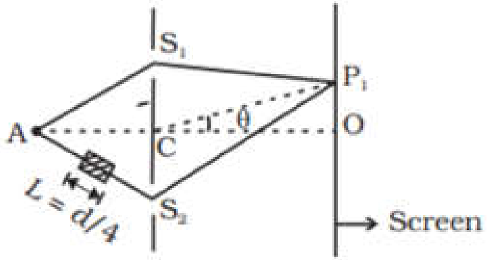
4. A small transparent slab containing material of μ = 1.5 is placed along AS_2 (Figure). What will be the distance from O of the principal maxima and of the first minima on either side of the principal maxima obtained in the absence of the glass slab?



AC = CO = D, $S_1C = S_2C = d << D$

Sol. As is clear from figure and difference between waves reaching P_1 from A is

$= 2d\sin\theta + (u-1)l$

For principal maximum, path difference = 0

i.e., $2d\sin\theta + (\mu-1)l = 0$

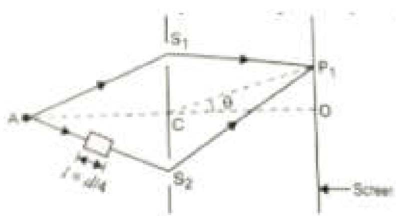
2d $= \sin\theta + (1.5-1)\frac{d}{4} = 0, \sin\theta = \frac{-1}{16}$

$\therefore OP_1 = (CO)\tan\theta \cong D\left(-\frac{1}{16}\right)$

For the first minimum, an angle θ_1, say,

path difference $= 2d\sin\theta_1 + 0.5l = \pm\lambda/2$

$\sin\theta_1 = \frac{\pm\lambda/2 - 0.5l}{2d}$



As diffraction occurs when d = λ,

$\therefore \sin\theta_1 = \frac{\pm\lambda/2 - \lambda/8}{2\lambda} = \pm\frac{1}{4} - \frac{1}{16}$

on the positive side, $\sin\theta_1 = +\frac{1}{4} - \frac{1}{16} = \frac{3}{16}$, on the negative side,

$\sin\theta_1' = -\frac{1}{4} - \frac{1}{16} = \frac{-5}{16}$

The first principal maximum on the positive side is at distance (above O)

= D than $\theta_1 = D\frac{\sin\theta_1}{\sqrt{1-\sin^2\theta_1}} = \frac{D.3/16}{\sqrt{1-9/256}} = \frac{3D}{\sqrt{16^2-3^2}}$

On the negative side, the distance of first principal maximum (below O) will be

$= D\theta_1' = D\frac{\sin\theta_1'}{\sqrt{1-\sin^2\theta_1}} = \frac{D(-5/16)}{\sqrt{1-(5/16)^2}} = \frac{-5D}{\sqrt{16^2-5^2}}$