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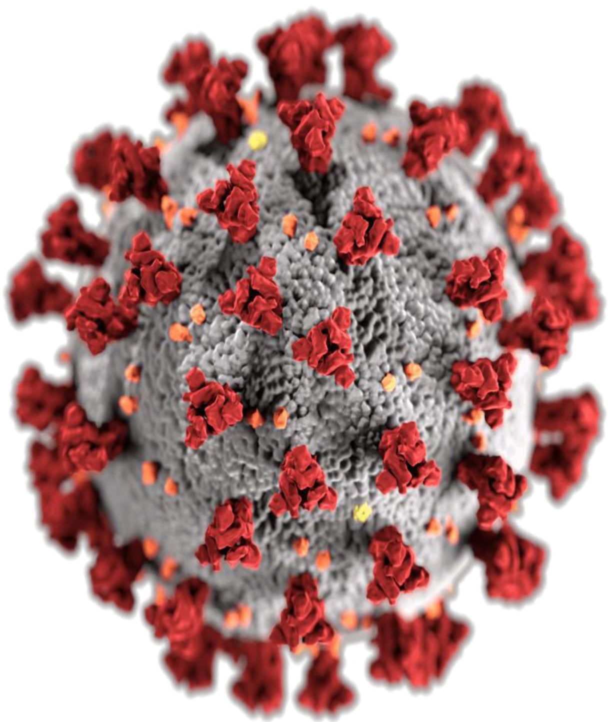
Welcome to my Class

Physics Ph 1109

11:45 AM
November 12, 2020

COVID-19 Precautions

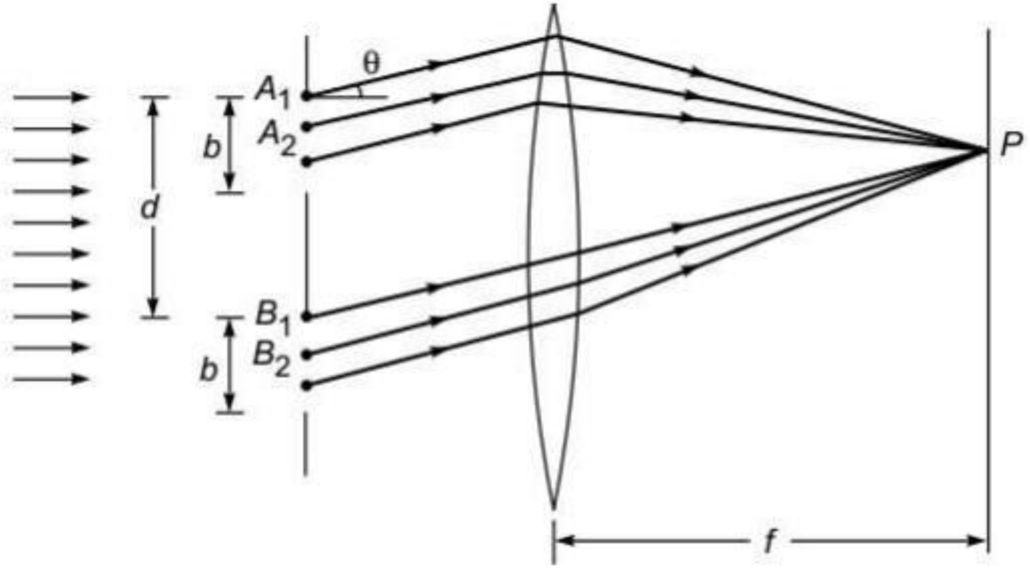


- Don’t be afraid
- Be aware of the pandemic
- Use appropriate outfits if you compelled to go out
- Try to maintain proper diet
- Do not forget to exercise (at least one hour) regularly
- Try to follow the guidelines of WHO and Bangladesh Government
- Try to stay at home

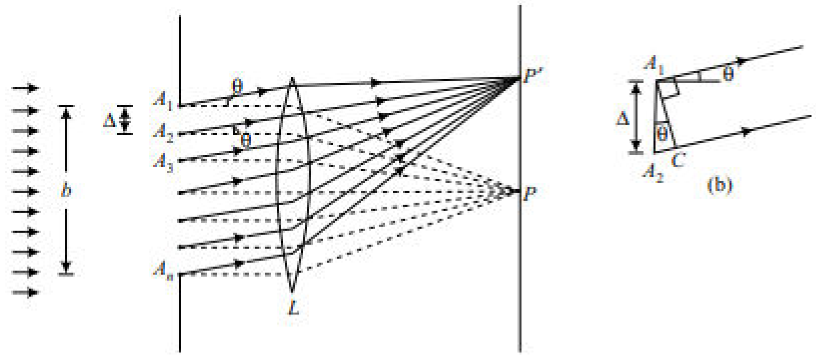
Two-Slit Fraunhofer Diffraction Pattern

$$E_1 = A\frac{sin\beta}{\beta}\cos\left(\omega t - \beta\right) \qquad (1)$$

$$E_2 = A\frac{sin\beta}{\beta}\cos\left(\omega t - \beta - \varphi_1\right) \qquad (2)$$



$$where \quad \varphi_1 = \frac{2\pi}{\lambda} d sin\theta$$



$$E = E_1 + E_2$$

$$= A\frac{sin\beta}{\beta}[\cos(\omega t - \beta) + \cos(\omega t - \beta - \varphi_1)] \quad (3)$$

$$E = 2A\frac{sin\beta}{\beta}\cos\gamma\cos\left(\omega t - \beta - \frac{1}{2}\varphi_1\right) \quad (4)$$

$$\text{where} \quad \gamma = \frac{\varphi_1}{2} = \frac{\pi}{\lambda} d sin\theta \quad (5)$$

The intensity distribution will be of the form

$$I = 4I_o \frac{sin^2\beta}{\beta^2} \cos^2\gamma \qquad (6)$$

Positions of Maxima and Minima

The intensity is zero wherever

$$\beta = \pi, 2\pi, 3\pi, \dots.. \qquad (7)$$

or when $\gamma = \frac{\pi}{2}, \frac{3\pi}{2}, \frac{5\pi}{2}, \dots..$ (8)

The corresponding angles of diffraction will be given by the following equations

$$b sin\theta = m\lambda; \quad (m = 1, 2, 3, \ldots\ldots) \tag{9}$$

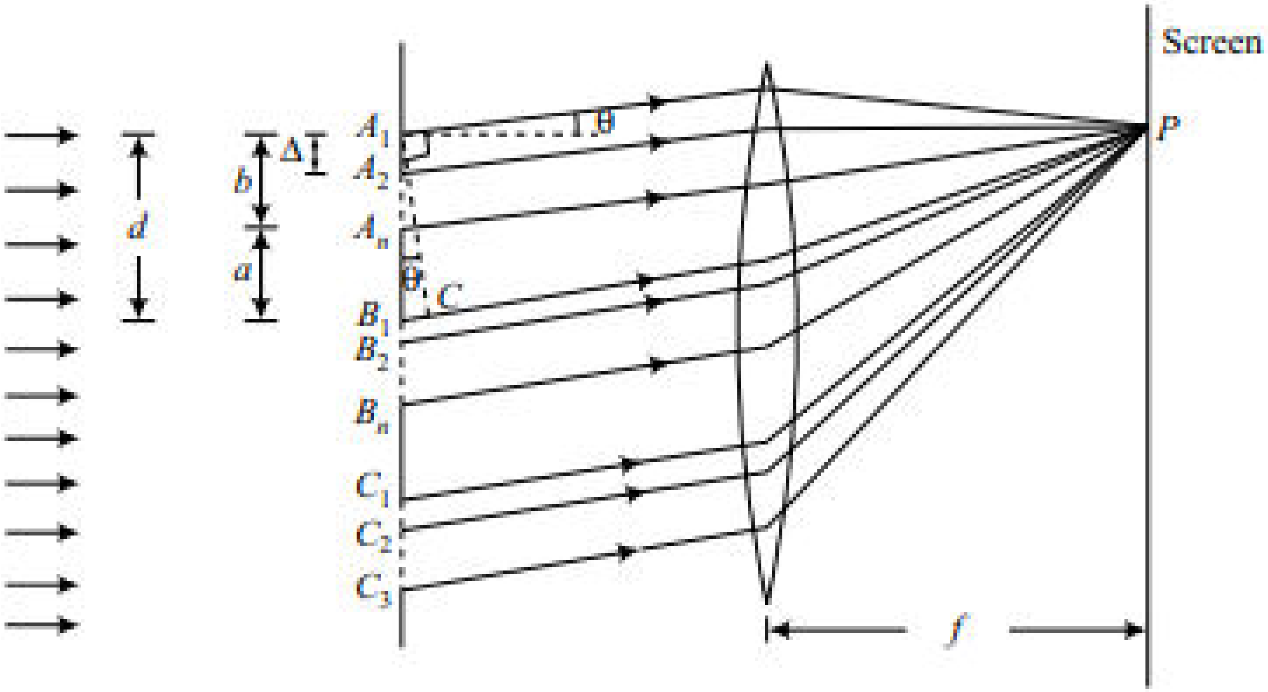
$$and \quad d sin\theta = \left(n + \frac{1}{2}\right)\lambda; \quad (n = 0, 1, 2, 3, \ldots\ldots) \tag{10}$$

The interference maxima occur when

$$\gamma = 0, \pi, 2\pi, 3\pi, \ldots\ldots \tag{11}$$

$$or \quad d sin\theta = 0, \lambda, 2\lambda, 3\lambda \ldots\ldots \tag{12}$$

N-Slit Fraunhofer Diffraction Pattern



$$E = A\frac{sin\beta}{\beta}\cos(\omega t - \beta) + A\frac{sin\beta}{\beta}\cos(\omega t - \beta - \varphi_1) + \cdots + A\frac{sin\beta}{\beta}\cos(\omega t - \beta - (N-1)\varphi_1) \quad (13)$$

$$E = A\frac{sin\beta}{\beta}[\cos(\omega t - \beta) + \cos(\omega t - \beta - \varphi_1) + \cdots + \cos(\omega t - \beta - (N-1)\varphi_1)]$$

$$= A\frac{sin\beta}{\beta}\frac{sinN\gamma}{sin\gamma}\cos\left(\omega t - \beta - \frac{1}{2}(N-1)\varphi_1\right) \quad (14)$$

$$\text{where} \quad \gamma = \frac{\varphi_1}{2} = \frac{\pi}{\lambda}dsin\theta \quad (15)$$

The corresponding intensity distribution will be

$$I = I_o \frac{sin^2\beta}{\beta^2} \frac{sin^2 N\gamma}{sin^2\gamma} \quad (16)$$

Positions of Maxima and Minima

When the value of N is very large, one obtains intense maxima at ϒ ≈ mπ

$$dsin\theta = m\lambda \, (m = 0, 1, 2, 3, \ldots \ldots) \quad (17)$$

The intensity is zero when

$$b\sin\theta = n\lambda \ (n = 1, 2, 3, \ldots\ldots) \quad (18)$$

$$\text{or } N\gamma = p\pi, \ \ p \neq N, 2N, \ldots. \quad (19)$$

$$d\sin\theta = \frac{\lambda}{N}, \frac{2\lambda}{N}, \ldots., \frac{(N-1)\lambda}{N}, \frac{(N+2)\lambda}{N},$$

$$\ldots., \frac{(2N-1)\lambda}{N}, \frac{(2N+1)\lambda}{N}, \frac{(2N+2)\lambda}{N}, \ldots. \quad (20)$$

Missing Orders

$$d sin\theta = m\lambda \, (m = 0, 1, 2, 3, \ldots\ldots) \quad (21)$$

$$b sin\theta = n\lambda \, (n = 1, 2, 3, \ldots\ldots) \quad (22)$$

Width of the Principal Maxima

$$d sin\theta_m = m\lambda \, (m = 0, 1, 2, 3, \ldots\ldots) \quad (23)$$

If $\Theta_m+\Delta\Theta_{1m}$ and $\Theta_m-\Delta\Theta_{2m}$ represent the angles of diffraction corresponding to the first minimum on either side of the principal maximum, then $(\Delta\Theta_{1m}+\Delta\Theta_{2m})/2$ is known as the angular half width of the mth order principal maximum. For a large value of N, $\Delta\Theta_{1m}\approx\Delta\Theta_{2m}$ which we write as $\Delta\Theta_m$. Clearly,

$$d\sin(\theta_m \pm \Delta\theta_m) = m\lambda \pm \frac{\lambda}{N} \tag{24}$$

But

$$\sin(\theta_m \pm \Delta\theta_m) = \sin\theta_m \cos\Delta\theta_m \pm \cos\theta_m \sin\Delta\theta_m$$

$$\cong \sin\theta_m \pm \Delta\theta_m \cos\theta_m \tag{25}$$

$$\therefore \quad \Delta\theta_m \cong \frac{\lambda}{Nd\cos\theta_m} \qquad (26)$$

The Diffraction Grating

The diffraction grating, a useful device for analyzing light sources, consists of a large number of equally spaced parallel slits. A transmission grating can be made by cutting parallel lines on a glass plate with a precision ruling machine

15000 lines/inch

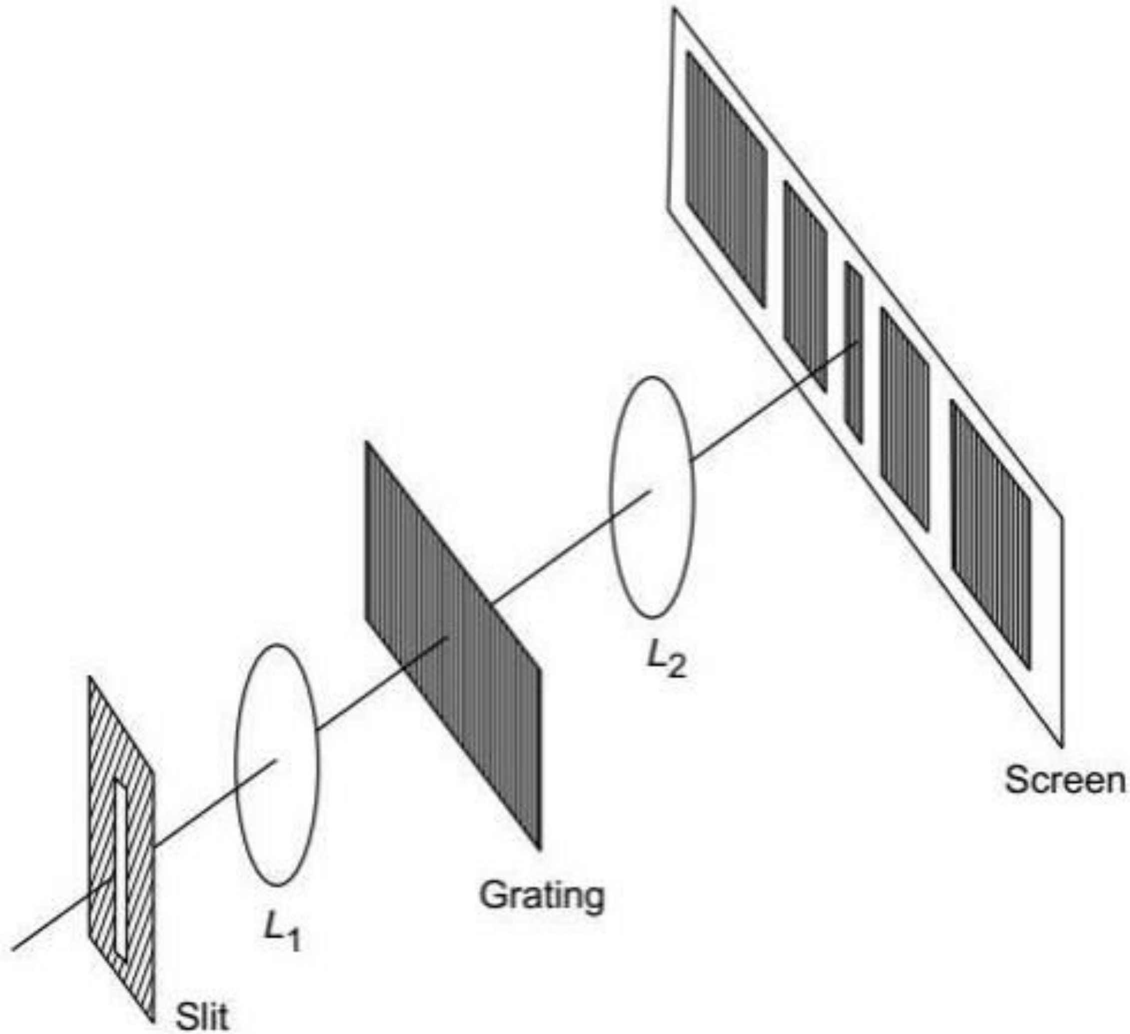
Rowland (1882) – 14438 lines/inch

The Grating Spectrum

$$d sin\theta_m = m\lambda \; (m = 0, 1, 2, 3, \ldots\ldots) \qquad (27)$$

If we differentiate eqn. (27), we obtain

$$\frac{\Delta\theta}{\Delta\lambda} = \frac{m}{d cos\theta} \qquad (28)$$

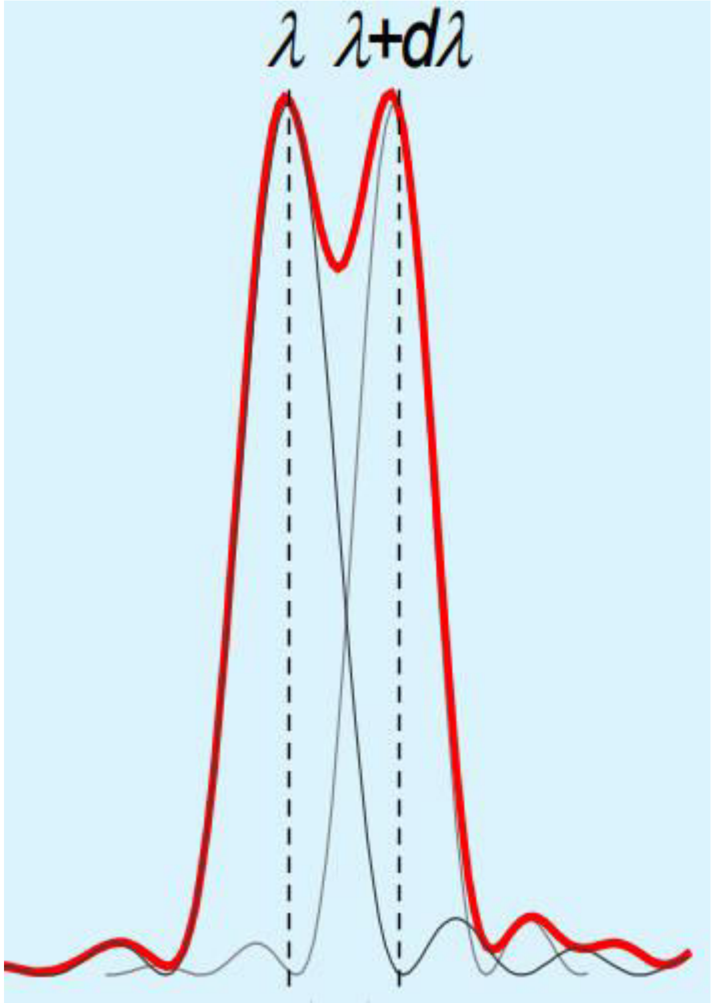


L_2
Screen
L_1
Grating
Slit

Resolving Power of a Grating

$$Resolving\ Power, \qquad R = \frac{\lambda}{\Delta\lambda} \tag{29}$$

Rayleigh criterion: Two wavelengths in a line spectrum are resolved if the maximum in the diffraction pattern from light with one wavelength coincides with the minimum in the diffraction pattern from light with the other wavelength.


λ
λ+dλ

$$d sin\theta = m(\lambda + \Delta\lambda) \tag{30}$$

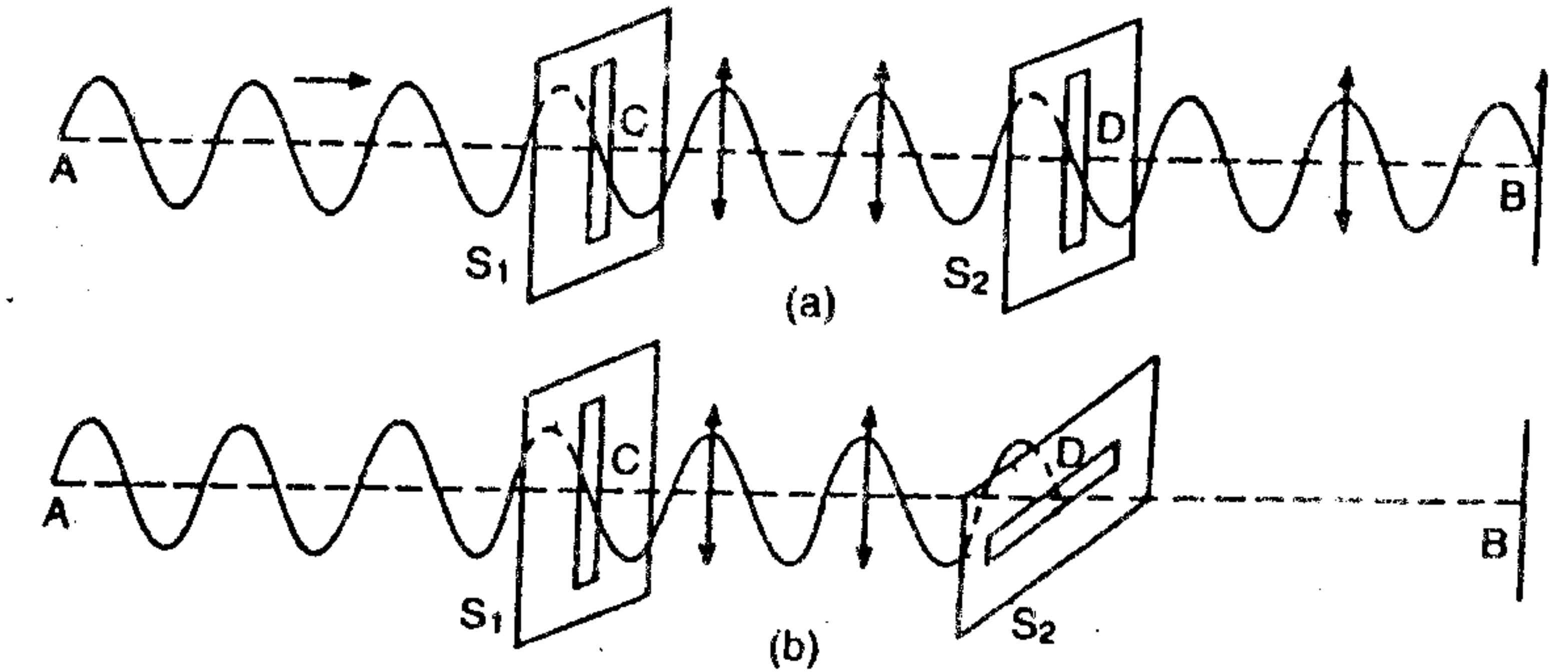
$$d sin\theta = m\lambda + \frac{\lambda}{N} \tag{31}$$

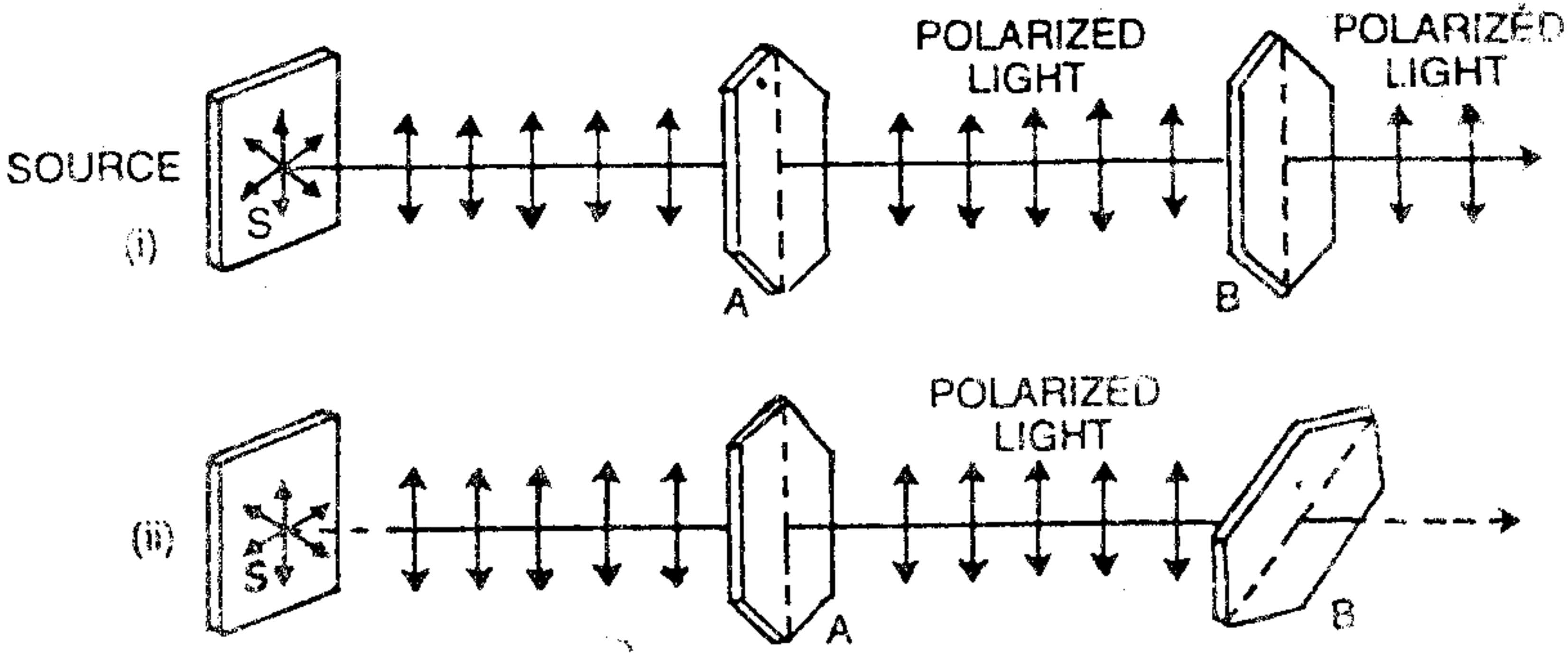
$$Thus \qquad R = \frac{\lambda}{\Delta\lambda} = mN \tag{32}$$

Polarization of Light

Experiments on interference and diffraction have shown that light is a form of wave motion. These effects do not tell us about the type of motion i.e., whether the light waves are longitudinal or transverse, or whether the vibrations are linear , circular or torsional. The phenomenon of polarization has helped to establish beyond doubt that light waves are transverse waves.

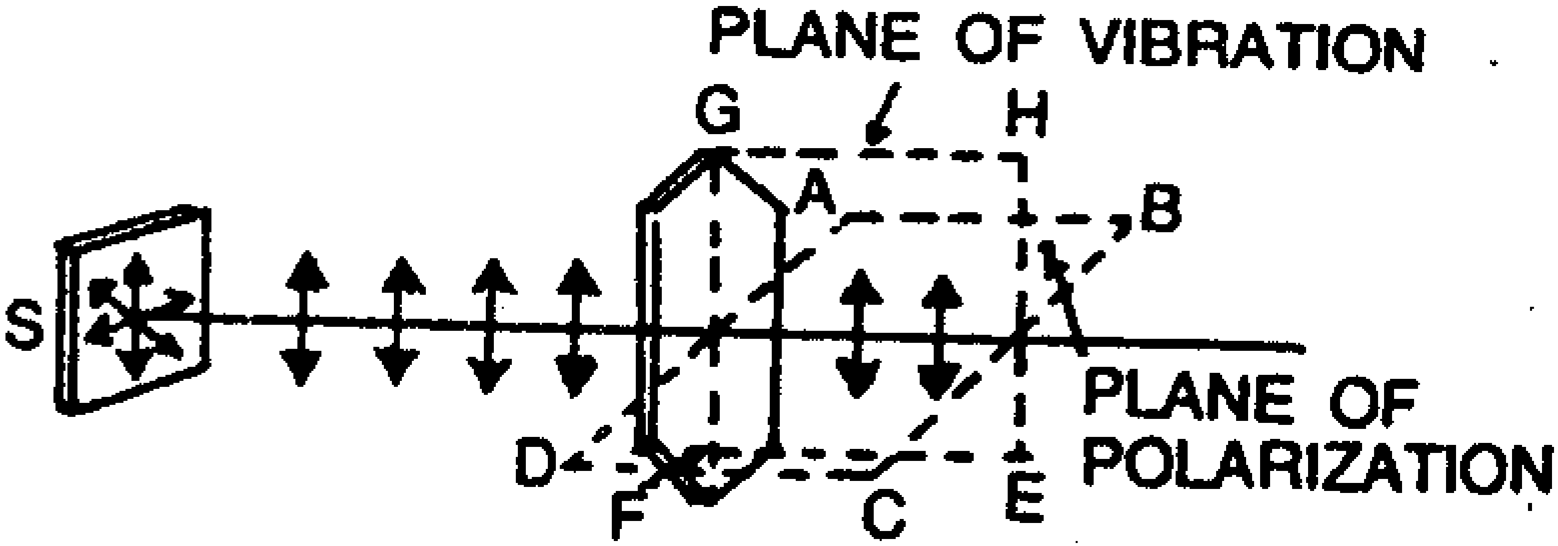
Polarization of Transverse Waves

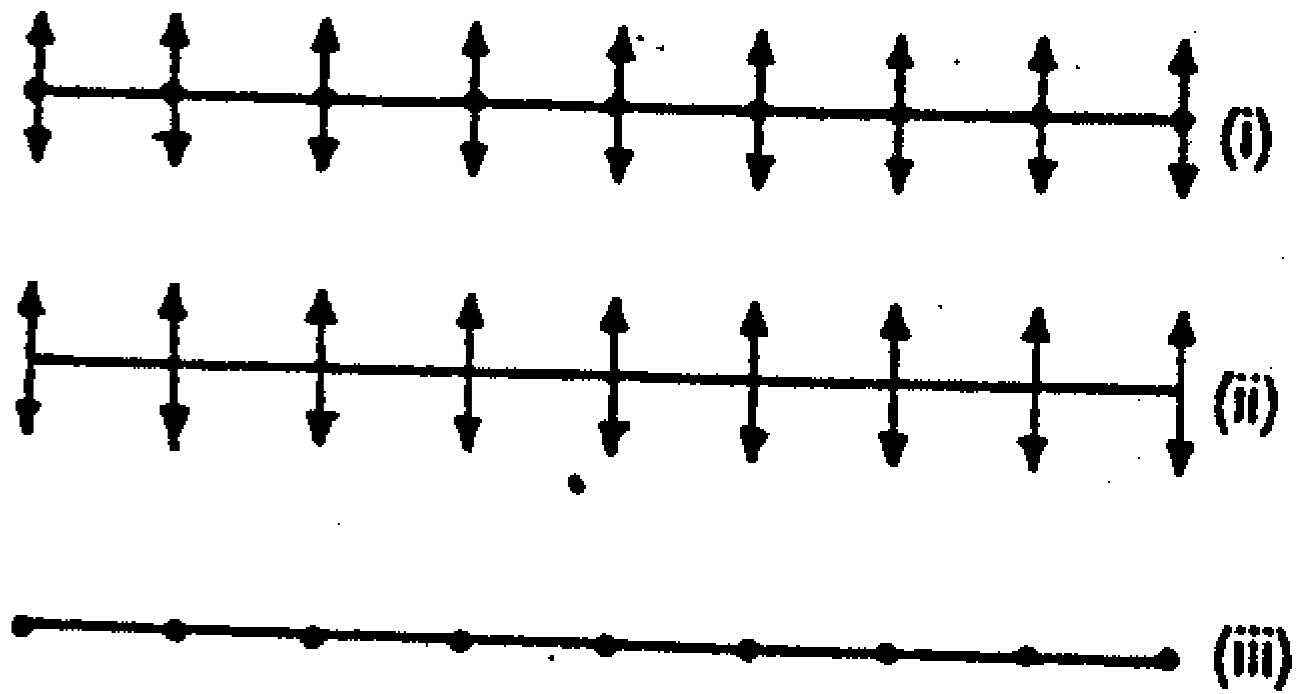




SOURCE
S
(i)
A
POLARIZED LIGHT
B
POLARIZED LIGHT
(ii)
S
A
POLARIZED LIGHT
B

Plane of Polarization




(i)
(ii)
(iii)


I Thank you