Total reflection

20131218061001 Total Internal Reflection

While swimming under water and opening the eyes, one can experience sometimes a mirror like reflection on the surface. This optical phenomenon is called total internal reflection or total reflection. It usually appears when waves of a light source enter from a medium with a higher refractive index (n_1) into another one with a lower refractive index (n_2). Another condition for the occurrence of total internal reflection is that the angle of incidence is greater than the critical angle.

For visual demonstration purposes of total internal reflection one can use a body with a semicircular shape made out of glass. In this case there are only two options for the light beam. If the angle of incidence (θ) is smaller than the critical angle (θ_c), some of the rays will refract and leave the boundary while the others are reflected. On the other side, if the angle of incidence (θ) is greater than the critical angle (θc), the beam will be entirely reflected. At this point it is called total internal reflection.

At the critical angle the angle of refraction in the low refractive index medium reaches 90°. This can be explained practically and theoretically by Snell’s Law. Practically one can explain the 90° by taking a light beam that travels from glass into air. When the incident angle becomes larger, the ray is more and more put into a horizontal position until it reaches 90°. Then there is no light that is transmitted into the air anymore.

The critical angle (θ_c) can also be pointed out by Snell’s law in theory, $n_1 \bullet \sin\theta_i = n_2 \bullet \sin\theta_t$. N1 and n2 are the refractive indices of the two mediums, which the light ray passes through. θi is the angle of incidence and θt is the angle of transmission (also known as angle of refraction). θi is equal to θc when θt= 90°. Therefore, sin •(90°)=1 and putting it into the formula it means n1•sinθi = n2. Afterwards the equation should be rearranged to sinθi = n2/ n1 and lastly to θi =$\sin^{-1}$ (n2/ n1).

The angle of incidence has to be greater than the critical angle for total internal reflection. Another condition for the occurrence of this phenomenon is that the light ray always has to pass from a medium of lower refractive index into a higher one. Total internal reflection is very common in Diamonds. It is one of the reasons why it has such a nice sparkle inside.

Sources:

Total internal reflection. (n.d.). Retrieved from http://www.physicsclassroom.com/class/refrn/u14l3b.cfm The critical angle. (n.d.). Retrieved from http://www.physicsclassroom.com/class/refrn/U14L3c.cfm Total internal reflection. (n.d.). Retrieved from http://en.wikipedia.org/wiki/Total_internal_reflection