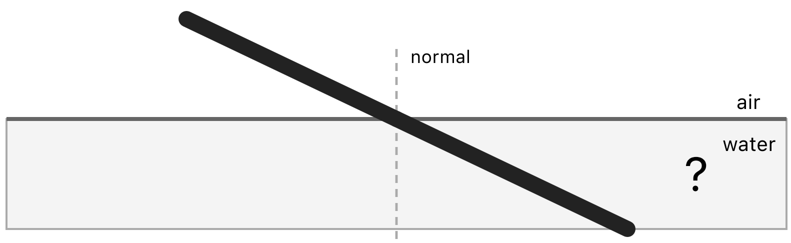
GEOMETRIC OPTICS DAY 5: REFRACTION, SNELL'S LAW, AND TOTAL INTERNAL REFLECTION

CED 13.3 · Skill 2.B · FRQ: MR

PREDICT BEFORE VIEWING

Place a straight straw in water and view it from the side. Predict how the submerged section will appear: **shifted toward the normal / shifted away from the normal / unchanged**. Commit before the observation or key panel is revealed.

STRAW AT A WATER BOUNDARY - APPARENT LINE WITHHELD



INDEX AND SPEED

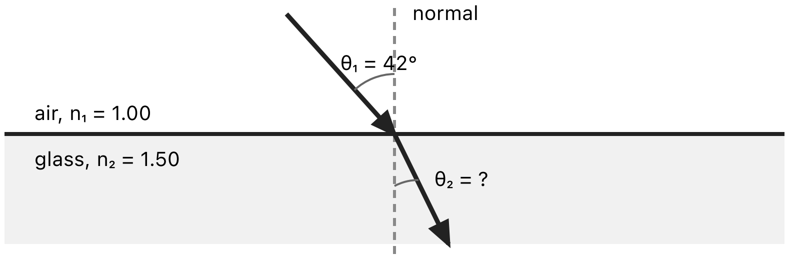
$$n = \frac{c}{v}$$

Refractive index n has no unit. A higher index means a lower light speed in that medium.

Light travels at $2.00 \times 10^8\,\mathrm{m/s}$ in a glass. Calculate its refractive index.

SNELL'S LAW

AIR TO GLASS - CALCULATE THE WITHHELD REFRACTED ANGLE



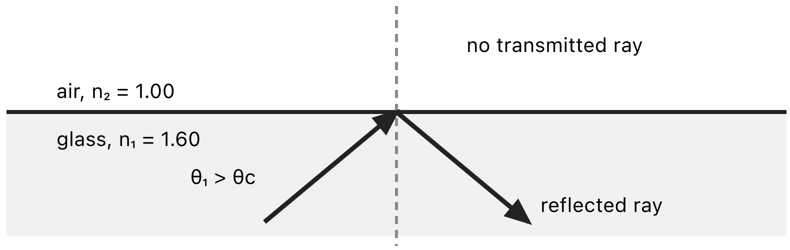
$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

Both angles are measured from the normal. Entering a higher-index medium makes $\theta_2 < \theta_1$.

WE DO A ray enters glass from air with $n_1 = 1.00$, $n_2 = 1.50$, and $\theta_1 = 42.0^\circ$. Find θ_2.

CRITICAL ANGLE AND TIR

DENSE TO RARE ABOVE THE CRITICAL ANGLE



Total internal reflection requires both:

1. light travels from higher n to lower n;
2. the incident angle exceeds the critical angle.

$$\sin\theta_c = \frac{n_2}{n_1} \qquad (n_1 > n_2)$$

Find the glass-to-air critical angle for $n_1 = 1.60$ and $n_2 = 1.00$. State what happens at $\theta_1 = 50.0^\circ$.

PRACTICE

1. A ray goes from air into a transparent medium. Its refracted angle is smaller than its incident angle. Compare n_2 with n_1.

2. For the $n = 1.50$ glass, find the light speed.

3. A ray in glass reaches an air boundary below the critical angle. Explain why a transmitted ray still exists.

4. Draw a normal and show the reflected ray for a dense-to-rare incident angle above θ_c.