Al-Makassed High School Subject: physics Class: Gr 12		Date: Diffraction Mrs. Hawraa Houmani

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. $\widehat{OIM} = \theta$ (θ is very small) is the angle of diffraction corresponding to the second dark fringe (Fig. 1).

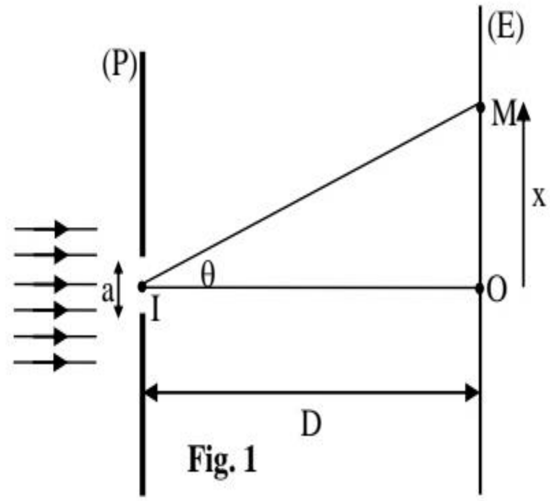

Fig. 1

1) Write the expression of θ in terms of a and λ.
2) Determine the expression of OM = x in terms of a, D and λ.
3) Determine the value of a if 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)?

Applications of the diffraction of light

A – Measurement of the width of a slit

A laser beam of light, of wavelength in vacuum $\lambda = 632.8$ nm, falls normally on a vertical slit of width «a». The diffraction pattern is observed on a screen placed perpendicularly to the laser beam at a distance D = 1.5 m from the slit.

Let «L» be the linear width of the central fringe (Fig. 1).

The angle of diffraction θ corresponding to a dark fringe of order n is given by $\sin\theta = \frac{n\lambda}{a}$ where $n = \pm1, \pm2, \pm3\ldots$

For small angles, take $\tan\theta \approx \sin\theta \approx \theta$ in radian.

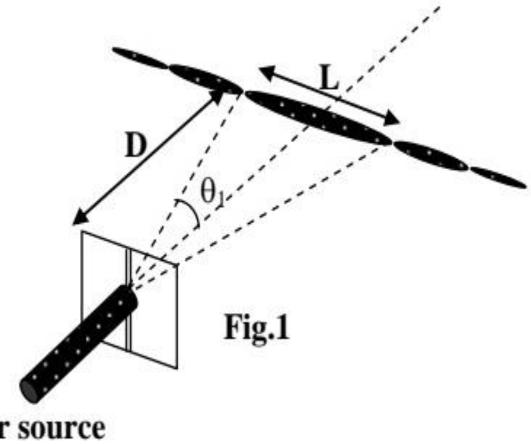

Fig.1

1) Describe the aspect of the diffraction pattern observed on the screen.
2) Write the relation among a, θ_1 and λ.
3) Establish the relation among a, λ , L and D.
4) Knowing that L = 6.3 mm, calculate the width «a» of the used slit.

B – Controlling the thickness of thin wire

A manufacturer of thin wires wishes to control the diameter of his product. He uses the same set-up mentioned in part (A) but he replaces the slit by a thin vertical wire. He observes on the screen the phenomenon of diffraction (figure 2).

For D = 2.60 m, he obtains a central fringe of constant linear width $L_1 = 3.4$ mm.

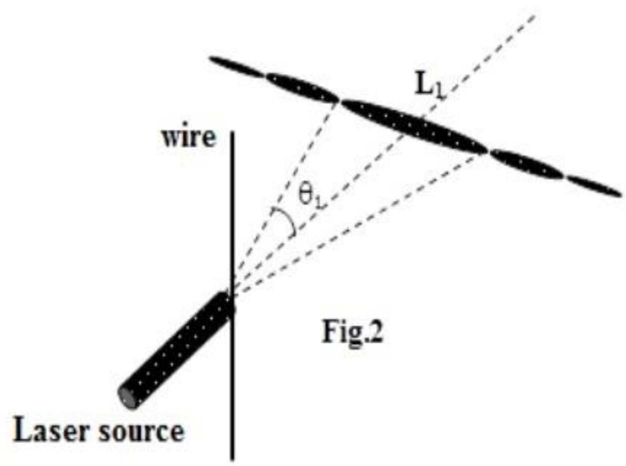

Fig.2

1) Calculate the value of the diameter «a_1» of the wire at the illuminated point.
2) The manufacturer illuminates the wire at different positions under the same precedent conditions. Specify the indicator that permits the manufacturer to check that the diameter of the wire is constant.

C – Measurement of the index of water

We place the whole set-up of part (A) in water of index of refraction n_{water}. We obtain a new diffraction pattern.

We find that for D = 1.5 m and a = 0.3 mm, the linear width of the central fringe is $L_2 = 4.7$ mm.

1) Calculate the wavelength λ' of the laser light in water.
2) **a)** Determine the relation among λ , λ' and n_{water}.
   b) Deduce the value of n_{water}.