HC Verma Solutions Light Waves

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Light Waves HC Verma Concepts of Physics Solutions

Light Waves HC Verma Concepts of Physics Solutions Chapter 17

1. Given that, 400 m < λ < 700 nm.

$$\frac{1}{700\text{nm}} < \frac{1}{\lambda} < \frac{1}{400\text{nm}}$$

$$\Rightarrow \frac{1}{7\times10^{-7}} < \frac{1}{\lambda} < \frac{1}{4\times10^{-7}} \Rightarrow \frac{3\times10^{8}}{7\times10^{-7}} < \frac{c}{\lambda} < \frac{3\times10^{8}}{4\times10^{-7}}$$ (Where, c = speed of light = 3×10^8 m/s)

$\Rightarrow 4.3 \times 10^{14} < c/\lambda < 7.5 \times 10^{14}$

$\Rightarrow 4.3 \times 10^{14}$ Hz < f < 7.5×10^{14} Hz.

2. Given that, for sodium light, $\lambda = 589$ nm $= 589 \times 10^{-9}$ m

a) $f_a = \frac{3\times10^{8}}{589\times10^{-9}} = 5.09 \times 10^{14}$ sec^{-1} $\left[\because f = \frac{c}{\lambda}\right]$

b) $\frac{\mu_a}{\mu_w} = \frac{\lambda_w}{\lambda_a} \Rightarrow \frac{1}{1.33} = \frac{\lambda_w}{589\times10^{-9}} \Rightarrow \lambda_w = 443$ nm

c) $f_w = f_a = 5.09 \times 10^{14}$ sec^{-1} [Frequency does not change]

d) $\frac{\mu_a}{\mu_w} = \frac{v_w}{v_a} \Rightarrow v_w = \frac{\mu_a v_a}{\mu_w} = \frac{3\times10^{8}}{1.33} = 2.25 \times 10^8$ m/sec.

3. We know that, $\frac{\mu_2}{\mu_1} = \frac{v_1}{v_2}$

So, $\frac{1472}{1} = \frac{3\times10^{8}}{v_{400}} \Rightarrow v_{400} = 2.04\times10^{8}\,\text{m/sec.}$

[because, for air, μ = 1 and v = 3×10^8 m/s]

Again, $\frac{1452}{1} = \frac{3\times10^{8}}{v_{760}} \Rightarrow v_{760} = 2.07\times10^{8}\,\text{m/sec.}$

4. $\mu_t = \frac{1\times3\times10^{8}}{(2.4)\times10^{8}} = 1.25$ $\left[\text{since, } \mu = \frac{\text{velocity of light in vaccum}}{\text{velocity of light in the given medium}}\right]$

5. Given that, $d = 1\ cm = 10^{-2}\ m$, $\lambda = 5 \times 10^{-7}\ m$ and $D = 1\ m$

   a) Separation between two consecutive maxima is equal to fringe width.

   $$\text{So, } \beta = \frac{\lambda D}{d} = \frac{5 \times 10^{-7} \times 1}{10^{-2}}\ m = 5 \times 10^{-5}\ m = 0.05\ mm.$$

   b) When, $\beta = 1\ mm = 10^{-3}\ m$

   $$10^{-3} m = \frac{5 \times 10^{-7} \times 1}{D} \Rightarrow D = 5 \times 10^{-4}\ m = 0.50\ mm.$$

6. Given that, $\beta = 1\ mm = 10^{-3}\ m$, $D = 2.t\ m$ and $d = 1\ mm = 10^{-3}\ m$

   $$\text{So, } 10^{-3} m = \frac{25 \times \lambda}{10^{-3}} \Rightarrow \lambda = 4 \times 10^{-7}\ m = 400\ nm.$$

7. Given that, $d = 1\ mm = 10^{-3}\ m$, $D = 1\ m$.

   $$\text{So, fringe with} = \frac{D\lambda}{d} = 0.5\ mm.$$

   a) So, distance of centre of first minimum from centre of central maximum = 0.5/2 mm = 0.25 mm

   b) No. of fringes = 10 / 0.5 = 20.

8. Given that, $d = 0.8\ mm = 0.8 \times 10^{-3}\ m$, $\lambda = 589\ nm = 589 \times 10^{-9}\ m$ and $D = 2\ m$.

   $$\text{So, } \beta = \frac{D\lambda}{d} = \frac{589 \times 10^{-9} \times 2}{0.8 \times 10^{-3}} = 1.47 \times 10^{-3}\ m = 147\ mm.$$

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