GLY 4200 HOMEWORK 9

25 Points

Properties of Light in Minerals

Show all work. Label answers, including units. Express answers to the correct number of significant figures.

The relationship between the speed of light (c), frequency (f), and wavelength (λ) is:

$$c = f\lambda$$

$$c = 2.998 \times 10^{8} \text{ m/s.}$$

1. If λ = 555 nm, what if f?

$$f = c/\lambda = (2.998 \times 10^{8} m/\text{sec})/(555 nm) \times (1/1 \times 10^{-9} m/nm) = 5.40 \times 10^{14} hertz$$

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2. If f = 6.76 x 10^{14} Hz, what is λ (expressed in nm)?

$$\lambda = c/f = (2.998 \times 10^{8} m/\text{sec})/(6.76 \times 10^{14} hz) = 4.43 \times 10^{-7} \times 1 \times 10^{9} nm/m = 443 nm$$

The index of refraction is defined as:

$$n = \frac{c_{vacuum}}{c_{medium}}$$

3. $n_{Chloroargyrite}$ = 2.07. What is the speed of light in chloroargyrite?

$$C_{Chloroargyrite} = C_{vacuum}/n = (2.998 \times 10^{8} m/\text{sec})/2.07 = 1.45 \times 10^{8} m/\text{sec}$$

Snell's Law is given by the equation:

$$\frac{\sin \angle i}{\sin \angle r} = \frac{n_r}{n_i}$$

4. If light travels from air into sylvite, and the angle of incidence is 29.6°, what is ∠r?
n for sylvite = 1.490.

$\sin\angle r=(n_i\sin\angle i)/n_r=(1\sin(29.6°)/1.490)=0.3315$
$\angle r=19.4°$

Brewster's Law of maximum polarization is:

$$\frac{n_r}{n_i} = \tan\angle i$$

5. For sylvite, what is ∠i?

$\tan\angle i=n_i/n_i=(1.490)/(1.0003)=1.4896$
$\angle i=56.12°$

The critical angle is given by a variation of Snell's Law:

$$\frac{n_i}{n_r}\cdot\sin\angle i = 1.00$$

6. Suppose light passes from sylvite into air. What is the critical angle? HINT: Remember that light is going from sylvite into air. What is the incident medium?

$\sin\angle i=1.000/1.490-0.6711$
$\angle i=42.16°$

The formula for the Numerical Aperture (N.A.) Is:

$$N.A.= n\sin\angle\mu, \textit{ where}$$

$$\mu = \frac{\angle_{anguular\_aperature}}{2}$$

7. If the angular aperture is 35.7°, and n = 1.544, what is N.A.?
$\mu=35.7°/2=17.85°$
$N.A.=1.544\sin17.85°=0.473$