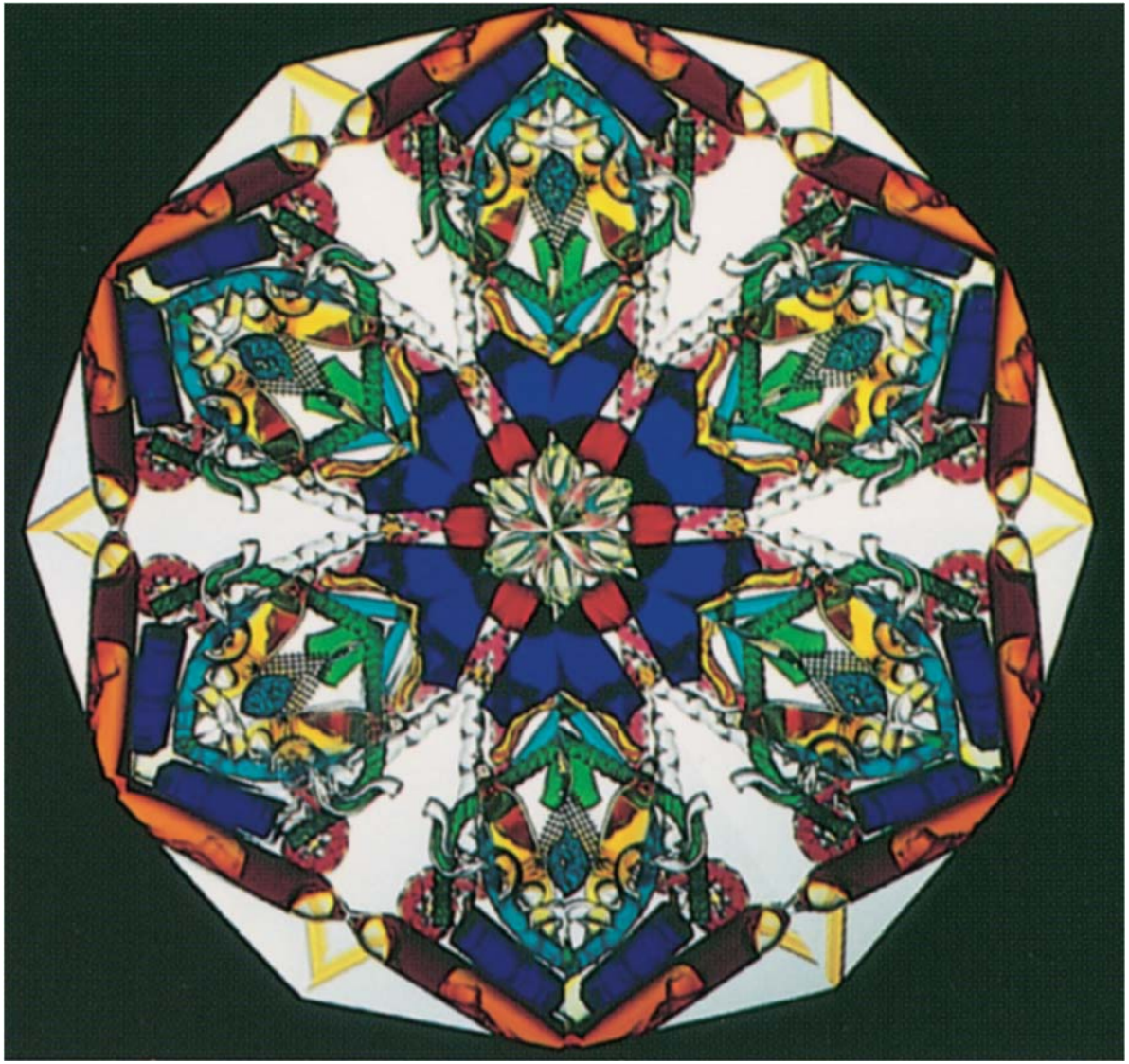
Geometrical optics



Wave propagation and wave front

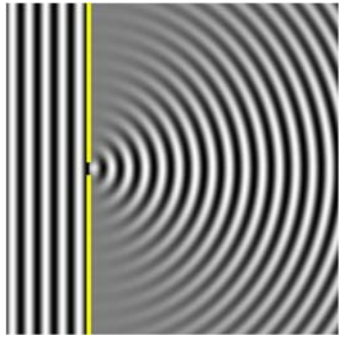
HRW: Ch35

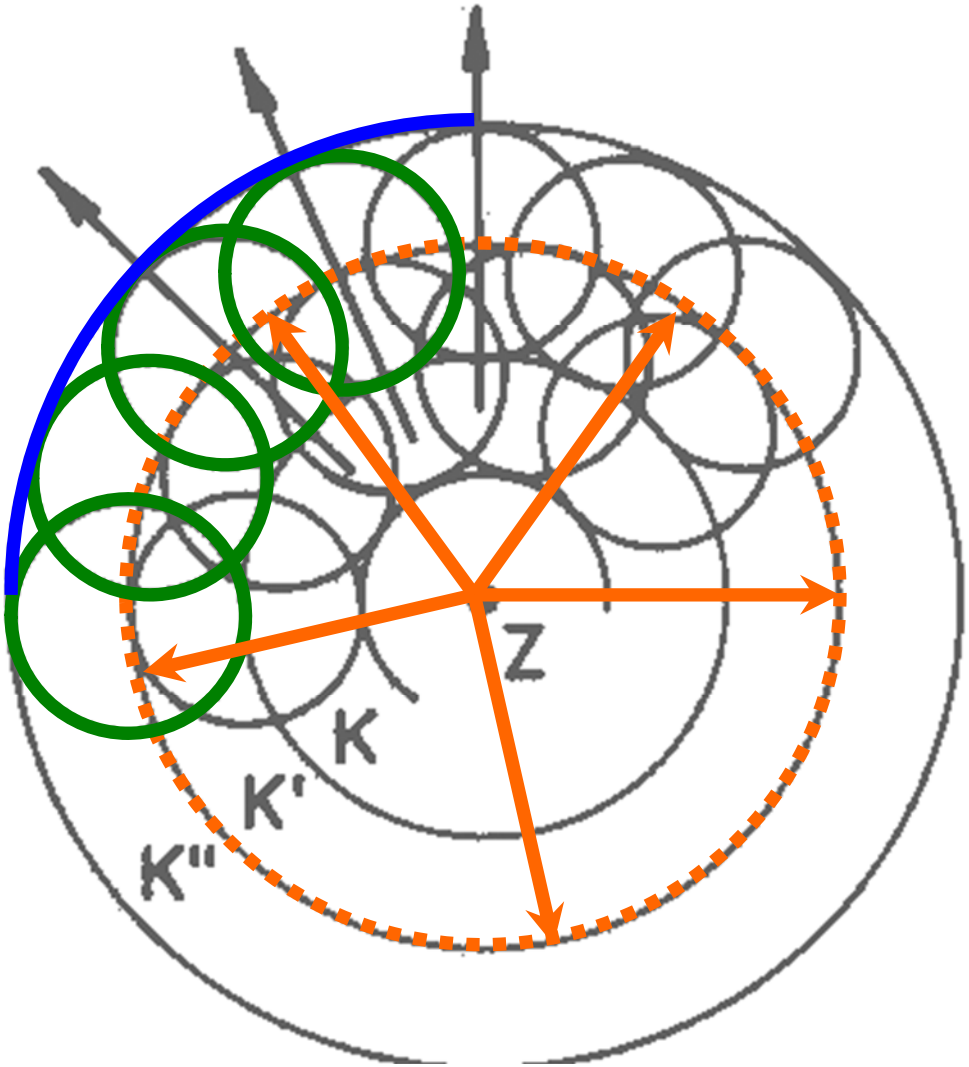
Homogenous and isotropic environment

Huygens principle

wave front

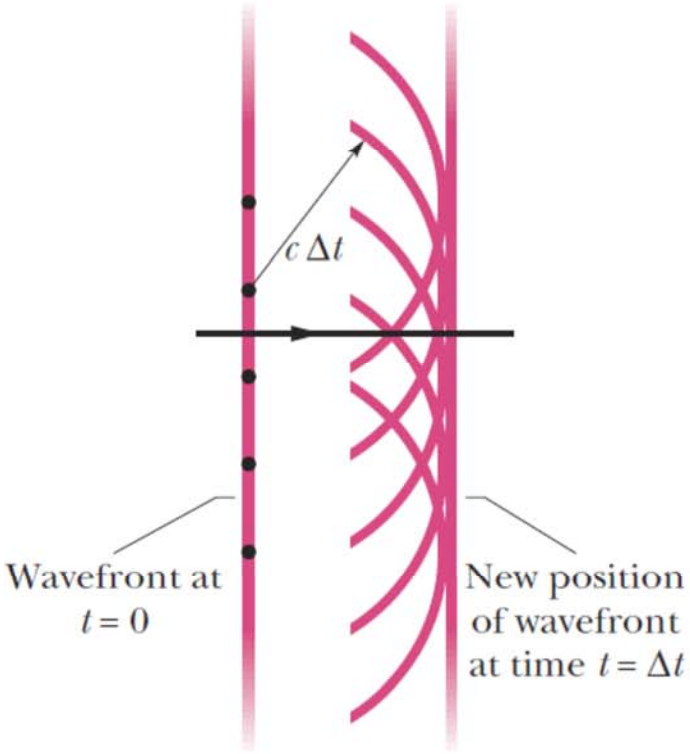
every point of a wave front could be a source of elementary wavelet

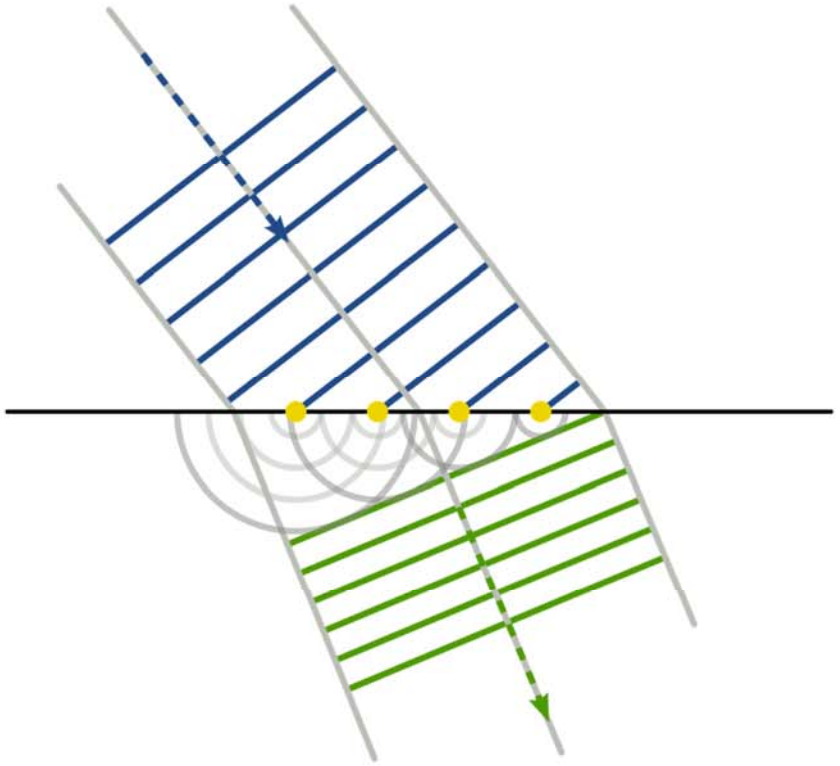




Plane wave

HRW: Ch35





Propagation of waves / rays

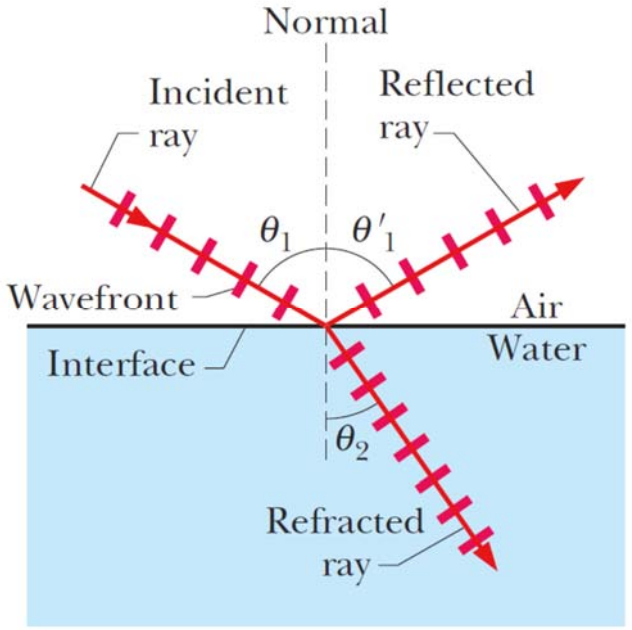
- isotropic matter: light waves are represented as straight-line rays
- independent propagating of waves (rays)
- on boundary between two transparent media, a reflected ray and a refracted ray appear. Both rays remain in the plane of incidence.

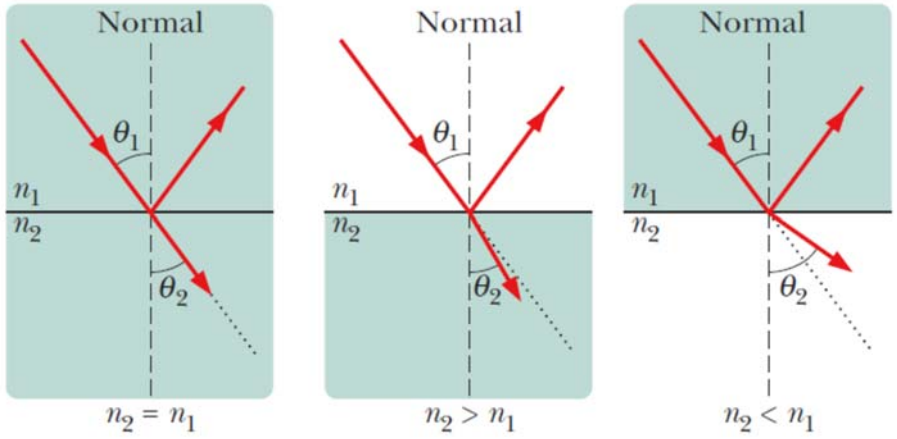
$$n = \frac{c}{v} = \sqrt{\varepsilon_r \mu_r}$$

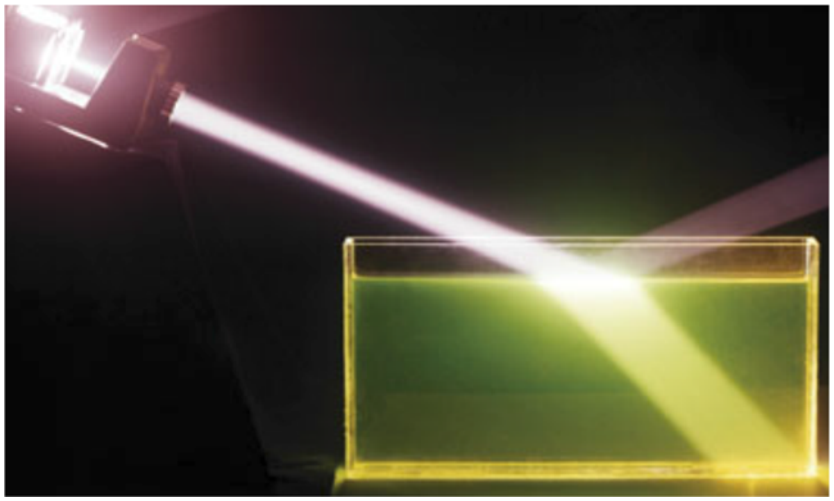
absolute refractive index

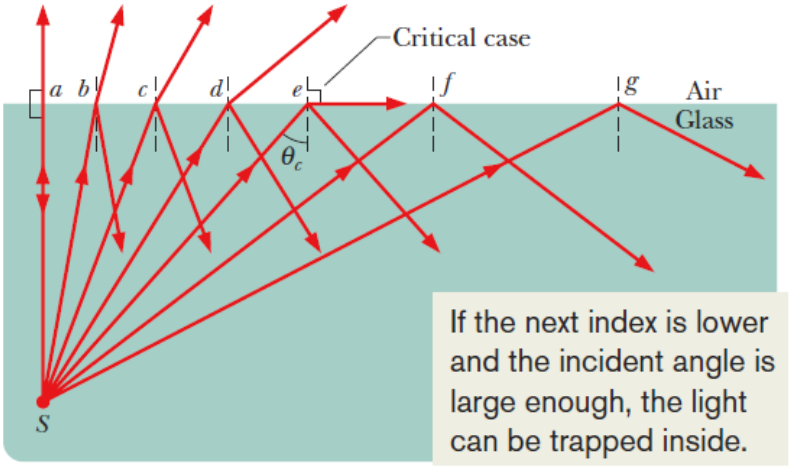
$$n_1 \sin\theta_1 = n_1 \sin\theta_1' = n_2 \sin\theta_2$$

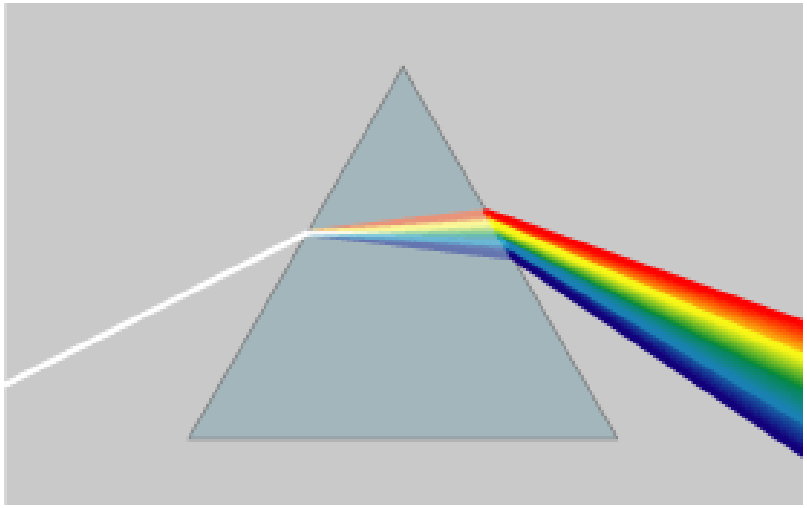
Snell's law

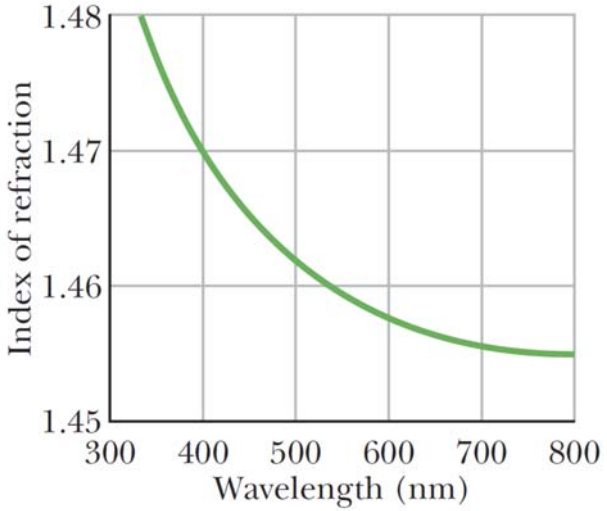


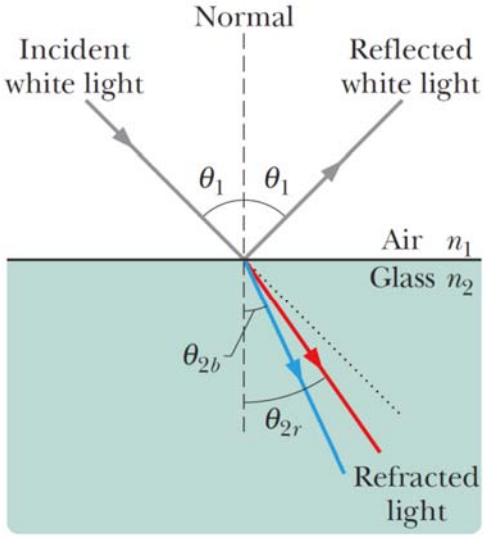

Normal
θ_1
n_1
n_2
θ_2
$n_2 = n_1$
Normal
θ_1
n_1
n_2
θ_2
$n_2 > n_1$
Normal
θ_1
n_1
n_2
θ_2
$n_2 < n_1$



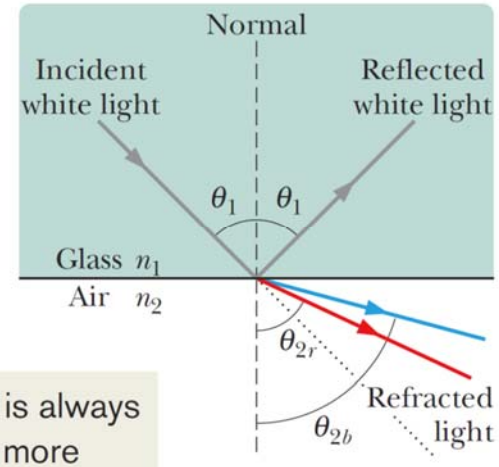

Critical case
a
b
c
d
e
f
g
Air
Glass
θ_c
S
If the next index is lower and the incident angle is large enough, the light can be trapped inside.





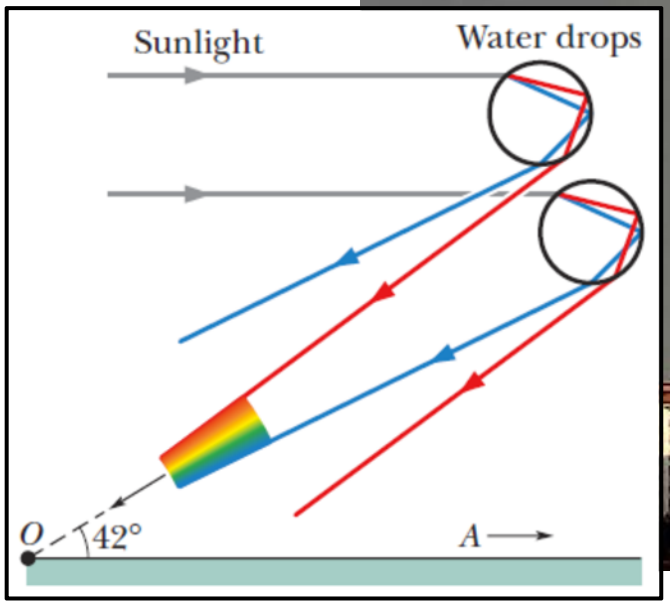


(*a*)

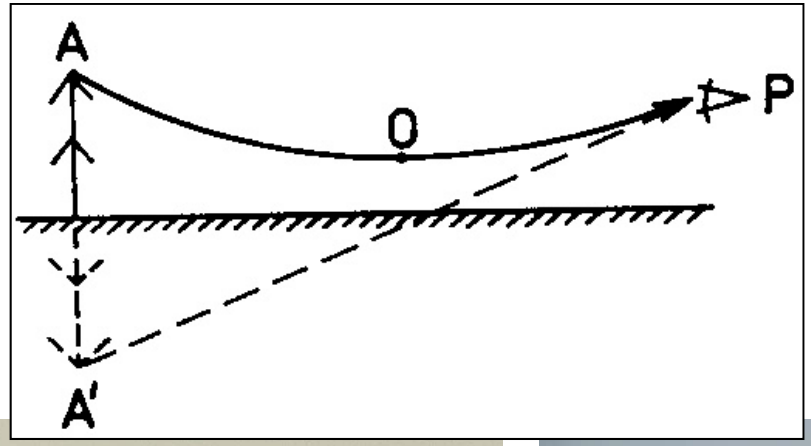


(*b*)

Blue is always bent more than red.


Sunlight
Water drops
O
42°
A

HRW: Ch33



HRW: Ch34

Sign convention

central axis

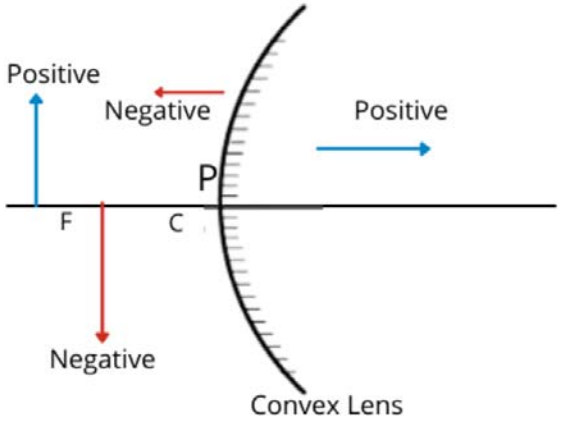
object / image

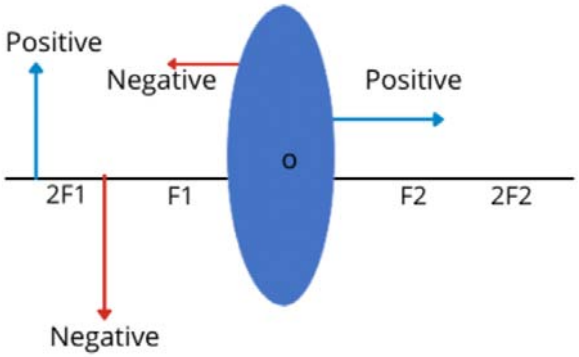
real / virtual focal point

focal length

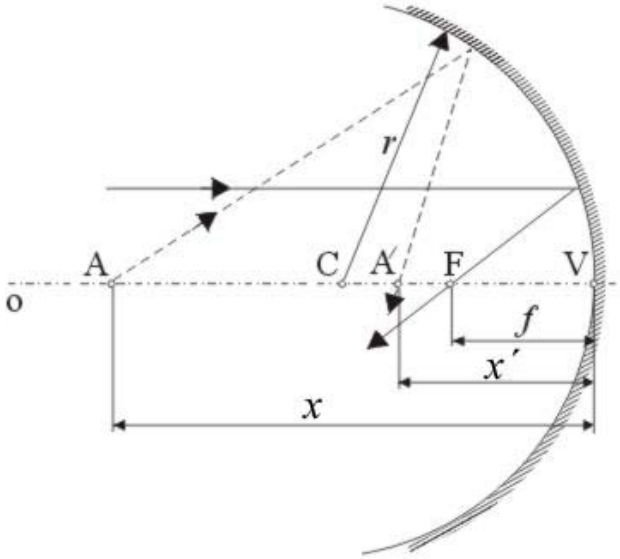
centre of curvature

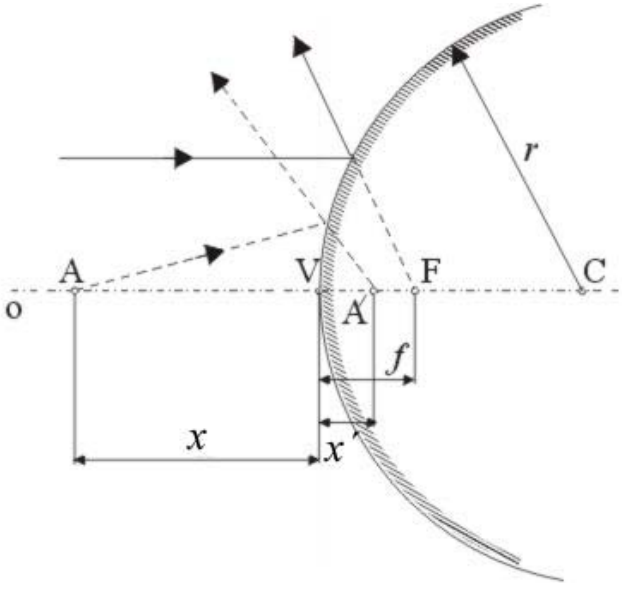
pole of the mirror





Spherical mirrors





$$\frac{1}{x'} + \frac{1}{x} = \frac{2}{r} = \frac{1}{f}$$

$$m = \frac{y'}{y} = -\frac{x'}{x}$$


Virtuell oder real!
immer virtuell

Thin lenses

converging / diverging lens

real / virtual focal point

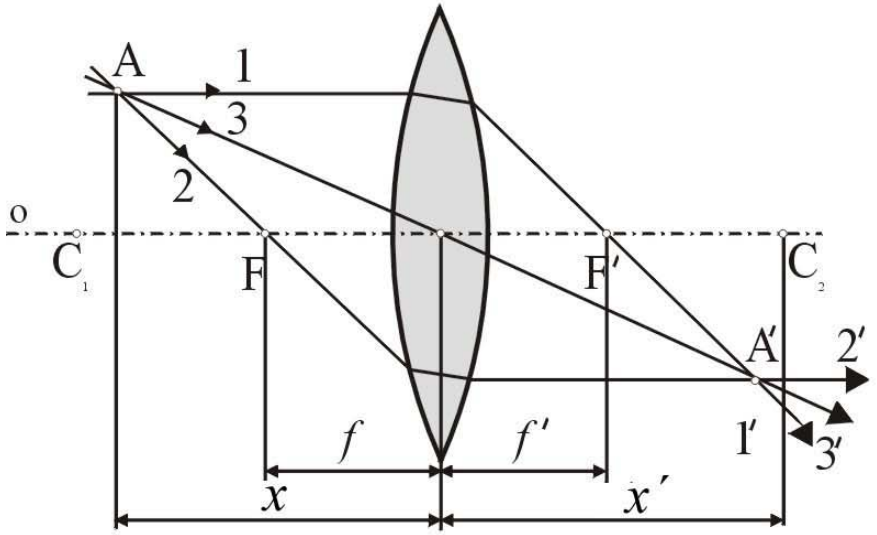
focal length

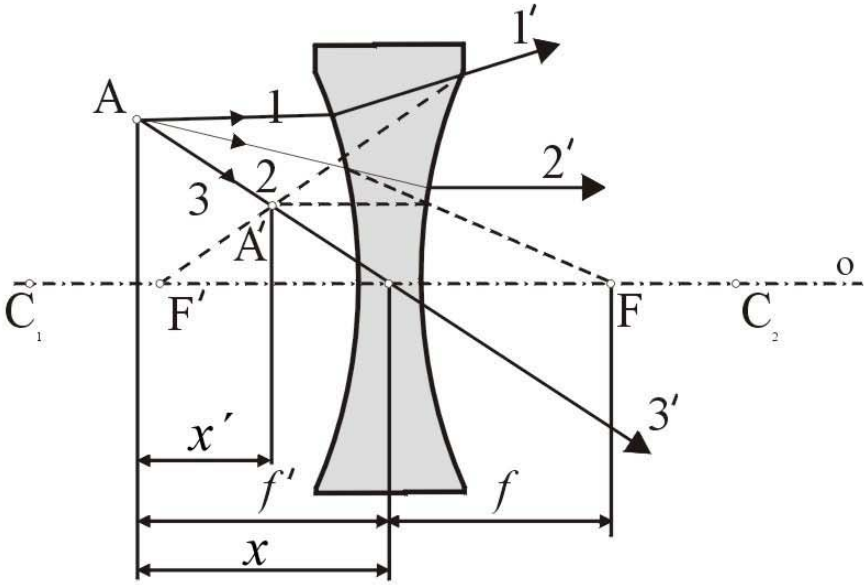
centre of curvature

centre of the lens

$$\frac{1}{x'} - \frac{1}{x} = \frac{1}{f'}$$

$$m = \frac{y'}{y} = \frac{x'}{x}$$





$$\varphi = \frac{1}{f'}$$

optical dioptre strength

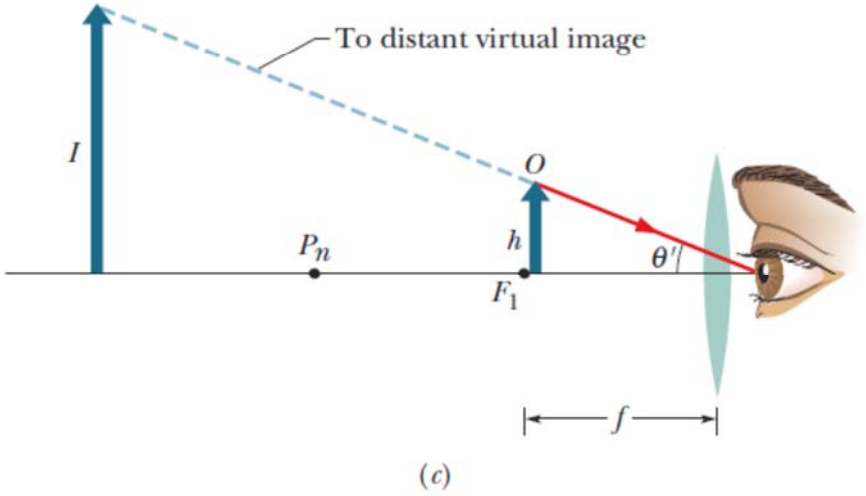
diopter (D)

HRW: Ch34

Optical instruments

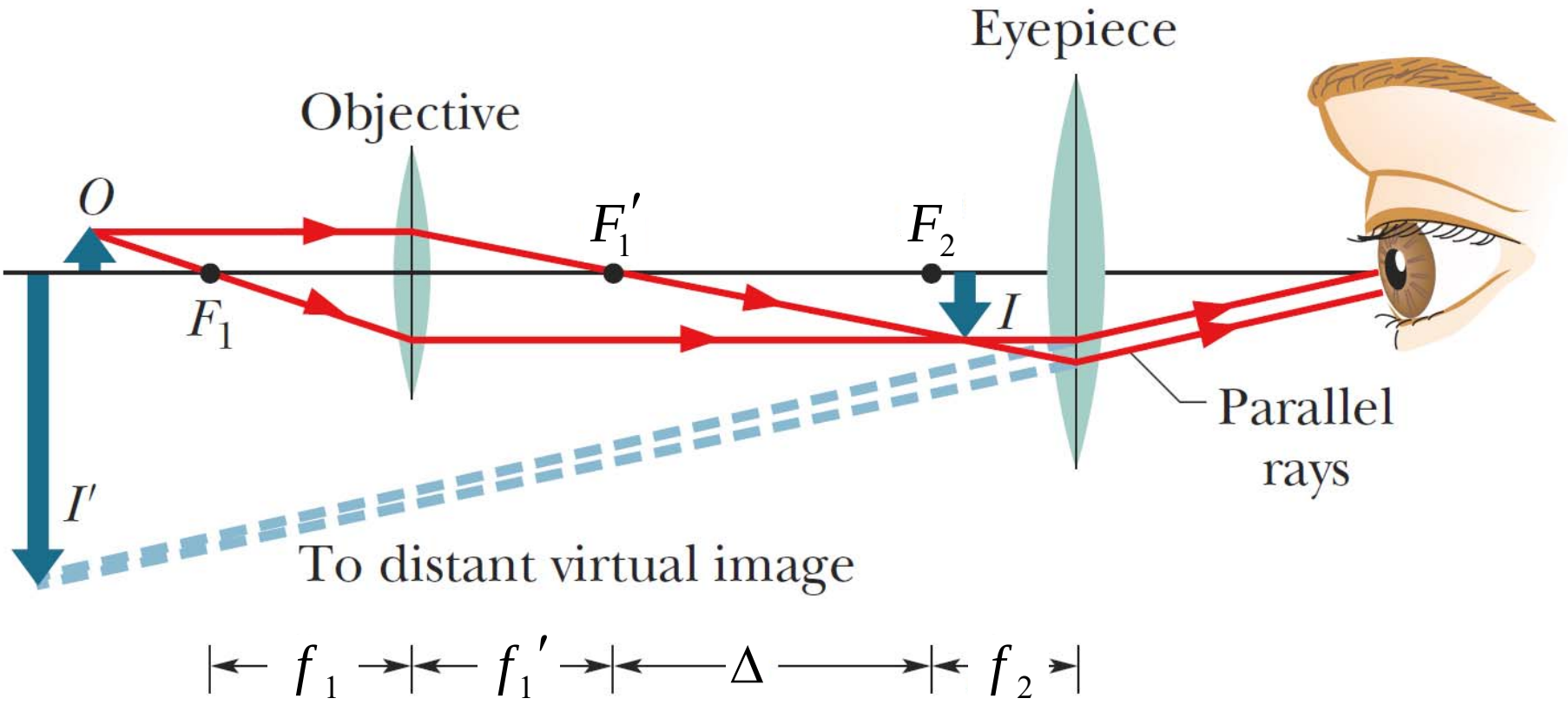
- magnifying lens
- microscope
- telescope

Human eye near point



$$m = -\frac{L}{f'} = \frac{25\ \text{cm}}{f'}$$

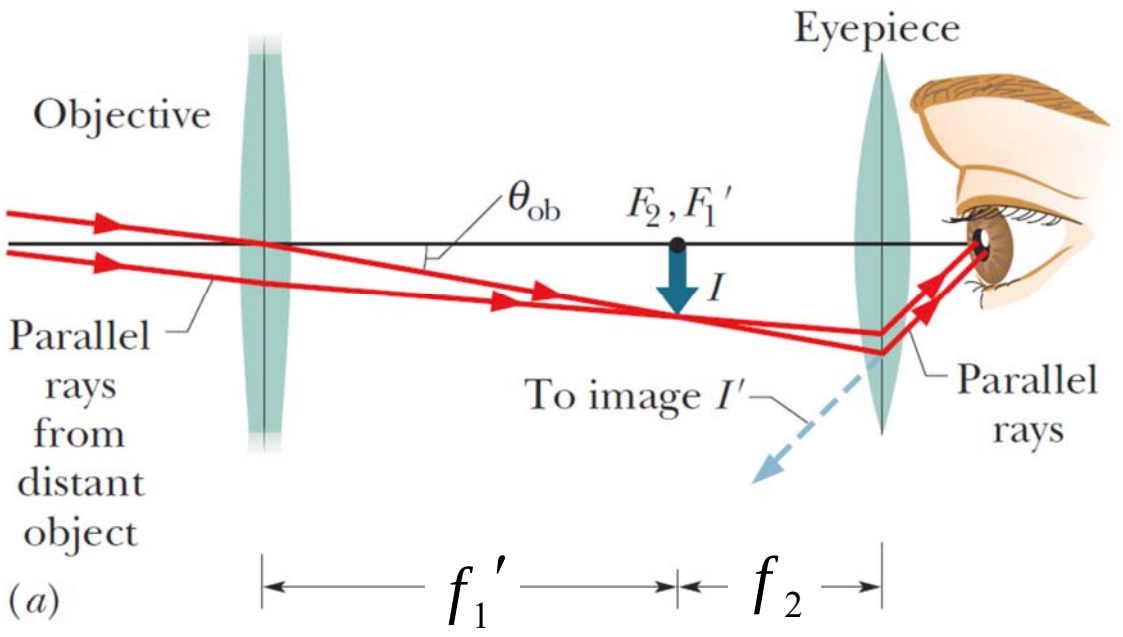
Microscope

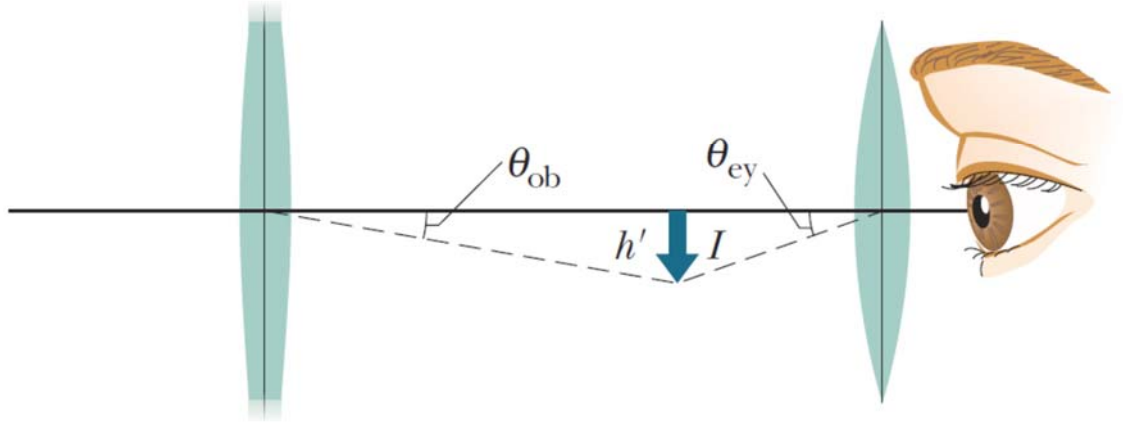


$$m = \frac{L}{f_2'}\frac{\Delta}{f_1'} = \frac{-25\text{ cm}}{f_2'}\frac{\Delta}{f_1'}$$

Refracting telescope

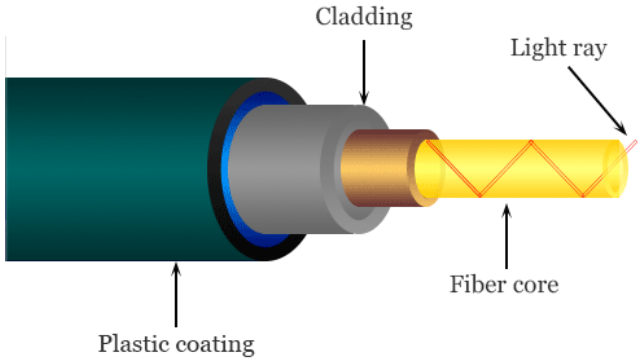
$$m = -\frac{f_1'}{f_2'}$$

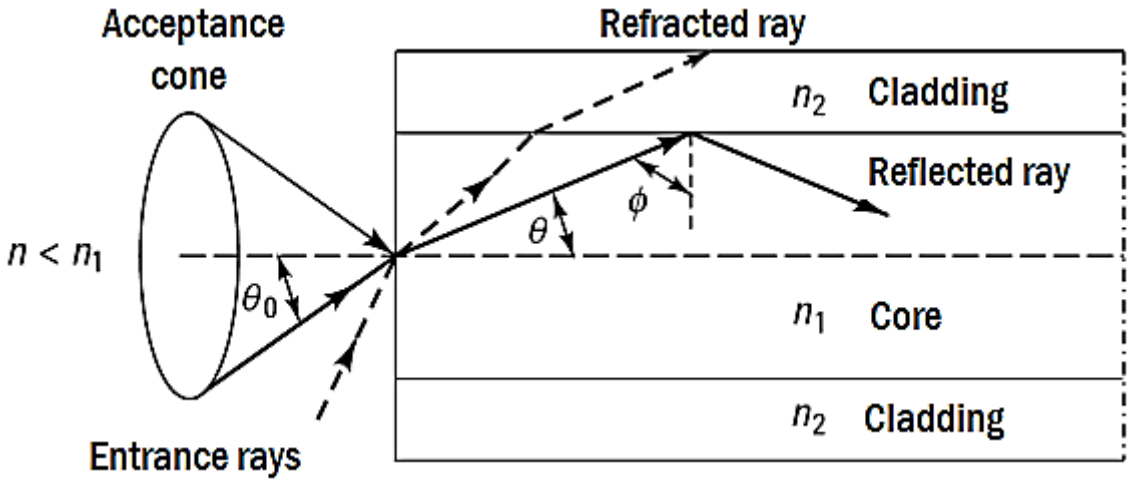




Optical fibres

HRW: Ch33-34





$$\frac{\sin\theta_0}{\sin\theta} = \frac{n_1}{1}$$

$$\sin\theta_0 = n_1\sqrt{1-\cos^2\theta} = n_1\sqrt{1-\sin^2\phi} = \sqrt{n_1^2 - n_2^2}$$

$$\sin\theta_0 = \mathrm{NA}$$