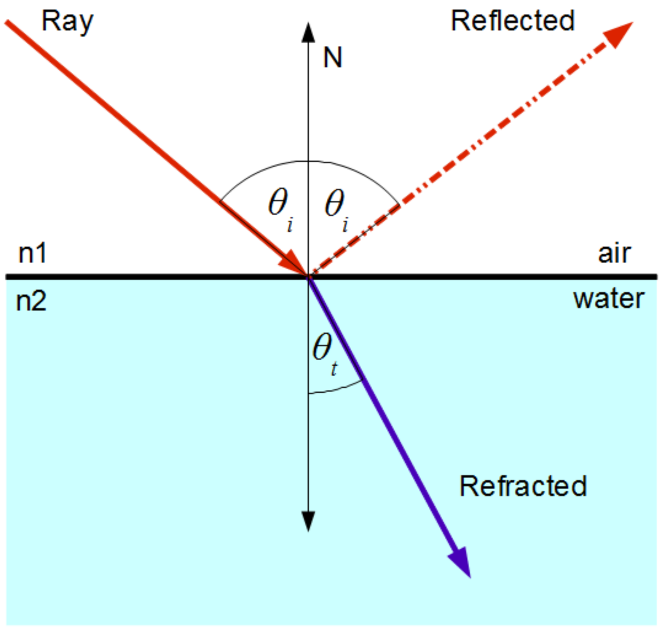
OPTICS

Reflection angle = incident angle

Refraction angle depends on refractive index, n:



$$n_1 \sin(\theta_i) = n_2 \sin(\theta_t)$$

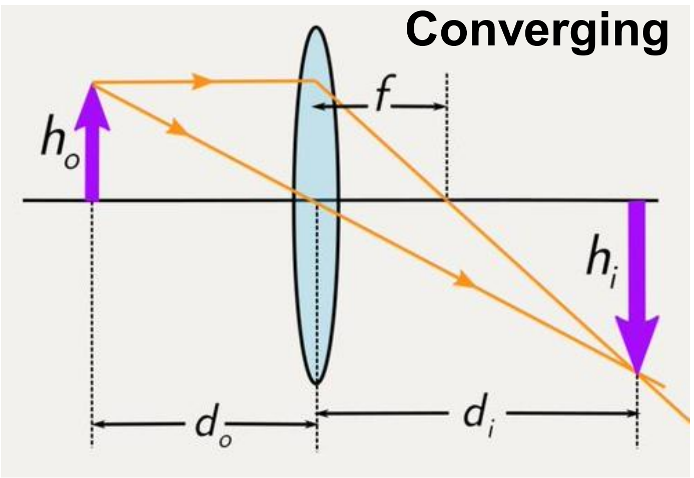
Here refractive index *n* indicates how much the light is slower in a particular medium than in vacuum.

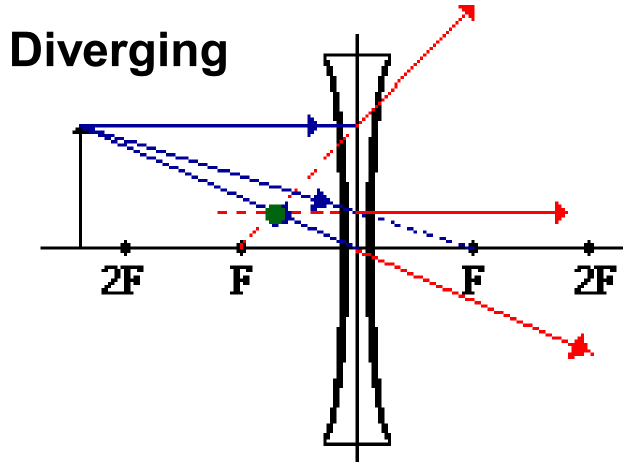
Examples:

Air: n= 1 (close to vacuum)
Water: n=1.33
Glass: n=1.5
Diamond: n=2.4

Lenses

- A ray passing through the center of a lens continues straight.
- **Converging (positive) lens**
  A ray parallel to the principal axis refracts through the focal point on the opposite side.
  A ray passing through the focal point refracts parallel to the principal axis.
- **Diverging (negative) lens**
  A ray parallel to the principal axis refracts as if it came from the focal point.
  A ray aimed toward the focal point on the far side refracts parallel to the principal axis





Thin lens formula: $$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$$

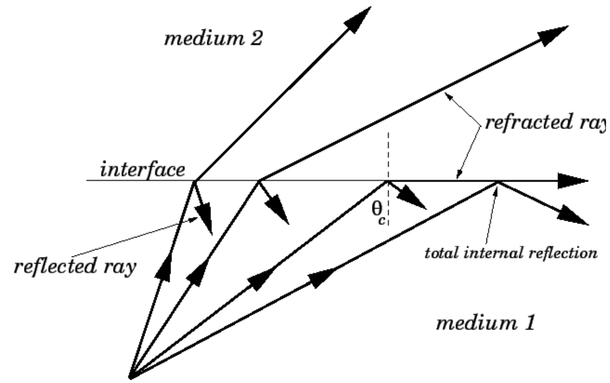
d_o, d_i: distances to object and image; f - focal distance (negative for divergent lens)

$$\text{Lense magnification} = \frac{h_i}{h_o} = \frac{d_i}{d_o}$$

Homework

Problem 1

Find the minimal angle at which the light ray coming from inside the water will not be able to pass the surface, and therefore will be completely reflected (It's called total internal reflection).



Problem 2

A concave lens of focal length - 8 cm is used to form the image of a 2.0 cm high object located 10 cm in front of the lens. Construct the diagram, use ray tracing techniques to locate the image. Measure the image position and height from your diagram, and compare to them thin lens formulas.

Problem 3

The **optical power** of a lens tells how strongly it bends light. It is equal to $1/f$, where f is the focal length in meters. Optical power is measured in **diopters**. It is positive for a converging lens and negative for a diverging lens.
Using the thin lens equation, prove that when two thin lenses are placed directly next to each other, their optical powers add.