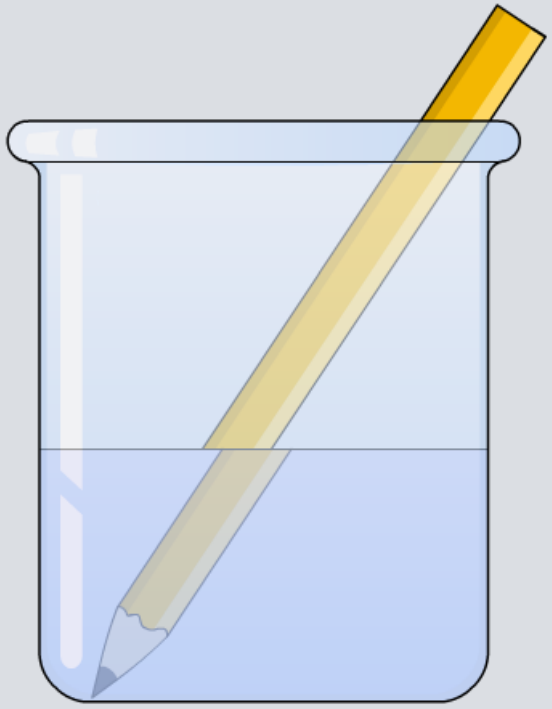
Refractive Index



Traveling through different materials

If you were running along a beach and then ran into the water, when would you be moving slower – in the water or on the sand?

In the water.

In a similar way, as light moves from one medium to another of different density, the speed of light **changes**.

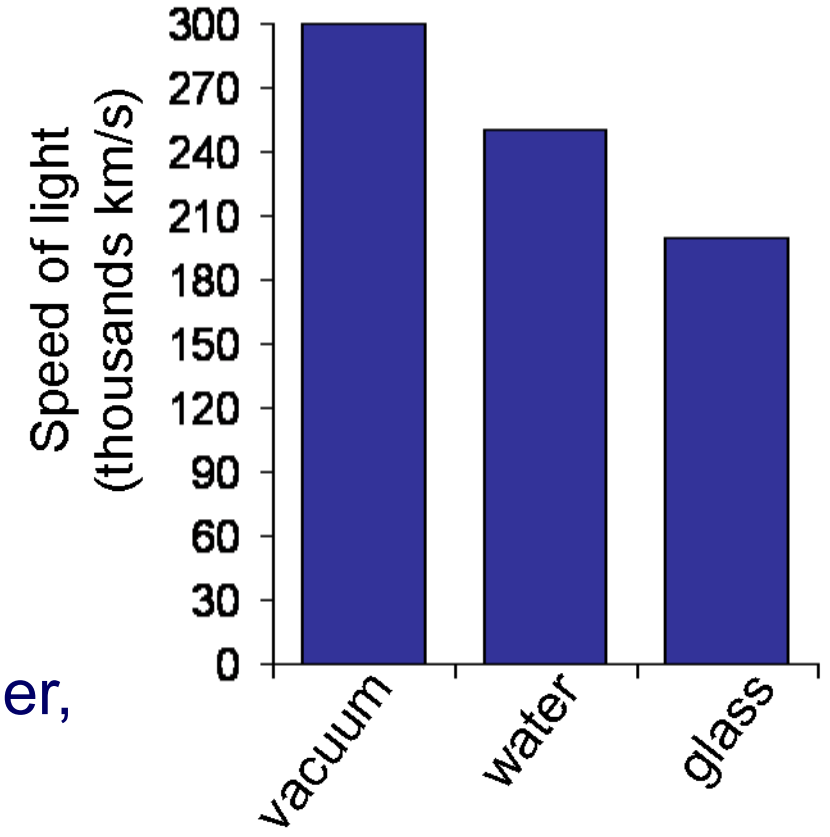
Do you think light moves faster or slower in a more dense medium?

Light moves slower through a more dense medium.

The speed of light

Light travels at 300,000 km/s in a vacuum.

As light enters denser media, the speed of light decreases.



From this bar chart, which material do you think is denser, glass or water?

Glass must be denser than water because light travels **more slowly** through glass than water.

The speed of light

We can study refraction of light by comparing its speed in air to that in a different material.

A number called the **refractive index** is the ratio of these two speeds:

$$\text{Refractive index} = \frac{\text{speed of light in air}}{\text{speed of light in material}}$$

Example:

The speed of light in air is 300,000,000 m/s, and the speed of light in water is 225,000,000 m/s. What is the refractive index of water?

1.33

Calculating refractive index

The speed of light in air is 300,000,000 m/s.

The speed of light in crystal is 150,000,000 m/s. What is the refractive index of crystal?

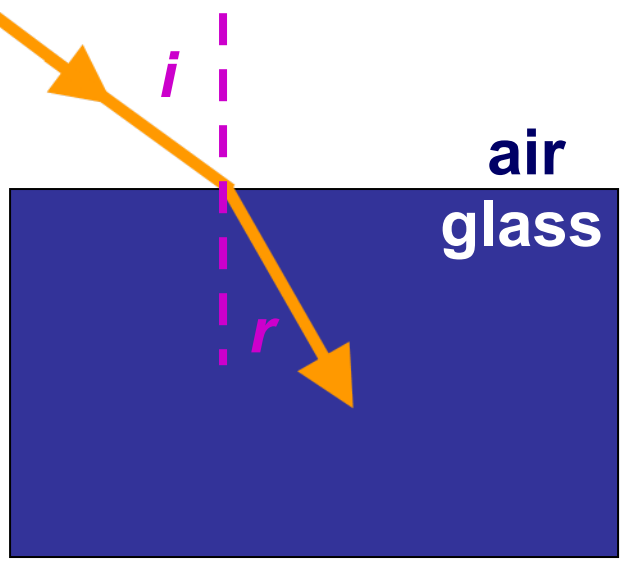
$$\text{Refractive index} = \frac{\text{speed of light in air}}{\text{speed of light in crystal}}$$

$$\text{Refractive index} = \frac{300{,}000{,}000}{150{,}000{,}000}$$

Refractive index of crystal = **2.0**

Snell's law

$$\text{Refractive index} = \frac{\sin i}{\sin r}$$



Example:

When a ray passes into a glass block, $i = 45°$ and $r = 28°$. What is the refractive index of the glass?

$$\text{Refractive index} = \frac{\sin 45}{\sin 28}$$

$$\text{Refractive index} = \mathbf{1.5}$$