

Third exercise: (7 ½ points)

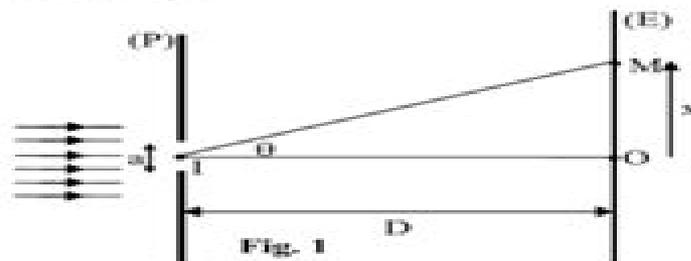
Diffraction and interference of light

A laser source emits a monochromatic cylindrical beam of light of wavelength $\lambda = 640$ nm in air.

A – Diffraction

This beam falls normally on a vertical screen (P) having a horizontal slit F_1 of width a . The phenomenon of diffraction is observed on a screen (E) parallel to (P) and situated at a distance $D = 4$ m from (P).

Consider on (E) a point M so that M coincides with the second dark fringe counted from O, the center of the central bright fringe. $\text{OIM} = \theta$ (θ is very small) is the angle of diffraction corresponding to the second dark fringe (Fig. 1).



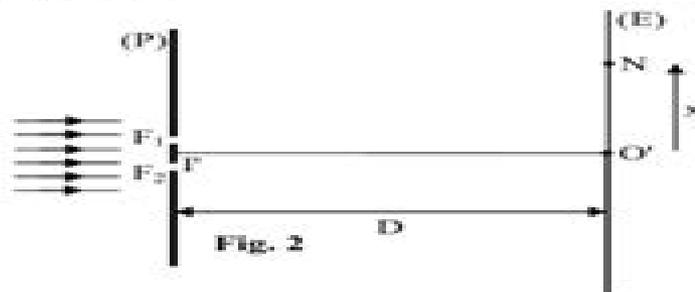
- 1) Write the expression of θ in terms of a and λ .
- 2) Determine the expression of $\text{OM} = x$ in terms of a , D and λ .
- 3) Determine the value of a if $\text{OM} = 1.28$ cm.
- 4) We replace the slit F_1 by another slit F_1' of width 100 times larger than that of F_1 . What do we observe on the screen (E)?

B – Interference

We cut in (P) another slit F_2 identical and parallel to F_1 so that the distance $F_1F_2 = a' = 1$ mm. The laser beam falls normally on the two slits F_1 and F_2 . We observe on (E) a system of interference fringes.

O' is the orthogonal projection of the midpoint I' of F_1F_2 on (E) (Fig. 2).

- 1) a) Due to what is the phenomenon of interference?
b) Describe the fringes observed on (E).
- 2) Consider a point N on (E) so that $\text{O'N} = x$.
 - a) Write the expression of the optical path difference $\delta = F_2N - F_1N$ in terms of a' , x and D .
 - b) If N is the center of a dark fringe of order k , write the expression of the optical path difference δ at N in terms of λ and k .
 - c) Deduce the expression of x in terms of a' , D , k and λ .
 - d) Knowing that the interfringe distance i is the distance between the centers of two consecutive dark fringes, deduce then the expression of i in terms of λ , D and a' .
- 3) The whole set up of figure 2 is immersed in water of index of refraction n .
 - a) i) The interfringe distance i varies and becomes i' . Why?
ii) Show that $i' = \frac{i}{n}$.
 - b) We move (E) parallel to (P) and away from it by a distance $d = \frac{4}{3}$ m. We notice that the interfringe distance takes again the initial value i . Deduce then the value of n .



31 Diffraction And Interference Exercise Answers

R Sandford



31 Diffraction And Interference Exercise Answers:

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In an electronic digital era where connections and knowledge reign supreme, the enchanting power of language has become much more apparent than ever. Its capability to stir emotions, provoke thought, and instigate transformation is really remarkable. This extraordinary book, aptly titled "**31 Diffraction And Interference Exercise Answers**," published by a very acclaimed author, immerses readers in a captivating exploration of the significance of language and its profound impact on our existence. Throughout this critique, we shall delve to the book's central themes, evaluate its unique writing style, and assess its overall influence on its readership.

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