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Glossary

Unprimed variables and symbols are in object space.
Primed variables and symbols are in image space.

Frequently used variables and symbols:

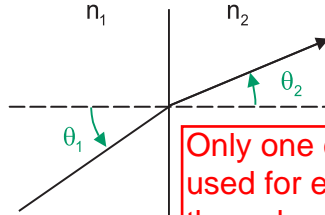
a	Aperture radius
A, A'	Object and image areas
B'	Image plane blur criterion
BFD	Back focal distance
c	Speed of light
C	Curvature
CC	Center of curvature
d, d'	Front and rear principal plane shifts
D	Diopters
D	Diameter
D	Airy disk diameter
DOF	Depth of focus, geometrical
E, E_V	Irradiance and illuminance
EFL	Effective focal length
EP	Entrance pupil
ER	Eye relief
f, f_E	Focal length or effective focal length
f_F, f'_R	Front and rear focal lengths
$f/\#$	F-number
$f/\#_w$	Working F-number
δf	Longitudinal chromatic aberration
F, F'	Front and rear focal points
FFD	Front focal distance
FFOV	Full field of view
FOB	Fractional object
FOV	Field of view
h, h'	Object and image heights
H	Lagrange invariant
H	Normalized field height
H, H_V	Exposure
HFOV	Half field of view
I	Optical invariant
I, I_V	Intensity and luminous intensity
L	Object-to-image distance
L, L_V	Radiance and luminance

Refraction and Reflection

Snell's law of refraction:

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

The incident ray, the refracted ray and the surface normal are coplanar.



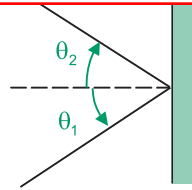
Only one color is used for emphasis throughout

When propagating through a series of parallel interfaces, the quantity $n \sin \theta$ is conserved.

Law of reflection:

$$\theta_1 = -\theta_2$$

The incident ray, the reflected ray and the surface normal are coplanar.



Figures have no numbers or captions, use 10-pt Arial font

Reflection equals refraction with $n_2 = -n_1$.

Key terms in bold

Total internal reflection TIR occurs when the angle of incidence of a ray propagating from a higher index medium to a lower index medium exceeds the **critical angle**.

$$\sin \theta_c = \frac{n_2}{n_1}$$

At the critical angle, the angle of refraction θ_2 equals 90°

The **reflectance** ρ of an interface between n_1 and n_2 is given by the **Fresnel reflection coefficients**. At normal incidence with no absorption,

$$\rho = \left(\frac{n_2 - n_1}{n_2 + n_1} \right)^2$$

n_1	θ_c
1.3	50.3°
1.4	45.6°
1.5	41.8°
1.6	38.7°
1.7	36.0°
1.8	33.7°
1.9	31.8°
2.0	30.0°

Critical angles
for $n_2 = 1.0$

The entire page is filled using 10-pt Century Schoolbook font, with no footnotes or endnotes, and it addresses one topic.

Equation Summary

General equations (index, refraction, mirrors, etc.):

$$\begin{array}{ll}
 OPL = nd & \rho = \left(\frac{n_2 - n_1}{n_2 + n_1} \right)^2 \\
 n_1 \sin \theta_1 = n_2 \sin \theta_2 & \sin \theta_C = \frac{n_2}{n_1} \\
 \tau = \frac{t}{n} & \omega = nu \\
 \gamma = 2\alpha & d \approx \left(\frac{n-1}{n} \right) t = t - \tau
 \end{array}$$

Power and focal length:

$$\phi = (n' - n)C = \frac{(n' - n)}{R} \quad f_E \equiv \frac{1}{\phi} = -\frac{f_F}{n} = \frac{f'_R}{n'}$$

Newtonian equations (z, z' measured from F, F')

$$\frac{z}{n} = \frac{f_E}{m} \quad \frac{z'}{n'} = -mf_E \quad \left(\frac{z}{n} \right) \left(\frac{z'}{n'} \right) = -f_E^2$$

Gaussian equations and imaging (z, z' measured from P, P')

$$\begin{array}{lll}
 \frac{z}{n} = \frac{(1-m)}{m} f_E & \frac{z'}{n'} = (1-m) f_E & m = \frac{z'/n'}{z/n} = \frac{\omega}{\omega'} \\
 \frac{n'}{z'} = \frac{n}{z} + \frac{1}{f_E} & \frac{\Delta z'/n'}{\Delta z/n} = m_1 m_2 & \bar{m} = \left(\frac{n'}{n} \right) m^2 \\
 z_{PN} = z'_{PN} = f_F + f'_R & & m_N = -\frac{f_F}{f'_R} = \frac{n}{n'}
 \end{array}$$

Gaussian reduction:

$$\begin{array}{lll}
 \phi = \phi_1 + \phi_2 - \phi_1 \phi_2 \tau & \frac{d}{n} = \frac{\phi_2}{\phi} \tau & \frac{d'}{n'} = -\frac{\phi_1}{\phi} \tau \\
 BFD = f'_R + d' & & FFD = f_F + d
 \end{array}$$

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