Reflection and Refraction
Supplemental Instruction
Iowa State University

Group Discussion

1. True or False: Although Light can bend or lose energy while travelling between materials, it will always maintain the same velocity i.e. the speed of light.
   
   FALSE

Work Problems

2. An electromagnetic standing wave in a certain material has frequency $1.2 \times 10^{10}$ Hz and speed of propagation $2.1 \times 10^8$ m/s. (a) What is the distance between a nodal plane of B and the closest anti-nodal plane of B? (b) What is the distance between an anti-nodal plane of E and the closest anti-nodal plane of B? (c) What is the distance between nodal plane of E and the closest nodal plane of B?
   
   $k = \frac{v}{f} = 0.175$
   
   a) $\frac{\lambda}{4} = 4.375\text{mm}$
   b) $\frac{\lambda}{4}$
   c) $\frac{\lambda}{4}$

3. 33.85

A light Beam of light has a wavelength of 650nm in vacuum. (a) What is the speed of this light in a liquid whose index of refraction at the wavelength is 1.47? (b) What is the wavelength of these wave in the liquid?

   a) $v = \frac{c}{n} = \frac{3.10^8}{1.47} = 2.04 \times 10^8 \text{m/s}$
   
   b) $c = \lambda \cdot f$
   
   $f = \frac{3.10^8}{650\text{nm}} = 4.615 \times 10^4$
   
   $\lambda = \frac{c}{f} = \frac{2.04 \times 10^8}{4.615 \times 10^4} = 42.448 \text{nm}$
4. \[ n_a \cdot \sin \theta_a = n_b \cdot \sin \theta_b \]
\[ 1 \cdot \sin(62.7) = n_b \cdot \sin(48.1) \]
\[ n = 1.19 \]
\[ \frac{c}{n} = 2.51 \cdot 10^8 \]

The critical angle for total internal reflection at a liquid-air interface is 42.5 degrees. (a) If a ray of light traveling in the liquid has an angle of incidence at the interface of 35 degrees, what angle does the refracted ray in the air make with normal? (b) If a ray of light traveling in air has an angle of incidence at the interface of 35 degrees, what angle does the refracted ray in the liquid make with the normal?

\[ \theta_c = \sin^{-1} \left( \frac{n_2}{n_1} \right) = 42.5^\circ \]

\[ \frac{n_2}{n_1} = 0.707 \]

\[ n_2 \cdot \sin(42.5^\circ) = 1 \cdot \sin(90) \]

\[ n_2 = \frac{1}{\sin(42.5^\circ)} = 1.48 \]

\[ \theta = 58.1^\circ \]

\[ 1 \cdot \sin(35^\circ) = 1.48 \sin(\theta) \]

\[ \theta = 22.8^\circ \]