Answer on Question 81581, Physics, Other

Question:

1) Calculate the wavelength of light in a vacuum that has a frequency of $8.5 \cdot 10^9\ Hz$.

2) What is its wavelength in glycerine? (The index of refraction of glycerine is 1.473.)

3) Calculate the energy of one photon of such light in vacuum. Express the answer in electron volts.

Solution:

1) We can find the wavelength of light in a vacuum from the formula:

$$\lambda = \frac{c}{f} = \frac{3 \cdot 10^8\ \frac{m}{s}}{8.5 \cdot 10^9\ Hz} = 0.035\ m = 3.5\ cm.$$

2) From the Snell's law we have:

$$\frac{sin\theta_1}{sin\theta_2} = \frac{n_2}{n_1} = \frac{\lambda_1}{\lambda_2},$$

here, θ_1 is the angle of incidence, θ_2 is the angle of refraction, n_1 is the refractive index of vacuum, n_2 is the refractive index of glycerine, λ_1 is the wavelength of light in a vacuum, λ_2 is the wavelength of light in the glycerine.

Then, from this formula we can find its wavelength in glycerine:

$$\lambda_2 = \frac{\lambda_1 n_1}{n_2} = \frac{0.035\ m \cdot 1.0}{1.473} = 0.024\ m = 2.4\ cm.$$

3) We can find the energy of one photon of such light in vacuum from the formula:

$$E = hf = \frac{hc}{\lambda},$$

here, E is the energy of the photon, f is the frequency of light, $h = 6.63 \cdot 10^{-34}\ J \cdot s$ is the Planck's constant, c is the speed of light and λ is the wavelength of light.

Then, we get:

$$E = \frac{hc}{\lambda} = \frac{6.63 \cdot 10^{-34}\ J \cdot s \cdot 3 \cdot 10^{8}\ \frac{m}{s}}{0.035\ m} = 5.7 \cdot 10^{-24}\ J \cdot \frac{1\ eV}{1.6 \cdot 10^{-19}\ J}$$
$$= 3.56 \cdot 10^{-5}\ eV.$$

Answer:

1) $\lambda = 0.035\ m = 3.5\ cm.$

2) $\lambda_2 = 0.024\ m = 2.4\ cm.$

3) $E = 3.56 \cdot 10^{-5}\ eV.$