Contents

Polarization

- Polarization is the phenomenon of vibration of particle.
- The vibration of particle in polarization occurs in a single plane.
- The direction of vibration of particle in polarization is expressed with the direction of propagation of wave.
- The direction of vibration of particle in polarization with respect to the direction of propagation of wave is perpendicular.

Types of wave

Basis of division of wave

The basis of division of wave is

- The nature of vibration of particle with the direction of propagation of wave

Nature of longitudinal wave on the basis of vibration of particle with respect to the direction of wave propagation

The nature of longitudinal wave on the basis of vibration of particle with respect to the direction of wave propagation is

- Particle of longitudinal wave vibrate along the direction of wave propagation

Nature of transverse wave on the basis of vibration of particle with respect to the direction of wave propagation

The nature of transverse wave on the basis of vibration of particle with respect to the direction of wave propagation is

- Particles of transverse wave vibrate in the direction perpendicular to wave propagation

Common observations of properties expressed by longitudinal and transverse wave

The common properties expressed by the observation of longitudinal and transverse wave are

- Reflection
- Refraction
- Interference
- Diffraction

Specific observation only expressed by transverse wave

The specific observation only expressed by transverse wave is

- Polarization

Cause of polarization of transverse wave

The cause of polarization of transverse wave is

- The vibration of the particles of transverse wave occur in all possible directions.
- The vibration of particles in the plane occurs which is perpendicular to the wave propagation.

Cause of unpolarization of longitudinal wave

The cause of unpolarization of longitudinal wave is

- The vibration of particles in longitudinal waves occur only along the direction of wave propagation.
- The longitudinal wave is already polarized.

Distinction for the observation of transverse and longitudinal wave

The distinction for the observation of transverse and longitudinal wave is

- Test for polarization

Types of light on the basis of polarization

The types of light on the basis of polarization are

- Polarized light
- Unpolarized light

Quantity of planes for the vibration of light in unpolarized light

The quantity of planes for the vibration of light in unpolarized light is - All the planes

Direction of a plane containing vibration of light with the direction of propagation of wave in unpolarized light

The direction of plane containing vibration of light with the direction of propagation of wave in unpolarized light is

- Perpendicular to the direction of propagation

Quantity of planes for the vibration of light in polarized light

The quantity of planes for the vibration of light in polarized light is

- $$1$$
  .
- The vibration in a polarized light occurs in a single plane.

Direction of plane containing vibration of light with the direction of propagation of wave in polarized light

The direction of plane containing vibration of light with the direction of propagation of wave in polarized light is

- Perpendicular to the direction of propagation of light

Experiment for the verification of transverse nature of light

Setup

Material needed for the verification of transverse nature of light

The material needed for the verification of transverse nature of light is

- Tourmaline crystals

Quantity of tourmaline crystals in verification of transverse nature of light

The quantity of tourmaline crystals in verification of transverse nature of light is

- 2

Expression of quantities for the verification of transverse nature of light

The expression for tourmaline crystals is

- C_1
- C_2

Direction of tourmaline crystal with respect to the direction of propagation of wave

The direction of plane of tourmaline crystal with the direction of propagation of wave is

- Perpendicular to the direction of propagation of wave

Parallel crystallographic axes

Relation of direction of crystallographic axes of tourmaline crystals in parallel crystallographic axes

The relation of direction of crystallographic axes of tourmaline crystals in parallel crystallographic axes is

- The direction of crystallographic axes is parallel

Physical arrangement of tourmaline crystals in verification of transverse nature of light wave

- The tourmaline crystals are placed as
-

$$C_2 \text{behind} C_1$$

Perpendicular crystallographic axes

Relation of direction of crystallographic axes of tourmaline crystals in perpendicular crystallographic axes

The relation of direction of crystallographic axes of tourmaline crystals in perpendicular crystallographic axes is

- The direction of crystallographic axes is perpendicular

Working principle of experiment for the transverse nature of light

- The C_2 crystal is rotated.
- The rotation is done tending to the perpendicular direction with the crystallographic axes of C_1 .
- The rotation of C_2 is stopped till the intensity of light is minimum.

Observation

Parallel crystallographic axes

Magnitude of intensity of light at parallel crystallographic axes

The magnitude of intensity of light at parallel crystallographic axes is

- Maximum

Perpendicular crystallographic axes

Magnitude of intensity of light at perpendicular crystallographic axes

The magnitude of intensity of light at perpendicular crystallographic axes is

- Minimum

Conclusion in verification of transverse nature of light

- The intensity of light reduces to minimum at perpendicular axes of second tourmaline crystal.
- The light waves are transverse.

Relation for expression for intensity of light in polarization

$$I = \frac{1}{2} I_0 \cos^2 \theta$$

Plane of vibration

Direction of propagation and direction of vibration

Direction of wave propagation with the vibration in plane of vibration

Parallel

Plane of polarization

Direction of wave propagation and perpendicular to vibration plane

Direction of wave propagation with the vibration in plane of vibration

Perpendicular

Brewster’s law

Factor influencing Polarization in Brewster’s law

Angle of incidence

Angle of polarization

Reflected light is completely plane polarized

Term for angle of polarization

Brewster’s angle

Consequence of equality of angle of polarization with incident angle in Brewster’s law in reflected and refracted rays

Reflected and refracted rays are perpendicular to each other

Relation of degree of reflection of Electric vectors perpendicular to the plane of incidence with Electric vectors parallel to the plane of incidence in Brewster’s Law in angle of incidence other than polarization

Degree of reflection or perpendicular > Degree of reflection of parallel

Degree of reflection of Electric vectors perpendicular to the plane of incidence in Brewster’s law in angle of polarization

Partial

Degree of reflection of Electric vectors parallel to the plane of incidence in Brewster’s law in angle of polarization

Null

- The electric vectors parallel to the plane of incidence are completely refracted.

Statement of Brewster's law

Tangent of angle of polarization is equal to refractive index of the medium

Verification of Brewster's law

Representation of incident unpolarized light

$$AB$$

Angle of unpolarized incident light with the normal

$$i_p$$

Representation of plane of air glass interface

$$XY$$

Representation of refracted light

$$BD$$

Angle of refracted light with the normal

$$r$$

Mathematical derivation for verification of Brester's law

$$\text{Refractive index of glass } = \mu$$
$$\mu = \frac{\sin i_p}{\sin r}$$
$$i_p + r = 90^\circ$$
$$r = 90^\circ - i_p$$
$$\mu = \frac{\sin i_p}{\sin 90^\circ - i_p}$$
$$\mu = \frac{\sin i_p}{\cos i_p}$$
$$\mu = \tan i_p$$

Mathematical expression for relation of Brewster's law

$$\mu = \tan_{i_p}$$

Expression for angle of polarization with critical angle in two different medium

$$i_p = \tan^{-1}\left(\frac{1}{\sin C}\right)$$

Expression for critical angle with angle of polarization in two different medium

$$C = \sin^{-1} \frac{1}{\tan i_p}$$

Expression for angle of polarization in two different mediums other than air

$$i_p = \tan^{-1}\left(\frac{\mu_{\text{final medium}}}{\mu_{\text{initial medium}}}\right)$$

Expression for angle of refraction in brewster's law

$$r = 90 - i_p$$