Plane polarized light :- The polarised light wave in which electric field vector $\vec{E}$ vibrates in a single plane perpendicular to the direction of propagation of light wave, is known as plane polarised light wave.

plane polarized light wave is also known as linearly polarized light wave because direction of vibration of electric field vector $\vec{E}$ at some point in space and time lies along a line in a plane perpendicular to direction of propagation of light wave.

In linear polarization, the orientation of electric field vector $\vec{E}$ remains constant at a point in space i.e. direction of $\vec{E}$ does not vary with time but its magnitude varies sinusoidally with time.

If the field vector $\vec{E}$ is pointing inward or outward the plane of paper perpendicular to the direction of wave propagation then it is said to be vertical polarization which is represented as shown in fig-1.

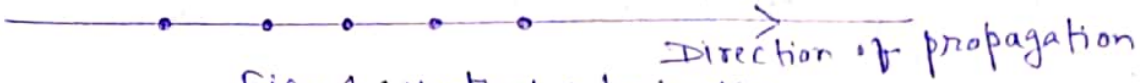

Fig-1 : Vertical polarization.

If the field vector $\vec{E}$ is pointing either left or right in a plane perpendicular to direction of wave propagation then it is said to be horizontal polarisation which is represented as shown in fig-2.

Fig-2 : Horizontal polarization.

It is not necessary that electric field vector $\vec{E}$ is always pointing exactly along vertical or horizontal but

it can be at any arbitrary angle to those axes. Linearly polarized light, polarized at any arbitrary angle may be considered as a combination of horizontally and vertically polarized light with appropriate amplitude and which are oscillating in phase or 180° out of phase. The key point is that the two component waves are coherent.

A light wave polarized at an arbitrary angle has been shown in fig-3.

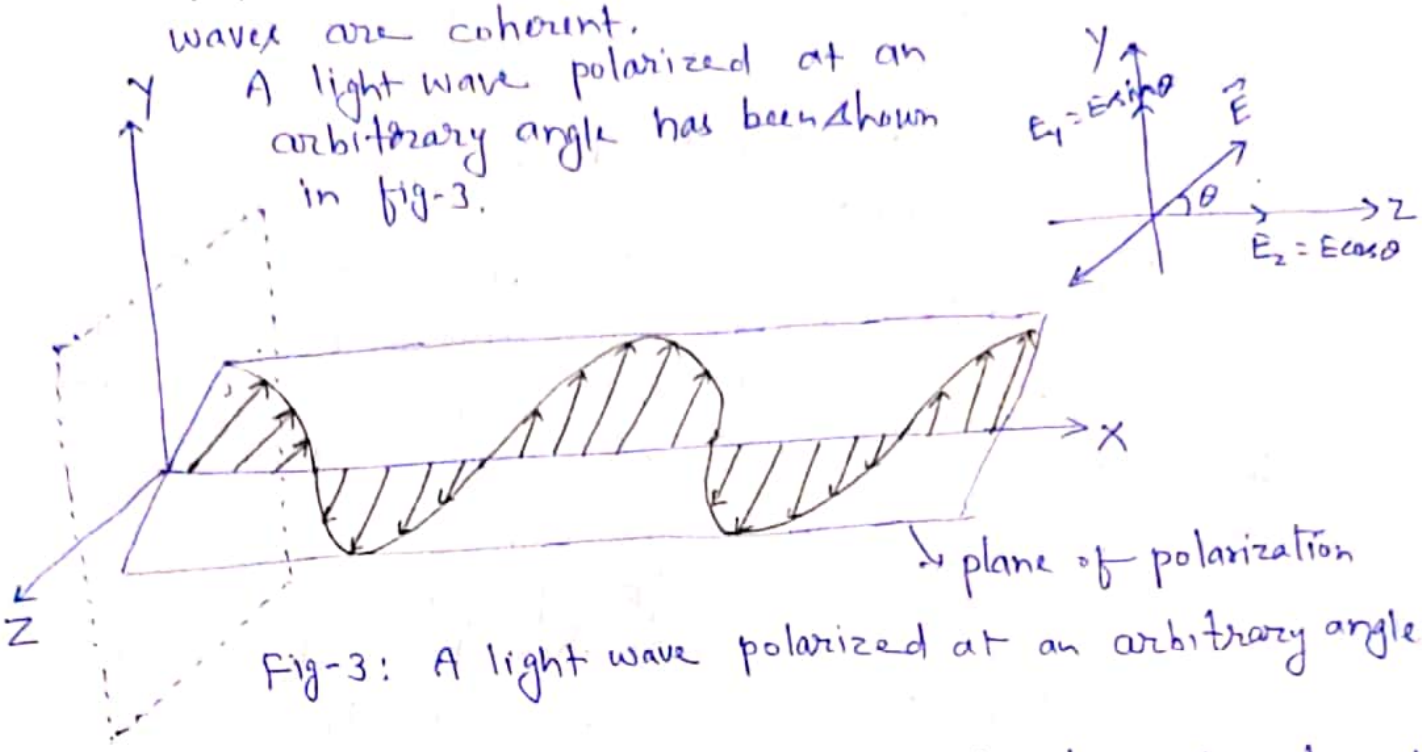

Fig-3: A light wave polarized at an arbitrary angle.

A linearly polarized wave as a combination of coherent horizontally and vertically polarized wave has been shown in fig-4.

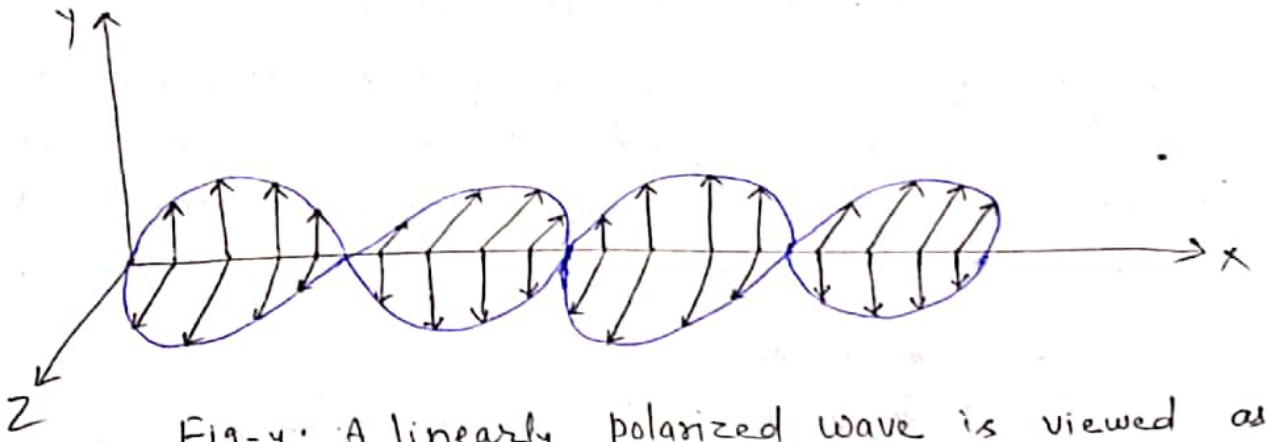

Fig-4: A linearly polarized wave is viewed as a combination of coherent horizontally and vertically polarized wave.

partially polarized light :- The mixture of plane polarized wave and unpolarized wave, is known as partially polarized wave. Thus partially polarized wave consists of polarized and unpolarized wave. Like unpolarized light wave, partially polarized wave can be represented in the form of a superposition of two incoherent plane polarized waves with mutually perpendicular plane of oscillations. In case of unpolarized light wave, amplitude of two superposing incoherent waves is same but in the case of partially polarized light wave, amplitude of these two superposing waves is different. symbollic representation of partially polarized waves has been shown in fig-5.

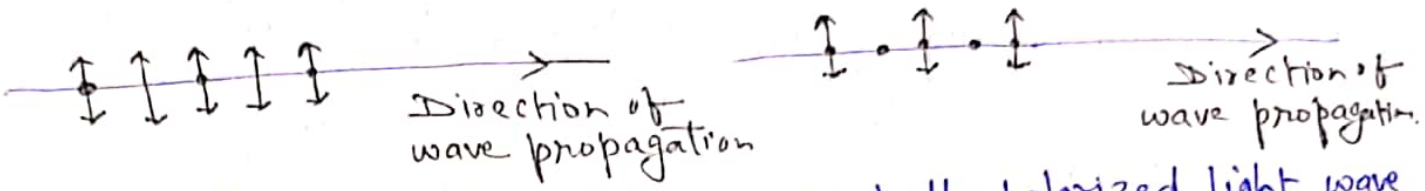

Fig-5: Representation of partially polarized light wave.

* When partially polarized light waves is incident on a polarizer and the polarizer is rotated about the direction of propagation of light wave then it is found that intensity of transmitted light wave will change within the limit from I_{max} to I_{min}. The transition of intensity from I_{max} to I_{min} or I_{min} to I_{max} will occur upon rotation of the polarizer through an angle of 90°.

Degree of polarization in partially polarized light is defined as

$$P = \frac{I_{max} - I_{min}}{I_{max} + I_{min}}$$

percentage polarization in partially polarized light is defined as

$$\% \text{ polarization} = \frac{I_{max} - I_{min}}{I_{max} + I_{min}} \times 100\%$$

* For polarized light, $I_{max} = I_0$ and $I_{min} = 0$

$$\% \text{ polarization} = \frac{I_0 - 0}{I_0 + 0} \times 100\% = 100\%$$

It represents complete polarization.

* For unpolarized light, $I_{max} = I_{min} = 2I_0$

$$\% \text{ polarization} = \frac{2I_0 - 2I_0}{2I_0 + 2I_0} \times 100\% = 0$$

It represents zero polarization.

* For partially polarized light, if $I_{max} = 2I_{min}$ then

$$\% \text{ polarization} = \frac{2I_{min} - I_{min}}{2I_{min} + I_{min}} \times 100\%$$

$$= 33.33\%$$

It represents 33.33% polarization in partially polarized light.

Note :- The concept of degree of polarization is applicable only for plane (linearly) polarized light wave not for circularly or elliptically polarized light wave.