Solved Examples (Interference)

Ex. 1 White light falls at an angle 45^0 on a parallel soap film of refractive index 1.33. At what minimum thickness of the film will it appear bright yellow of wavelength 5900 A^0 in the reflected light ?

Soln :

Given : I = 45^0, $\mu = 1.33$, $\lambda = 5900 A^0$, = 5900×10^{-10} m

Formula : $2\mu t \cos r = (2n - 1)$, n = 1,2,3,….For bright fringes

For minimum thickness, n is minimum i.e. n = 1

Now,

.

. = 0.8469

t = 1309 A^0

Ex. 2 A wedge shaped air film having an angle of 40seconds is illuminated by monochromatic light and fringes are observed vertically through a microscope. The distance measured between consecutive bright fringes is 0.12 cm. Calculate the wavelength of light used.

Soln:

Given : ϴ40 seconds = degrees =

Formula : Spacing between the consecutive bright fringes is,

The wavelength is,

Ex. 3 An oil drop of volume 0.2 c.c. is dropped on the surface of a tank of water of area 1 sq. meter. The film spreads uniformly over the surface and white light which is incident normally is observed through a spectrometer. The spectrum is seen to contain one dark band whose centre has wavelength 5.5×10^{-5} cm in air. Find the refractive index of oil.

Soln:

The oil drop of volume 0.2 c.c. spreads uniformly over 1 m^2, hence the thickness of the film so formed is given by,

.

The film appears dark by reflected light. Hence

$2\mu t \cos r = n\lambda$

For normal incidence r = 0, Hence cos r = 1

n = 1 and λ= 5.5

Refractive index of oil is,

μ =

μ = 1.375

Ex. 4 Two plane glass surfaces in contact along one edge are separated at the opposite edge by a thin wire. If 20 interference fringes are observed between these edges in sodium light at normal incidence. What is the thickness of the wire ? (Given λ = 5893 A^0)

Soln:

Fringes width .....(For normal incidence)
For air film
Thickness of wire $t = X_n \tan\Theta = Xn\Theta = 20 \cdot \omega \cdot \Theta$
Putting the value of ω, we get,

t

t

Ex. 5 Two optically plane glass strips of length 10cm are placed one over the other. A thin foil of thickness 0.010 mm is introduced between the plates at one end to form an air film. If the light used has wavelength 5900 A0, find the separation between consecutive bright fringes.

Soln:

Separation between two consecutive bright fringes = Fringes width =
For air film
Thickness of foil $t = x \tan \Theta = x \cdot \Theta$ (As Θ is small)
Data Given :

t = 0.010 mm = 10-3 cm.

x = 10 cm

λ = 5900 A0 = 5900 × 10-8 cm.

So,
Then, fringes width

ω =

Ex. 6 In Newton's ring experiment the diameter of 4th and 12th dark rings are 0.400 cm and 0.700 cm respectively. Deduce the diameter of 20th ring.

Soln:

Formulae : radius of curvature $R = D^2_{12} - D^2_4/4\eta\lambda$

$D_{12} = 0.70$ CM, $D_4 = 0.40$CM.

$\eta = 8$

So, $R\lambda =$

Hence, diameter of 20th dark ring

$D^2_{20} = 4\eta\, R\, \lambda = 4 \times 20 \times 0.0103 = 0.825$

$\mathbf{D_{20} = 0.90}$ **cm**

Ex. 7 Light falls normally on a soap film of thickness 5×10^{-5} cm and of refractive index 1.33. Which wavelength in the visible region will be reflected most strongly ?

Soln:

The condition of maxima is given by,

$2\mu t \cos r = (2n - 1)\, \lambda/2$ where n = 1,2,3,.....

Here, Given : $t = 5 \times 10^{-5}$ cm $\mu = 1.33$

$r = 0^0$ i.e. $\cos r = 1$

Now,
By substituting the values of n = 1,2,...we get a series of wavelengths which shall be predominantly reflected by the film.

For n = 1, $\lambda_1 =$

Similarly, For n = 2, $\lambda_2 = 8.866 \times 10^{-5}$ cm

For n = 3, $\lambda_3 = 5.32 \times 10^{-5}$ cm

For n = 4, $\lambda_4 = 3.8 \times 10^{-5}$ cm

Out of these wavelengths 5.320×10^{-5} cm lies in the visible region ($4000 \times 10^{-5\,t}$ cm to

7500×10^{-5} cm).
Hence 5320 A^0 is the most strongly reflected wavelength.

Ex. 8 Newton's ring formed with sodium light between a flat glass plate and a convex lens are viewed normally. What will be the order of the dark ring which will have double the diameter of that of the 40th dark ring ?

Soln:

Let the diameter of the nth dark ring be double the diameter of 40th dark ring.

Hence, $D_n = 2\ D_{40}$ ………………(1)

Now the diameter of n^{th} dark ring is given by the expression

$D^2_n = 4\ n\ R\ \lambda$ ……………..(2)

Where R = Radius of curvature of lens. λ = wavelength of light.

Hence for the 40th dark ring.

$D^2_{40} = 4 \times 40 \times R\lambda$

Hence Equation (1) and (2) we have,

$D^2_n = 4 \times D^2_{40}$

$4\ n\ R\ \lambda = 4 \times 4 \times 40 \times R\lambda$

N = 160

Ex. 9 A beam of monochromatic light of wavelength 5.82×10^{-7} m falls normally on a glass wedge angle of 20 seconds of an arc. If the refractive index of glass in 1.5, find the number of dark interference fringes per cm of the wedge length.

Soln:

Formula : Fringes width

Data given : $\mu = 1.5$

Θ

ω

So, no. of dark fringes per cm.

=

Ex. 10 In Newton's rings experiment the diameters of nth and (n + 8)th bright rings are 4.2 mm and 7.00 mm respectively. Radius of curvature of the lower surface of the lens is 2.00 m. Determine the wavelength of light.

Soln:

λ

$= 4.9 \times 10^{-7}$ m $= 4900 \times 10^{-10}$m = **4900 A^0**