Geometrical Optics

Refraction in spherical surface

$$\frac{n_1}{a} + \frac{n_2}{b} = \frac{n_2 - n_1}{R}$$

Gauss Formula

$$\frac{1}{a} + \frac{1}{b} = \frac{1}{f}$$

Lateral Enlargement

$$M \equiv \frac{y_b}{y_a} \qquad M = -\frac{b}{a}$$

Focal Length Curved Mirror

$$f = -\frac{R}{2}$$

Refractive Power (Lens)

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

Lens

Lens with refractive index n_1 in medium with refractive index n_2:

$$B \equiv \frac{1}{f} = \left[\frac{n_1}{n_2} - 1\right] \cdot \left[\frac{R_2 - R_1}{R_1 \cdot R_2}\right]$$

Aparture Number

$$b_t \equiv \frac{f}{D}$$

Depth of Field

$$s \approx \frac{a^2}{1000 f} b_t$$

Angular Magnification of Magnifier

$$G = \frac{d_0}{f} \text{ where, } \quad d_0 = 25\,\text{cm}$$

Angular Magnification of Microscope

$$G = |M_{ob}| \cdot G_{ok} = \frac{L}{f_{ob}} \frac{d_0}{f_{ok}}$$

where the tube length $L = 16\,\text{cm}$

Angle magnification of the Kepler and Galileo binoculars

$$G = \left|\frac{f_{ob}}{f_{ok}}\right|$$

Refraction in a spherical surface

Positive if: C is to the right of O
- Positive if: A is to the left of O
- Positive if: B is to the right of O
- Positive if: F_A is to the left of O
- Positive if: F_B is on the right of O

Image with thin lens in air
- Positive if: the lens is convex (gathers light)
- Positive if: the object is to the left of the lens
- Positive if: the image is to the right of the lens
- Positive if: the object is above the optical axis
- Positive if: the image is above the optical axis
- Positive if: the image is upside up

Image with a curved mirror
- Positive if: C is to the right of O (convex)
- Positive if: F is to the left of O (concave)
- Positive if: A is to the left of O
- Positive if: B to the left of O
- Positive if: the image is upside up

Refractive Index for Some Materials

Refractive Index with $\lambda = 589\,\text{nm}$ at 20 °C:

Water	$1,333$
Diethyl Ether	$1,353$
Ethanol	$1,361$
Glycerin	$1,455$
Benzene	$1,501$
Carbon Sulfur	$1,628$
Is (0 °C)	$1,31$
NaCl	$1,544$
Polystyrene	$1,59$
Crown Glass (FK5)	$1,487$
Crown Glass (BK7)	$1,517$
Canada balsam	$1,542$
Flint Glass (F2)	$1,620$
Flint Glass (SF10)	$1,728$
Flint Glass (SFS1)	$1,922$
Quarts	$1,458$
Plexiglass	$1,49 - 1,52$
Diamond	$2,417$