# Refractive index of light

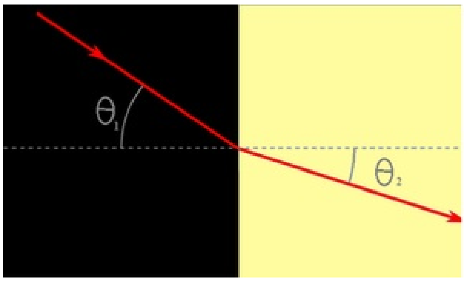
The **refractive index of light**, usually denoted n, is the ratio of the speed of light in two optical media. It is a dimensionless number for a given pair of media and a given frequency. We distinguish between **absolute** and **relative** refractive index depending on how we compare the speed of light in a given medium.

## Absolute and relative refractive index

### Absolute refractive index

The **absolute refractive index** is defined as the ratio of the speed of propagation of light in a vacuum *c* to the speed v in a given medium:

$$n = \frac{c}{v}$$



Refraction of light

The absolute refractive index is a characteristic of a particular environment, it is a material constant ans is tabulated for many solids. Since the refractive index depends on the wavelength of the radiation, light is decayed on the optical prism.

Since the speed of light in any medium is less than the speed of light in a vacuum, the absolute refractive index is always greater than one.

### Relative refractive index

The **relative refractive index** is defined as the ratio of the speed of light in two optical media *v1* and *v2*:

$$n_{12} = \frac{v_1}{v_2}$$

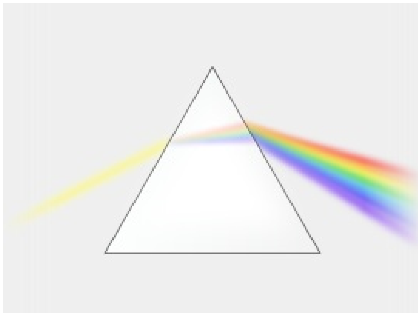


Diagram of a dispersion prism

While the absolute refractive index is a material constant, the relative refractive index characterizes the properties of the interface between two optical media. It is closely related to these environments' absolute refractive indices $n_1$ and $n_2$. In fact, it is determined by their ratio (in reverse order). The relative refractive index at the interface (usually denoted $n_{12}$) relationship is derived as follows:

$$n_{12} = \frac{v_1}{v_2} = \frac{\frac{v_1}{c}}{\frac{v_2}{c}} = \frac{\frac{c}{v_2}}{\frac{c}{v_1}} = \frac{n_2}{n_1}$$

## Refraction

When light hits the interface of two different optical media, it **is reflected** (the beam returns to the medium from which it came at the same angle and in the same plane) and **refracted** (the beam refracts into the other medium). In refraction, a ray of light entering with a velocity $v_1$ at the angle of incidence $\alpha$ between the ray and the normal (line perpendicular to the interface of two optical media) changes its direction and refracts at an angle of refraction $\beta$ with a changed velocity $v_2$ characteristic to the other medium.

This is described by Snell‘s law:

$$n_{12} = \frac{\sin\alpha}{\sin\beta} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$$

If the angle of incidence $\alpha$ is greater than the angle $\beta$, the beam is refracted towards the normal. This situation occurs when light enters from a medium with a higher refractive index into a medium with a lower refractive index.

If the angle $\beta$ is greater than the angle α, the beam is refracted away from the normal, towards the interface. This occurs when light enters from a medium with a lower refractive index to a medium with a higher refractive index.

## Total internal reflection

Suppose the beam is refracted away from the normal. At a certain angle of incidence $\varphi$, it may occur that the reflected beam will be perpendicular to the normal, therefore parallel to the interface between the two optical media. This angle $\varphi$ is called the **critical angle**. For rays with an incident angle greater than the critical angle, the interface behaves like a mirror and **total reflection** occurs (the beam is completely reflected back into the first medium). The first medium is usually referred to as the internal medium and the second one as external. The value of the critical angle $\varphi$ depends only on the indices of refraction of the two media:

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

# Refractive index measurement

The instrument used to measure the refractive index is called a **refractometer**. A refractometer is usually based on the measurement of a critical angle (Abbe refractometer for liquids, Pulfrich refractometer for solids). The refractive index can also be measured directly by measuring the refraction of, for example, a laser beam as it passes through a given medium using a goniometer (a device for accurate measurement of angles), but a geometrically well-defined piece of the material must be used for the measurement.

In medicine, the most important is the measurement of the refractive index of liquids. The refractive index of a solution depends on the concentration of the solution, thus refractive index measurement can be used as a quantitative analytical method. The measurement of the refractive index of urine can be used as a method of determining relative density. Similarly, measuring the refractive index of serum is used to determine the serum total protein.

# Links

## Related sources

- Polarization of light
- Polarimetry
- Visible light
- Reflection of light
- Refractometry

## Source


- KUBATOVA, Senta. *Biofot* [online]. [cit. 2011-01-31]. <https://uloz.to/!CM6zAi6z/biofot-doc>.