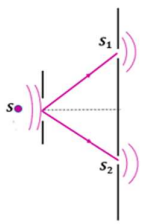
a. In Young's slits experiment the separation of the first to fifth fringes is 2.5 mm when the wavelength used is 620 nm. The distance from the slits to the screen is 80 cm. Calculate the separation of two slits. [3]

b. The given diagram shows the experimental arrangement to produce the interference fringes in Young's double slit experiment. What happens to the interference fringe width if,



i. Slit width is reduced to half? [1]
ii. One of the slits is closed? [1]
iii. The whole arrangement is immersed in water ($\mu = 1.33$)? [1]

c. What is the effect on the interference pattern in Young's double-slit experiment when,

i) screen is moved closer to the plane of slits? [1]
ii) separation between two slits is increased? [1]

2. a. Write the condition for getting dark and bright fringes in Young's experiment. Hence write the expression for fringe width. [2]

b. In young's double slit experiment, the distance from the two slits to the screen is 1.8m. The separation of first bright fringe from central maximum is 4.6mm and the distance between the slits is 0.25mm. Calculate the wavelength of light. [2]

c. In young's double slit experiment, the distance from slits to the screen is 2m. The separation of fourth bright fringe from central maximum is 1.6cm and the distance between the slits is 0.2mm. Calculate the wavelength of light. [2]

d. What happens to the interference pattern if white light is passed through two slits? [2]

e. Two slits are 0.3mm apart and placed 50 cm from the screen. what is the distance between the second and third dark lines of interference pattern when the slits are illuminated with a light of 600nm wavelength? **[1mm]** [2]

f. Two coherent source A and B of radio waves are 5m apart. Each source emits waves wavelength 6m. Consider points along the line between two sources, at what distance, if any, from A is the interference constructive? **[2.5m]** [2]

Diffraction of Light

For central maximum, $path\ difference = 0$ and $phase\ difference = 0$.

- ✓ Angular width of central maximum $= 2\frac{\lambda}{d}$ (in radians) $[\pi^c = 180^o]$
- ✓ Linear width of central maximum $= 2\frac{\lambda D}{d}$

When the whole apparatus is immersed in water, the width of central maxima decreases due to decrease in wavelength of light in water.

Secondary maxima:

Linear position: $y_n = (2n+1) \times \frac{\lambda D}{2d}$

$\theta_n = (2n+1) \times \frac{\lambda}{2d}$

$[n = 1, 2, 3, \dots]$

Secondary minima:

Linear position: $y_n = n\frac{\lambda D}{2d}$

$\theta_n = n\frac{\lambda}{d}$

Diffraction Grating:

$N = number\ of\ lines\ per\ unit\ length$

Grating element: $(a+b) = \frac{1}{N}$

$n = 0$, for central maximum
$n = 1$, for first order maxima
$n = 2$, for second and so on.

Working formula: $(a+b)sin\theta = n\lambda$

Highest number of diffraction maxima: $n_{max} = \frac{(a+b)}{\lambda}$

**If N *is number of lines per mm*
Then, $(a+b) = \frac{1}{N}$;
*the unit of $(a+b)$ will be mm.***

1. a. Distinguish between Fresnel diffraction and Fraunhofer diffraction. [1]

b. Why is diffraction of sound waves easier to observe than that of light waves? [2]

c. What is diffraction of light? Draw a graph showing the variation of intensity with the angle in a single-slit diffraction experiment. What would be the effect on diffraction pattern when:

i. The width of the slit is decreased? [1]
ii. The experimental arrangement is immersed into water? [1]
iii. White light is used as the source of light? [1]

d. Explain the formation of maxima and minima due to diffraction through a single slit. Establish the fringe width of central maximum in diffraction and compare it with that in interference. [3]

e. Estimate the angular separation between first order maximum and third order minimum of the diffraction pattern due to single slit of width $1mm$, when light of wavelength $600\ nm$ is incident normal on it. [$\boldsymbol{Ans: 9 \times 10^{-4} rad.}$] [2]

f. Find the angular width of the central bright maximum in Fraunhofer's Diffraction pattern of a slit width $12 \times 10^{-5} cm$ when the slit is illuminated by monochromatic light of wavelength $6000A^o$. **[30°]** [2]

2. a. What is diffraction grating? Diffraction grating is better than a two-slit set up for measuring the wave length of a monochromatic light. Explain. [2]

b. A parallel beam of sodium light of wavelength 5893 A^o is incident normally on a diffraction grating. The angle between two first order spectra on either side of the normal is 28^0. Find the number of ruling lines per mm on the grating. **[410]** [2]

c. Parallel beam of light from a source is incident normally on a plane diffraction grating. If the angle of diffraction for the first order is 30^0, Find the grating element and the number of lines per mm of the grating, considering the wavelength of incident beam is $5893\dot{A}$. [2]

d. In a plane transmission grating, the angle of diffraction for the second order maximum for the wavelength $5 \times 10^{-7} m$ is 30^{o}. Calculate the number of lines in one cm, of the grating surface. **[Ans: 4000 lines/cm]** [2]

e. A plane transmission grating having 500 lines/mm is illuminated normally by a light source of 600 nm wavelength. How many diffraction maxima will be observed on a screen behind the grating? **[Ans:3]** [2]

3. What is resolving power of optical instrument? Write down the expression for resolving power of microscope and telescope. [2]

Polarization of light

Polarization property determines the Nature of wave either as transverse or as longitudinal.

a. Show that light is transverse in nature. 2
b. Write mathematical form of Brewster's law. 1

Brewster's law:
$\mu = \tan\theta_p \quad | \quad \theta_p + r = 90^o$

c. How would you obtain plane polarized light by reflection?

d. A ray of light incident on a glass plate at an angle of 33^0 with its surface. If the reflected and refracted light are perpendicular to each other, what is the index for refraction of glass? What is the angle of refraction? [Ans: 1.539; 33°]