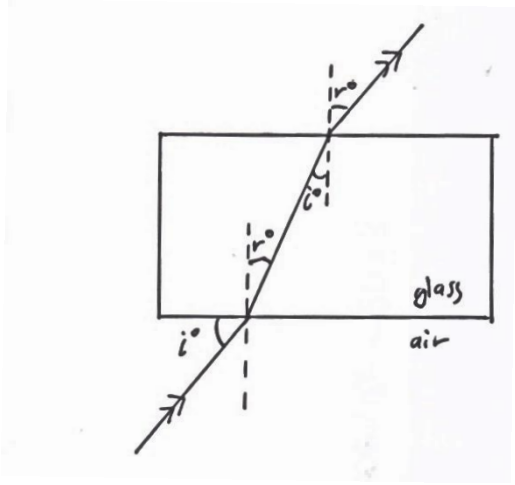
2.9: Refraction summary (physics)

Refraction occurs when light rays travel from a substance to another of **different density** and **bend**. The light bends **towards the normal** when moving from **less dense to more dense**. And **away from the normal** when moving from **more dense to less dense**.



In refraction, the "r" represents **angle of refraction** and not reflection.

The **denser the medium**, the **slower light travels** through it. Light always finds the **shortest** (in terms of time, not distance) **path to travel**. (Analogy: Man walking through different surfaces, will walk more on sand and less in mud.)

Refractive index is speed of light in the given medium divided by the speed of light in a vacuum. (Refractive index of vacuum is 1. Air has a negligible refractive index, usually considered to be 1.) The refractive index is a measure of optical density.

Snell's Law: $n_1\sin(i_1)=n_2\sin(i_2)$

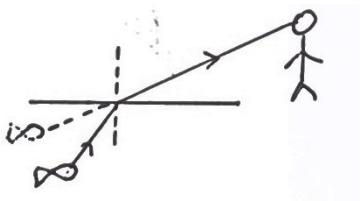
n_1 and n_2 are the refractive indices of medium 1 and 2 respectively.

i_1 and i_2 are the angles of incidence and refraction respectively.

Light traveling into a denser medium bends towards the medium (travel less in harsh ground analogy)

Applications:

Example: When trying to spear fish, the fisherman should aim lower than where he sees the fish, due to refraction.



Total internal reflection: when the angle of incidence is the critical angle or larger, light would not refract out but instead **reflect within the medium**, following the i=r law. TIR occurs only when **light travels from a denser medium to a less dense medium.**

Critical angle: the angle at which light ray will reflect internally.

$C=\sin^{-1}(n_2/n_1)$ (Application of Snell's law)

It might be simpler to simply memorise Snell's Law, instead of memorizing the formula to find critical angle. To derive formula for critical angle, just sub in $i_2=90^o$ (since when angle of incidence is critical angle, the light will refract perpendicular to normal)

For calculations in physics, the first step is always to write down the formula that you are going to use (with the unknowns). Second step is to substitute in the values that you know. The third step is to solve and find the unknown that the question asks.

Optical fibers: Application of TIR. Light travels within clear wire, and cannot escape into the air due to the critical angle being too high, so light simply keeps reflecting of the surfaces of the wire and remains within the wire. The information coded into the light travels at the speed of light, extremely fast and reliable way to transmit information.