

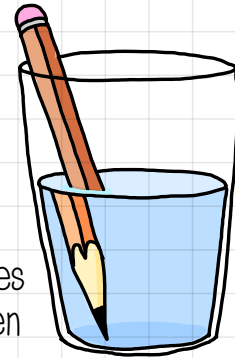
# Refraction of waves



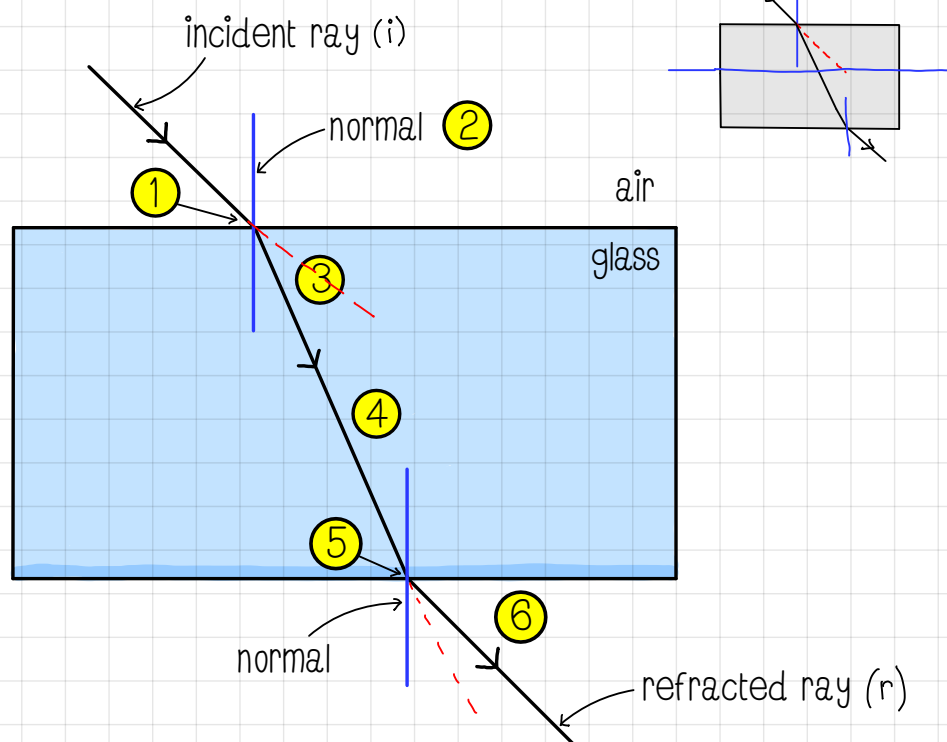
Light appears to change direction as it passes through water. This is due to refraction. Refraction (the bending of light) occurs when light passes from one medium to another.



Refraction is due to the difference in velocity of the waves in different substances. Waves can **change direction** when they **change velocity**.



## Refraction ray diagrams



① When light passes from air into glass, the velocity of light decreases.

② The normal is a line drawn at  $90^\circ$  to the surface of the glass.

③ When waves **slow down**, they **bend towards** the **normal**.

④ The light wave then passes through the glass.

⑤ The waves pass from glass into the air and its velocity increases.

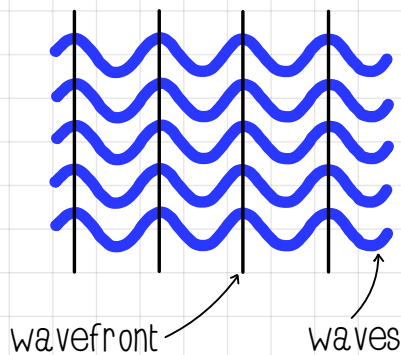
⑥ When waves **speed up**, they **bend away** from the **normal**.



Light waves which enter or leave glass at right angles to the surface (e.g. along the normal), do not change direction. They pass straight through the block.

# Refraction of waves...

## Wavefront diagrams

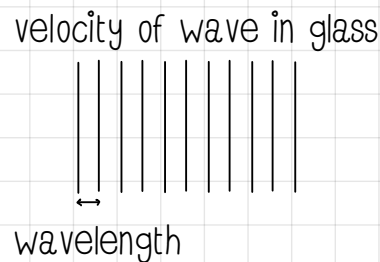
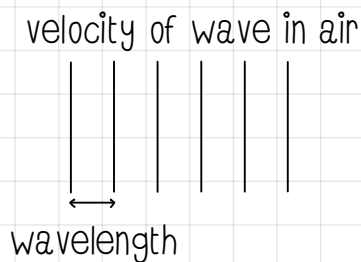


The wavefront is a line that connects all the same points in a group of waves. In the diagram on the left, the wavefronts have been drawn by connecting the peaks of each wave.

Wavefronts make it easier to visualise groups of waves moving together.

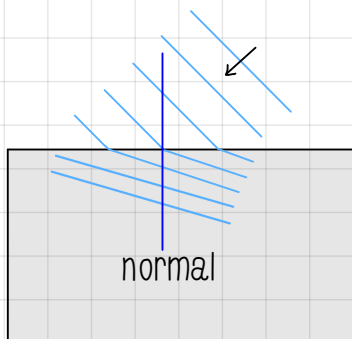


## Velocity of waves using wavefronts

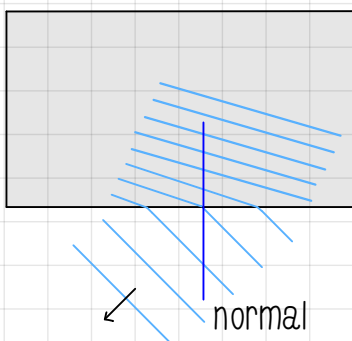


Waves are faster in air than in glass. This is shown in wavefront diagrams by drawing the wavefronts closer together. This also means that their wavelengths get shorter.

## Wavefront refraction diagrams



When the first part of the wavefront move into the glass, the wavefronts slows down. Note how the wavefronts become closer (shorter wavelength). This causes the wave to change direction towards the normal.



When waves leave glass, they speed up increasing the wavelength.

As the waves speed up they change direction away from the normal.



 watch video