SNELLS LAW AND THE CRITICAL ANGLE

Snells Law states

\[ \frac{n_r}{n_i} = \frac{\sin i}{\sin r} \]

Where
- \( n_r \) = the refractive index of the medium that light is passing into.
- \( n_i \) = the refractive index of the medium that light is passing out of.
- \( i \) = the angle that the incident light ray makes with the normal.
- \( r \) = the angle the light ray is refracted to relative to the normal.

Air has a refractive index of 1.0003, which we will round off to 1. Thus, for light passing from air into a gem (Fig. 1) \( n_i \) is 1 and Snells Law simplifies to:

\[ n_r = \frac{\sin i}{\sin r} \]

Figure 1

For light passing from a gem into air (Fig. 2) the incident ray is within the gem and the medium that light is passing into is air. Thus \( n_r \) is 1 and Snells Law is:

\[ \frac{1}{n_i} = \frac{\sin i}{\sin r} \quad \text{or} \quad n_i = \frac{\sin r}{\sin i} \]

Figure 2

We define a special angle, the **Critical Angle** (CA), as the angle of incidence **within a gem** for which light is refracted parallel to the surface it is incident upon (Fig. 3). By this definition, the angle of refraction (\( r \)) at the critical angle is 90°. Plugging this special relationship into Snells Law yields the following:

\[ \frac{1}{n_i} = \frac{\sin \text{CA}}{\sin 90^\circ} \]

The sine of 90° equals 1, which reduces the equation to:

\[ \frac{1}{n_i} = \sin \text{CA} \]

This equation simply states that high refractive index materials have small critical angles and vise versa.