !*



(a) Constructive interference occurs at point P when the waves combine.
(b) Constructive interference also occurs at point Q.
(c) Destructive interference occurs at R when the two waves combine because the upper wave falls half a wavelength behind the lower wave.