N° 1
Wavelength of a laser source in a school

A laser beam, of wavelength λ, falls normally on a thin rectangular slit of width a. A diffraction figure is produced on a screen, parallel to the slit. Let D be the distance between the slit and the screen.

1) Specify the position of the center O of the central bright fringe.
2) Let O_k be the center of the dark fringe of order k. Show that : $\overline{OO_k} = k\frac{\lambda D}{a}$.
3) Deduce that the width of the central bright fringe is : $\ell = 2\frac{\lambda D}{a}$ and that of its lateral fringe is $\ell_1 = \frac{\lambda D}{a}$.
4) For D = 2 m and a = 100 µm, we find : $\ell = 2.7$ cm and $\ell_1 = 1.4$ cm.
a) Do the values of ℓ and ℓ_1 agree with those obtained from the theory.
b) Deduce the average value of λ.

N° 2
Studying diffraction

Consider two electromagnetic waves, of frequencies : $\nu_1 = 2.10^{20}$ Hz and $\nu_2 = 5\times10^{14}$ Hz, falling normally on a vertical rectangular slit of width a = 50 µm.

Given that the speed of light in vacuum is : $c = 3\times10^8$ m/s.

1) a) Calculate the wavelengths of the preceding radiations.
b) One of the preceding waves undergoes diffraction phenomenon using the slit. Specify which wave.
2) The diffraction figure, of the suitable wave, is produced on a vertical screen placed at a distance D = 2.5 m from the slit.
a) Calculate the angular width α of the bright fringe.
b) How would the angular width become if :
- We move the screen away and parallel to itself by 50 cm from the slit ?
- The device is put in water of index of refraction $n = \frac{4}{3}$?

N° 3
Diffraction of light

A monochromatic light, produced by a source S, of wavelength λ = 625 nm, falls normally, on a rectangular slit F of width a in an opaque screen (E_0). We observe the diffraction phenomenon on the screen (E) parallel to (E_0) and placed at a distance D = 4 m from (E_0) as shown in figure (1).

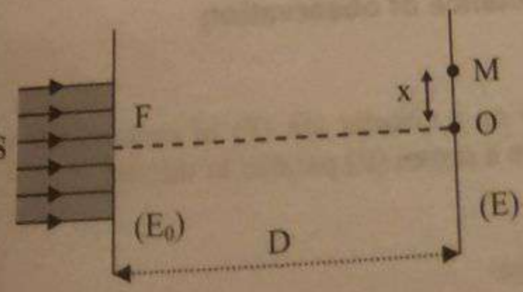

Figure (1)

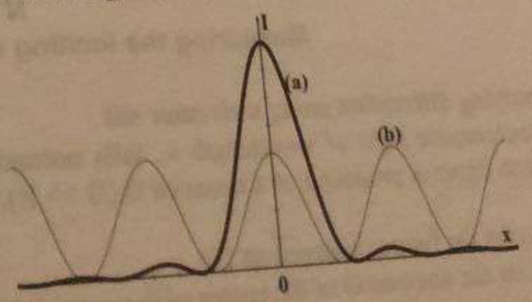

Figure (2)

1) Describe the diffraction figure observed on (E).
2) The figure of diffraction shows :
a) An evidence of a certain aspect of light. Name it.
b) An error in a certain principle of light. Name it.
3) In figure (2), we represent two curves (a) and (b) where one corresponds to the variation of the luminous intensity as a function of the abscissa x of a point M of the screen (E). Specify, the corresponding curve.
4) The width of the first bright fringe is 2.5 cm. Calculate a.
5) Calculate the width of the main figure observed in the cases where:
a) $a = 1$ cm ;
b) $a = 200$ µm.

N° 4
Diffraction of two monochromatic beams

A beam of monochromatic red light, of wavelength $\lambda = 670$ nm, traverses a rectangular thin opening of $a = 0.1$ mm. On a screen placed at a distance D = 6 m from the opening we observe fringes.

1) a) Name, with justification, the phenomenon observed.
b) Describe the observed figure on the screen.
c) Interpret the formation of bright fringes.
2) Calculate the width of the central fringe.
3) Another beam of monochromatic blue light, of wavelength $\lambda' = 500$ nm, traverses the same opening.
a) Are the two beams synchronous ? Can they superpose ? Why ?
b) Calculate the width of the central fringe of the new radiation.
c) Describe the color of the central fringe obtained when we illuminate the two slits simultaneously by the two beams.

N° 5
Various applications

1) The diffraction of a monochromatic light of a wavelength 670 nm, through a rectangular slit of width a and observed on a screen at 82.3 cm from the slit a figure of diffraction such that the distance separating the center of the first minimum intensity to the right and the center of the third minimum intensity to the left is ... mm. Calculate a.

2) In an aim to determine the diameter « d » of a hair, we place it normal to the direction of propagation of a He-Ne laser beam of wavelength 632.8 nm.
A figure of the produced diffraction is found on a screen, at 2.7 m, where the width of the central spot is 2... mm. Calculate d. The hair is a similar to a slit of width « d ».

N° 6
Measuring the limiting distance of observation

A – Studying diffraction using a circular slit
A monochromatic light of wavelength λ, falls normally on a circular slit (F) of center I and radius R, a diffraction figure is produced, at a distance D (D >> R), on a screen (E) parallel to the slit.

1) Describe the figure observed on (E).
2) Indicate the position O of the center of the central fringe.
3) If M is a point of the dark fringe.

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Represent the curv...

B – Measuring d...

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images is farthe...

A person can ...
maximum dist...

We suppose t...
The diameter...

Using Ralei...

The angular abscissa of M is given by : $\theta = \widehat{OIM} = p\frac{\lambda}{R}$ where p is a real number whose values are :

$\ldots, -1.62 ; -1.12 ; -0.61 ; 0.61 ; 1.12 ; 1.62 ; \ldots$

Represent the curve of the luminous intensity I_x of M as a function of x.

B – Measuring distance

Rayleigh Criterion : The human eye can observe distinctly the images of two luminous sources obtained by diffraction through the pupil if the same image is received by retinue's grains and if the center of one of the images is farther from the first minimum of the other.

A person can distinguish the two headlamps of a car separated by a distance $\Delta = 1.42$ m, when it is at a maximum distance D from the car.

We suppose that the headlamps are monochromatic sources of light of an average wavelength 562 nm. The diameter of the pupil (which plays the role of a circular slit) is 5 mm.

Using Raleigh's criterion, calculate the distance D.