PhyzExamples: Light

Physical Quantities • Symbols • Units • Brief Definitions

Wavelength • λ • meter: m • Light wavelength is the distance between successive electric field maxima or minima or successive magnetic field maxima or minima.
Frequency • f or ν *(nu)* • hertz: Hz • The rate at which a source emits light waves or an observer receives light waves.
Speed • v • meters per second: m/s • The rate at which a light wave propagates through a transparent material.
Speed of Light in a Vacuum • $c = 3.0 \times 10^8$ m/s
Index of Refraction • n • unitless • The ratio of the speed of light in a vacuum to the speed of light in a transparent material.
Angle of Incidence • θ_1 • degrees: ° • The angle between an incident ray of light and the normal line from the point of incidence.
Angle of Refraction • θ_2 • degrees: ° • The angle between a normal line from the point of incidence and a refracted ray of light.
Critical Angle • θ_c • degrees: ° • The angle of incidence for a beam of light passing from a denser material to a lighter material such that the angle of refraction is 90°.

Equations

$c = f\lambda$ • *speed of light = frequency · wavelength*
$n = c/v$ • *index of refraction of a material = speed of light in vacuum / speed of light in the material*
$n_2/n_1 = v_1/v_2$ • *index of refraction of a second material / index of refraction of a first material = speed of light in first material / speed of light in second material* • $n = v_1/v_2$ (if first medium is air)
$n_2/n_1 = \lambda_1/\lambda_2$ • *index of refraction of a second material / index of refraction of a first material = wavelength of light in first material / wavelength of light in second material* • $n = \lambda_1/\lambda_2$ (if first medium is air)

Smooth Operations Examples

1. "Wild 107" broadcasts with a carrier frequency of 107.7 MHz. What is the wavelength of such radio waves?

1. $f = 107.7 \times 10^6$ Hz $c = 3 \times 10^8$ m/s $\lambda = ?$
$c = f\lambda$
$\lambda = c/f$
$\lambda = 3 \times 10^8$ m/s / 107.7×10^6 Hz
$\lambda = 2.79$ m

2. The speed of light in a crystal is 1.2×10^8 m/s. What is the index of refraction of the crystal?

2. $v = 1.2 \times 10^8$ m/s $n = ?$
$n = c/v$
$n = 3.0 \times 10^8$ m/s / 1.2×10^8 m/s
$n = 2.5$

3. Light from a helium-neon laser emerges with a wavelength of 6328 Å. What is the wavelength when the light is passing through regular glass?

3. $\lambda_1 = 6328 \times 10^{-10}$ m $n_2 = 1.52$ $n_1 = 1.00$ (air)
$n_2/n_1 = \lambda_1/\lambda_2$
$\lambda_2 = \lambda_1 n_1/n_2$
$\lambda_2 = 6328 \times 10^{-10}$ m · 1.00 / 1.52
$\lambda_2 = 4163 \times 10^{-10}$ m (= 4163 Å)