# Critical Angle

# More Details

## Refraction and reflection

Light can actually only shine straight ahead. Once it is sent out, it races unswervingly through the room. But as soon as it hits an interface between two transparent materials, something strange happens: the light ray is split into two rays. One part is reflected as if by a mirror, the other part enters the material but changes direction — it is refracted. Light travels at different speeds in different media: in air it is almost as fast as in a vacuum; if it falls into glass, it is slowed down considerably and therefore bends (Fig. 1). How strongly the direction changes depends not only on the speed $c$ in the two media but also on the angle $\alpha$ at which the light hits the interface. The law of refraction determines exactly how the angle of refraction and angle of incidence behave when light falls from one medium into another (Fig. 2).

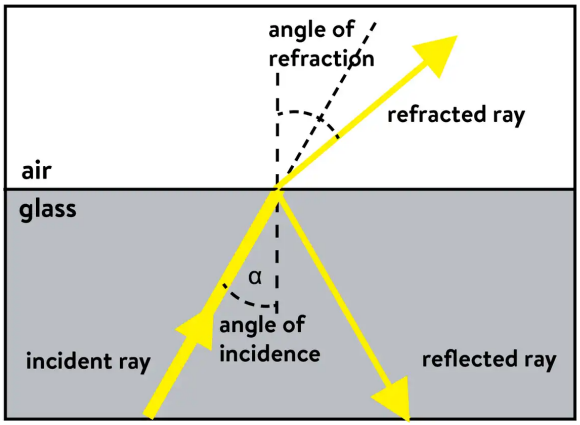


Fig. 1: In our experiment the light enters the air from the glass semicircle. Since light is faster in air than in glass, the ray proceeds flatter in air than in glass.

$$\frac{\alpha_{refraction}}{\alpha_{incidence}} = \frac{c_{medium\ 2}}{c_{medium\ 1}}$$

Fig. 2: The law of refraction determines exactly how the angle of refraction, the angle of incidence and the speed of light c behave when light falls from one medium into another.

## Thinking ahead consistently

As the light hits the interface increasingly flatter, it is refracted at an ever greater rate – i.e. it proceeds from the interface even flatter than it fell on it (Fig. 3a). At a certain angle, the light would continue to travel exactly along the interface. But because it would then no longer cross the interface, refraction no longer takes place. From this angle

onwards, the light ray is no longer split, but reflected completely. This is known as total reflection (Fig. 3b).

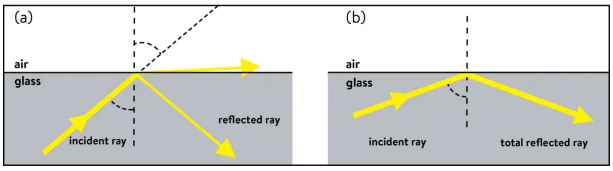


Fig. 3: Increasing angle of refraction with increasing angle of incidence (a) and total reflection (b).

## What do diamonds and a mirage have in common?

Both diamonds and a mirage are only this beautiful through total reflection!

A mirage or also the apparently wet street in the summer heat are only mirror images of a distant object or the sky, which are made by total reflection of the light at the interface between cool and hot air layers. Refraction and total reflection makes also cut diamonds sparkle: Due to the high optical density of diamond, light rays can easily enter the gemstone, but only leave the stone after a more or less large number of total reflections.