Light Waves (Geometric Optics)

Wave Transmission

Light travels as a ***transverse electromagnetic wave***.

- each colour of light has a unique wavelength
- wavelengths adjacent to violet on the E/M spectrum and shorter than violet are ***ultraviolet***
- wavelengths adjacent to red on the E/M spectrum and longer than red are ***infrared***
- E/M waves with very short wavelengths are higher energy radiation (X-rays, gamma rays, cosmic rays, etc.)

Recall that the universal wave equation is valid for ALL waves, including E/M waves:

$$\mathbf{v = f\lambda}$$

and for ALL waves,

- the speed of a wave depends on the medium through which it travels
- the frequency of a wave equals the frequency of the source of that wave

Thus, as a wave passes from one medium (material) into another,

- frequency remains constant
- speed and wavelength both change

So ...

$$\frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{v_2}{v_1}$$

where

- $\mathbf{n_1}$ and $\mathbf{n_2}$ are the refractive indices of the respective media

- λ_1 and λ_2 are the wavelengths of light in those respective media
- v_1 and v_2 are the speeds of light in those respective media

Recall also that Snell's Law dictates that

$$n_1 \text{Sin}\theta_1 = n_2 \text{Sin}\theta_2$$

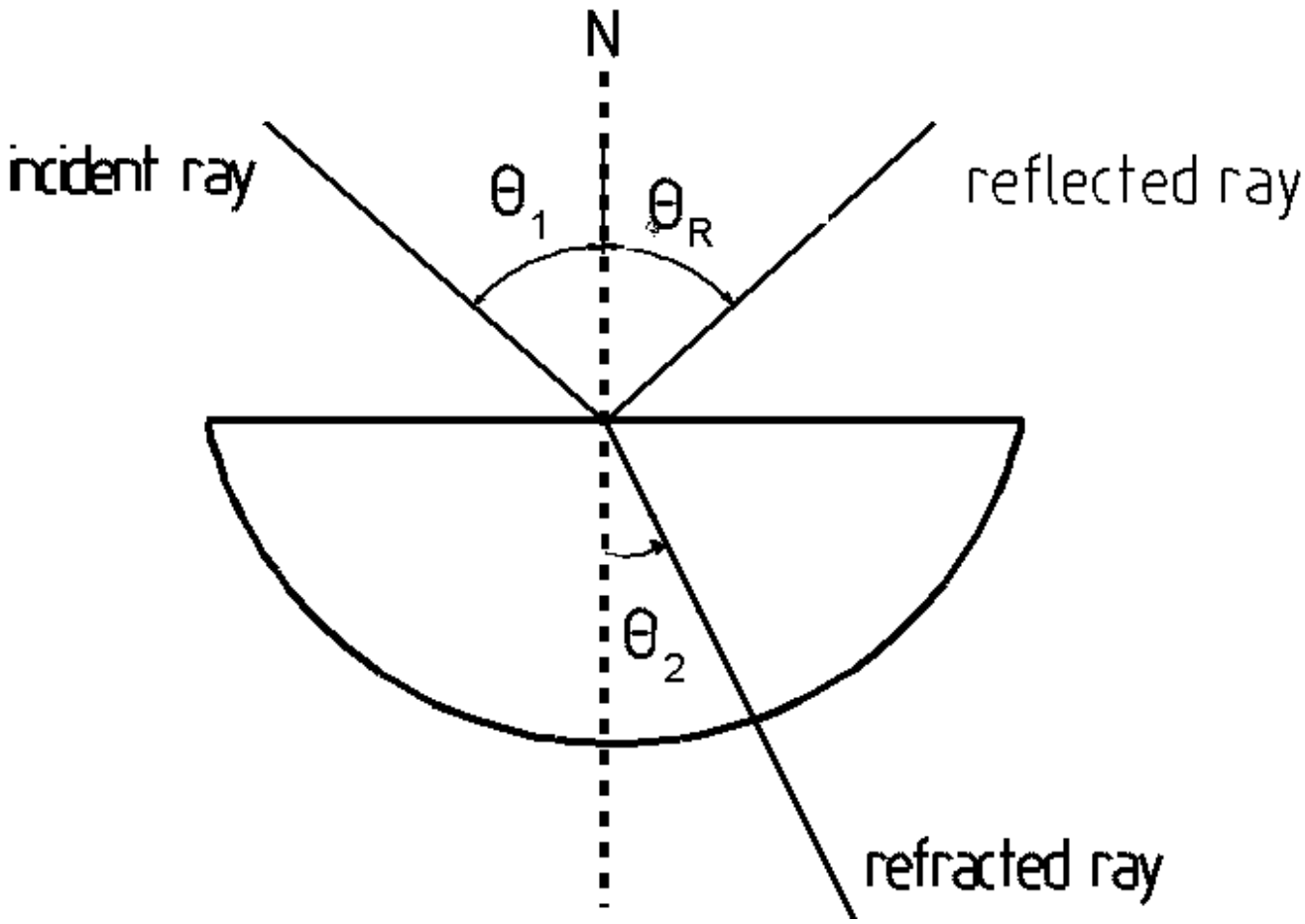
where

- θ_1 is the angle between the incident ray and the normal ("N"), also called the angle of incidence.
- θ_2 is the angle between the refracted ray and the normal ("N"), also called the angle of refraction.

Recall also, that the ***Law of Reflection*** states that

$$\theta_1 = \theta_R$$

where θ_R is the angle of reflection, in the case where the incident ray is partially reflected.

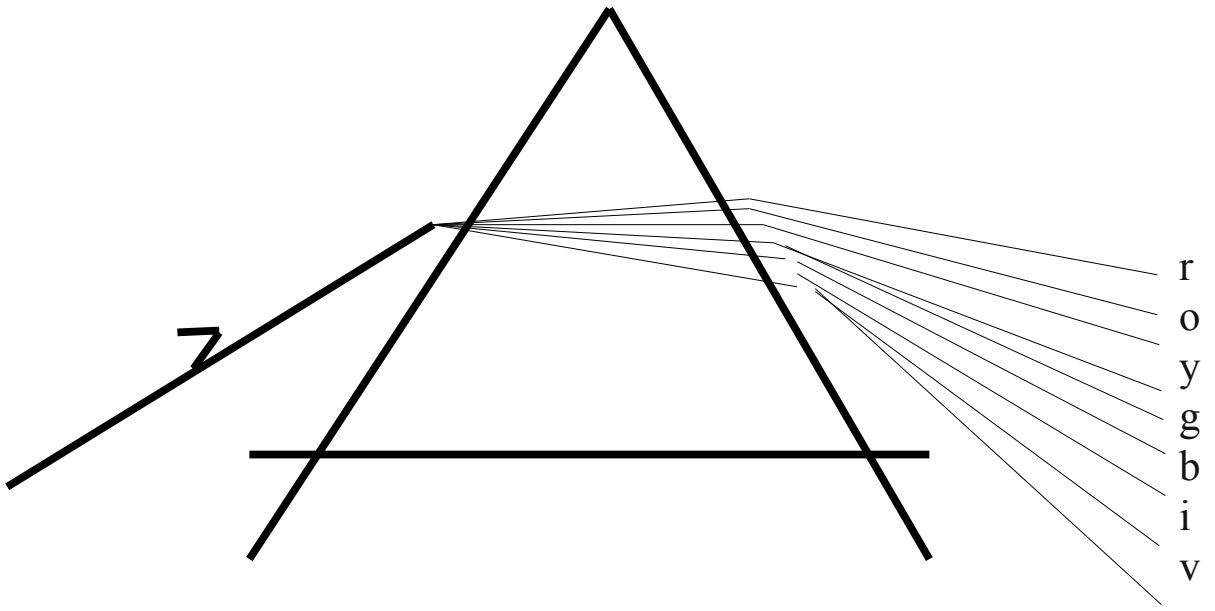


Newton developed a particle theory of light, in which he postulated that when light passes from one medium into another and speeds up, the light bends toward the normal.
Thus, according to his particle theory (now known to be incorrect),

$$\mathbf{n_2 Sin\theta_1 = n_1 Sin\theta_2}$$

and

$$\frac{n_1}{n_2} = \frac{v_1}{v_2}$$



Dispersion – The splitting of white light into its constituent colours (seen above). Newton's particle theory stated that this occurs because each colour has a different mass. (Each colour actually has a different refractive index)

Diffraction – The "bending" of waves as they pass through an opening or around an opaque object. Particle theory could not explain why light diffracts.