Answer on Question #49221-Physics-Optics

Red light of $\lambda = 650\ nm$ travels from air to water with an incident angle of $\theta = 30\ degree$. The refraction index for air is $n_{air} = 1.000293$ and for water is $n_{water} = 1.33$, the speed of light in vacuum is $c = 3 \cdot 10^8 \frac{m}{s}$. a) Find the frequency, wave length, and speed of the red light in the air; b) find the frequency, wave length, and speed of light of the red light in water; c) find the angle of the refraction

Solution

a) The frequency of the red light in the air

$$f_{air} = \frac{v_{air}}{\lambda_{air}} = \frac{c}{n_{air}\lambda_{air}} = \frac{3 \cdot 10^8 \frac{m}{s}}{650 \cdot 10^{-9}\ m} = 4.62 \cdot 10^{14} Hz.$$

Wave length of the red light in the air

$$\lambda_{air} = \frac{\lambda}{n_{air}} = \frac{650nm}{1.000293} = 649.8\ nm..$$

Speed of the red light in the air

$$v_{air} = \frac{c}{n_{air}} = \frac{3 \cdot 10^8 \frac{m}{s}}{1.000293} = 2.999 \cdot 10^8 \frac{m}{s}.$$

b) The frequency of light of the red light in water

$$f_{water} = f_{air} = 4.62 \cdot 10^{14} Hz$$

Wave length of light of the red light in water

$$\lambda_{water} = \lambda_{air} \frac{n_{air}}{n_{water}} = 650\ nm \cdot \frac{1.000293}{1.33} = 488.9\ nm.$$

Speed of light of the red light in water

$$v_{water} = \frac{c}{n_{water}} = \frac{3 \cdot 10^8 \frac{m}{s}}{1.33} = 2.256 \cdot 10^8 \frac{m}{s}.$$

c)

$$\frac{\sin\theta_r}{\sin\theta} = \frac{n_{air}}{n_{water}} \rightarrow \theta_r = \sin^{-1}\left(\frac{n_{air}}{n_{water}}\sin\theta\right) = \sin^{-1}\left(\frac{1.000293}{1.33}\sin 30\right) = 22°.$$