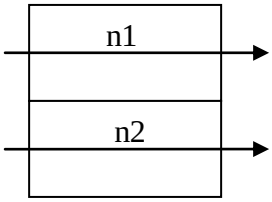
Q- Two light waves of wavelength 620 nm are initially exactly in phase. The waves pass through to different media of indexes of refraction n_1= 1.40 and n_2= 1.60. What is the thickness L of each medium that will put the waves out of phase once they pass through the two media? What is the next greater L that will do this?



The velocity of light in a medium is n (refractive index) times less than the velocity in vacuum and hence time taken in the medium is n times more. The distance covered by light in vacuum in this increased time is called equivalent path. Hence if the path in a medium if L, then equivalent path in vacuum will be n*L

Hence the path difference suffered by the waves in the two media will be

$$\delta = n_2L - n_1L$$

For the waves to be out of phase the phase difference between them is to be π and thus path difference must be equal to (2m -1) $\lambda/2$

Hence for phase difference between the emergent waves to be π we have

$$n_2L - n_1L = (2m -1)\,\lambda/2$$

Or $$L = \frac{(2m-1)\,\lambda}{2(n_2 - n_1)}$$

Minimum length for which this happens will be corresponding to m = 1 hence

$$L = \frac{\lambda}{2(n_2 - n_1)} = \frac{620*10^{-9}}{2(1.6-1.4)} = \frac{620*10^{-9}}{0.4} = 1.55*10^{-6}m$$

Next longer vale is corresponding to m = 2 and hence

$$L_1 = \frac{3\lambda}{2(n_2 - n_1)} = \frac{3*620*10^{-9}}{2(1.6-1.4)} = \frac{3*620*10^{-9}}{0.4} = 4.65*10^{-6}m$$