Warm-Up:

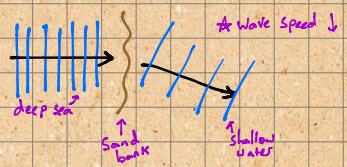
Stained Glass

The color of a transparent material, such as stained glass, is determined by the colors of light that are transmitted by the glass. When white light strikes a red piece of stained glass, the blue and green parts of the spectrum are absorbed, while the red part travels through and into your eye.

During the morning events, the stained glass windows in a church look bright when viewed from either the inside or the outside of the church. However, at night they look gray from the inside but still bright from the outside. Explain why.

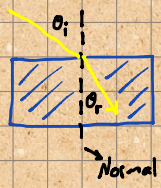
- Wave Speed: depends on the medium the wave is traveling through

Ocean Wave Analogy:



- Refraction: bending of light through different media

- Ex: laser shining through quartz



θ_i = angle of incidence
θ_r = angle of refraction

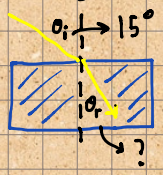
Snell's Law

$n_i[\sin(\theta_i)] = n_r[\sin(\theta_r)]$ n = index of refraction

☆ Less dense media = faster wave travel

Medium	n
Vacuum	1
Air	1.003
Water	1.33
Ethanol	1.36
Glass	1.52
Quartz	1.53
Diamond	2.42

Ex: A ray of light in air hits quartz at an angle of 15°. What θ_i?



$\frac{1.003 \cdot \sin(15°)}{1.53} = \frac{1.53 \cdot \sin(\theta_r)}{1.53}$

$\sin^{-1}(0.1696) = \sin^{-1}(\sin(\theta_r))$

$9.78° = \theta_r$

- Index of Refraction [n]: Speed of light through different materials

↳ Eq: $n = \frac{c}{v}$

n = index of refraction
c = speed of light, $3.0 \cdot 10^8$ m/s
v = velocity in substance

Ex 2: What is the speed of light in water?

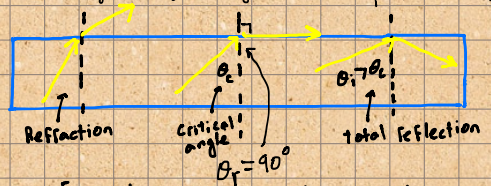
$$v \cdot 1.33 = \frac{3.0\cdot10^8 m/s}{v} \cdot v$$

$$\frac{v \cdot 1.33}{1.33} = \frac{3E8}{1.33}$$

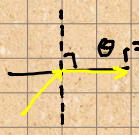
$$v = 2.26\cdot10^8 m/s$$

- When light travels from more dense to a less dense material light refracts away from normal

* If the angle is large enough, refraction is parallel to the boundary



Ex 3: Find the critical angle of light from water into air. $\theta_r = 90°$



$$\frac{1.33 \cdot \sin(\theta_c)}{1.33} = \frac{1.003 \cdot \sin(90)}{1.33}$$

$$\sin^{-1}(\sin(\theta_c)) = (0.7541)\ \sin^{-1}$$

$$\theta_c = 48.9°$$