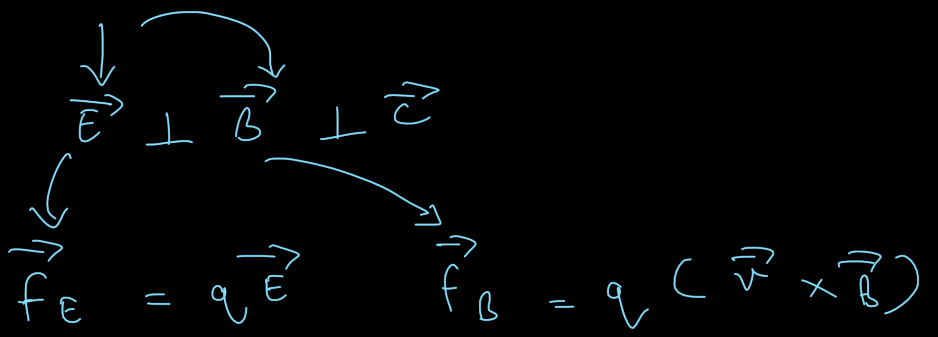
Polarisation :-

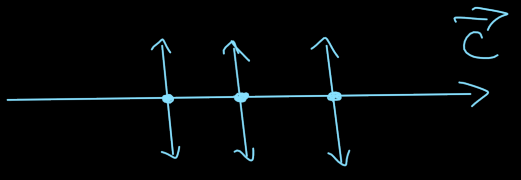
Light ⟶ em transverse wave



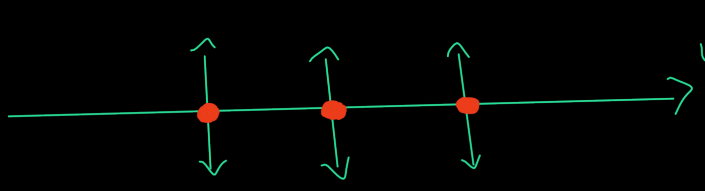
It travels in straight line path.

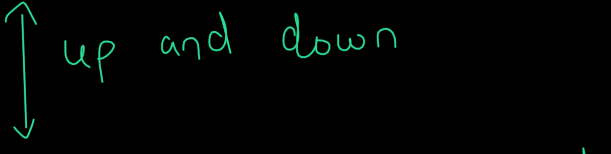
$\vec{E} = c\vec{B}$

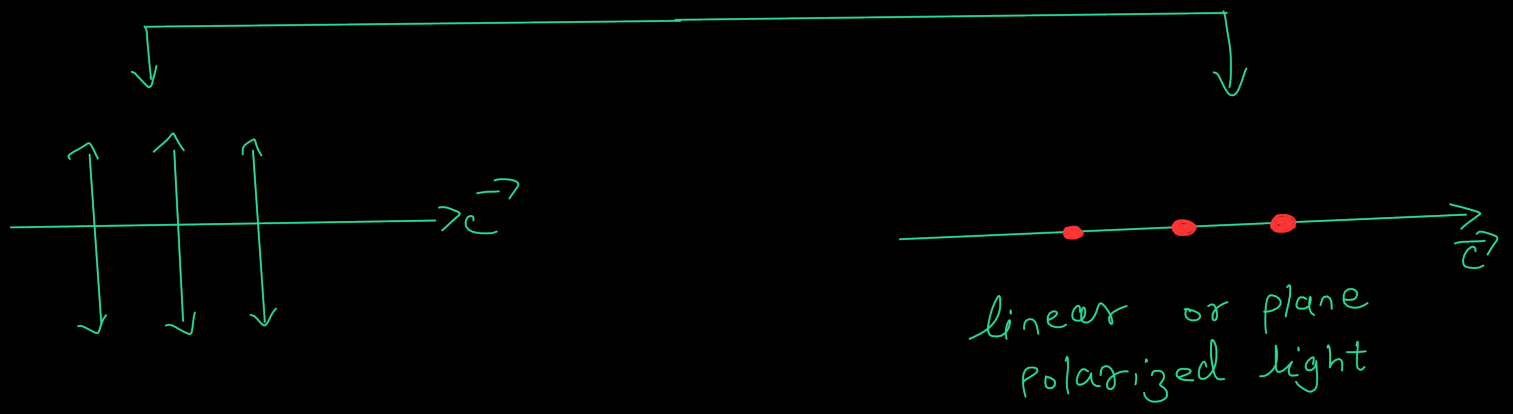
$E = 3\,000\,000\,00\,B$



Therefore in an ordinary light the vibrations of an electric field vectors are in all direction ⊥ to the direction of propogation of light. This light is called unpolarized light.







⇒ A line in which the vibration of electric feild vector are restricted to on plane ⊥ to the direction of propogation of light is called plane polarized light.

⇒ Plane which contains vibration of plane polarized light is called plane of vibration.

⇒ A plane which is perpendicular to the plane of vibration is called plane of polarization.

⇒ The process of conversion of unpolarized light in plane polarized light is called polarization.

Polarization is possible by reflection, refraction (or) scattering.

⊙ Malus Law :-

The intensity of light coming from analyser is directly propotional to sq. of cosine of

angle b/w plane of polarizer and analyzer.

θ is the angle b/w plane of polarizer and analyzer.

$$I \propto \cos^2\theta$$

⊙ Polarization by Reflection :-

① When unpolarized light is incident on a denser medium then reflected light is found to be plane polarized.

The angle of incidence at which the reflected light is completely polarized is called brewster's angle or polarizer angle.

⊙ Brewster's Law :-

When a ray of light is incident at polarizing angle then the refracted index of the medium is numerically equal to tan of polarizing angle.

It is found that the reflected and the refracted rays are perpendicular to each other.

① from Shell's law :-

$$\mu_2 = \frac{\sin i}{\sin r}$$

$$i = i_p$$

$$\mu_2 = \frac{\sin ip}{\sin r} \longrightarrow (1)$$

from eqn $ip + 90^\circ + r = 180^\circ$

$$ip + r = 180^\circ - 90^\circ$$

$$ip + r = 90^\circ$$

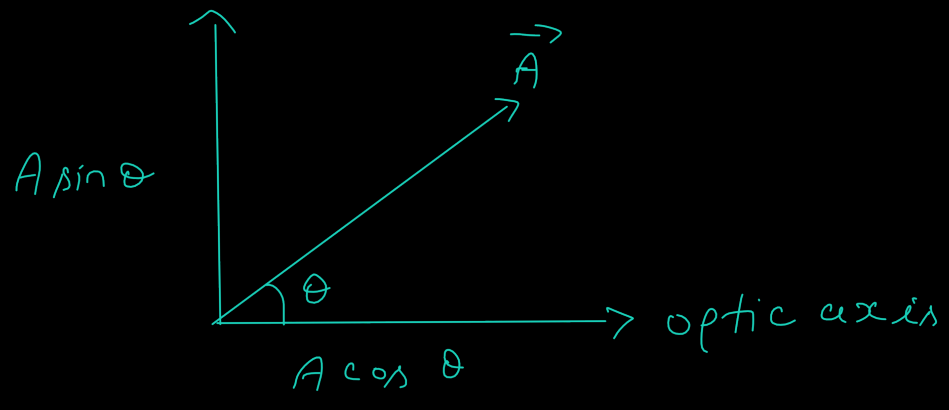
$$r = (90^\circ - ip) \text{ — } (2)$$

(2) $$\mu_2 = \frac{\sin ip}{\sin(90^\circ - ip)}$$

$$\mu_2 = \frac{\sin ip}{\cos ip}$$

$$\boxed{\mu_2 = \tan ip}$$

⊙ Circular and elliptical polarized light:—



Let A = Amplitude

If θ is angle with optic axis the amplitude of

E − ray = A cos θ

$$x = a \sin(\omega t + \delta) \text{ —— } (1)$$

where $a = A \cos\theta$

Amplitude of o-ray $= A \sin\theta$

$\therefore$ disp. of o-ray $y = A \sin\theta \sin \omega t$

$$y = b \sin \omega t \quad \text{—— (2)}$$

where $b = A \sin\theta$

from eqⁿ (2)

$$\sin \omega t = \frac{y}{b} \quad \text{—— (3)}$$

$$\cos \omega t = \left(1 - \frac{y^2}{b^2}\right)^{1/2} \quad \text{—— (4)}$$

from eqⁿ (1)

$$\frac{x}{a} = \sin \omega t \cos\delta + \left(1 - \frac{y^2}{b^2}\right)^{1/2} \cdot \sin\delta$$

$$\left(\frac{x}{a} - \frac{y}{b}\cos\alpha\right) = \left(1 - \frac{y^2}{b^2}\right)^{1/2} \sin\delta$$

on squaring,

$$\frac{x^2}{a^2} + \frac{y^2}{b^2}\cos^2\delta \cdot \frac{2xy\cos\delta}{ab} = \left(\frac{1-y^2}{b^2}\right)\sin^2\delta$$

$$\frac{x^2}{a^2} + \frac{y^2}{b^2}\cos^2\delta - \frac{2xy\cos\delta}{ab} = \sin^2\delta - \frac{y^2}{b^2}\sin^2\delta$$

$$\boxed{\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{2xy\cos\delta}{ab} = \sin^2\delta}$$

Important formula :-

(1) Brewster's Law :-

$$\tan ip = \mu$$

or, $$\tan \theta_B = \mu$$

$$ip + r = 90^\circ$$

(2) Malu's law.

$$I_A = I_p \cos^2\theta$$

$$I = I_0 \cos^2\theta$$

(3) phase difference b/w.

E - ray & O - ray

$$\phi = \left(\frac{2\pi}{\lambda}\right)(\mu_e - \mu_o)\, d.$$

(4) Resultant of two mutually perpendicular plane polarized waves.

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} - \frac{2xy}{ab}\cos\delta = \sin^2\delta$$

when $\delta = 0$ linearly polarized

when $a \neq b$, $\delta \neq 0$, $(2n+1)\frac{\pi}{2}$ => elliptically polarized.

when $a = b$, $\delta = (2n+1)\frac{\pi}{2}$ => circularly polarized.

$x \longrightarrow E_x$

$y \longrightarrow E_y$