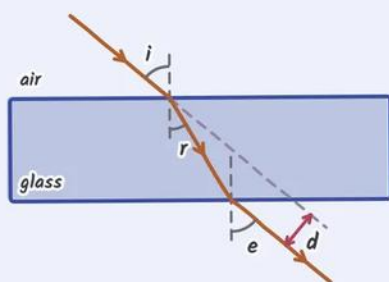


light bending at a boundary because its speed changes, and what happens when it cannot get out

Why light bends at all *

- refraction is the bending of light as it passes from one transparent medium into another
- the cause is the change in the speed of light, which travels slower in a denser medium
- the refractive index n of a medium is $\frac{c}{v}$, the speed in vacuum divided by the speed in that medium
- n has no units, being a ratio of two speeds, and it is always greater than 1 for a real medium
- optically denser means a higher refractive index, which is not the same as being physically heavier
- light entering a denser medium bends towards the normal, and leaving it bends away



a glass slab, $n = 1.5$, $i = 50^\circ$: entering, the ray bends towards the dashed normal ($r \approx 31^\circ$); leaving, it bends away again to $e = i$, so the angle in the rarer medium is the larger, both measured from the normal, and the ray comes out parallel but shifted sideways by d

The relations of this chapter

refractive index from speeds	$n = \frac{c}{v}$
Snell's law	$n_1 \sin i = n_2 \sin r$
the same law as a ratio	$\frac{\sin i}{\sin r} = \frac{n_2}{n_1}$
critical angle for a denser to rarer boundary	$\sin C = \frac{n_2}{n_1}$
critical angle when the second medium is air	$\sin C = \frac{1}{n}$

both angles in Snell's law are measured from the normal, never from the surface, and this is the most common source of a wrong substitution

What changes and what does not

- the speed of light changes, which is the whole cause of the bending
- the wavelength changes in proportion to the speed
- the frequency does not change, since it is set by the source and nothing at the boundary can alter it
- so a colour stays the same colour on entering glass, because colour is decided by frequency
- a ray travelling along the normal, at an angle of incidence of zero, does not bend at all, though it does slow down
- refraction is reversible: a ray retracing its path comes back exactly the way it came
- through a glass slab with parallel faces the ray leaves parallel to the incident ray, only shifted sideways: the lateral displacement

