Important

NICOL PRISM

Introduction :-

William Nicol invented an optical device for producing and analysing plane polarised light. Such optical device called Nicol prism.

Principle :-

The Principle of the Nicol prism based on when an ordinary light is passed through calcite crystal then its broken into two ray

- Ordinary ray → This ray is polarised and its vibration perpendicular to the principal section of the crystal

- Extra-Ordinary ray → This ray is also polarised but its vibration parallel to the principal axis.

If some optical instrument combine to each other and emerging through the crystal will be plane polarised light. In Nicol Prism the ordinary ray is eliminated by total internal reflection so that only the extra-ordinary ray becomes plane poldrised through the prism.

The construction of Nicol Prism is shown below.

• Construction :-

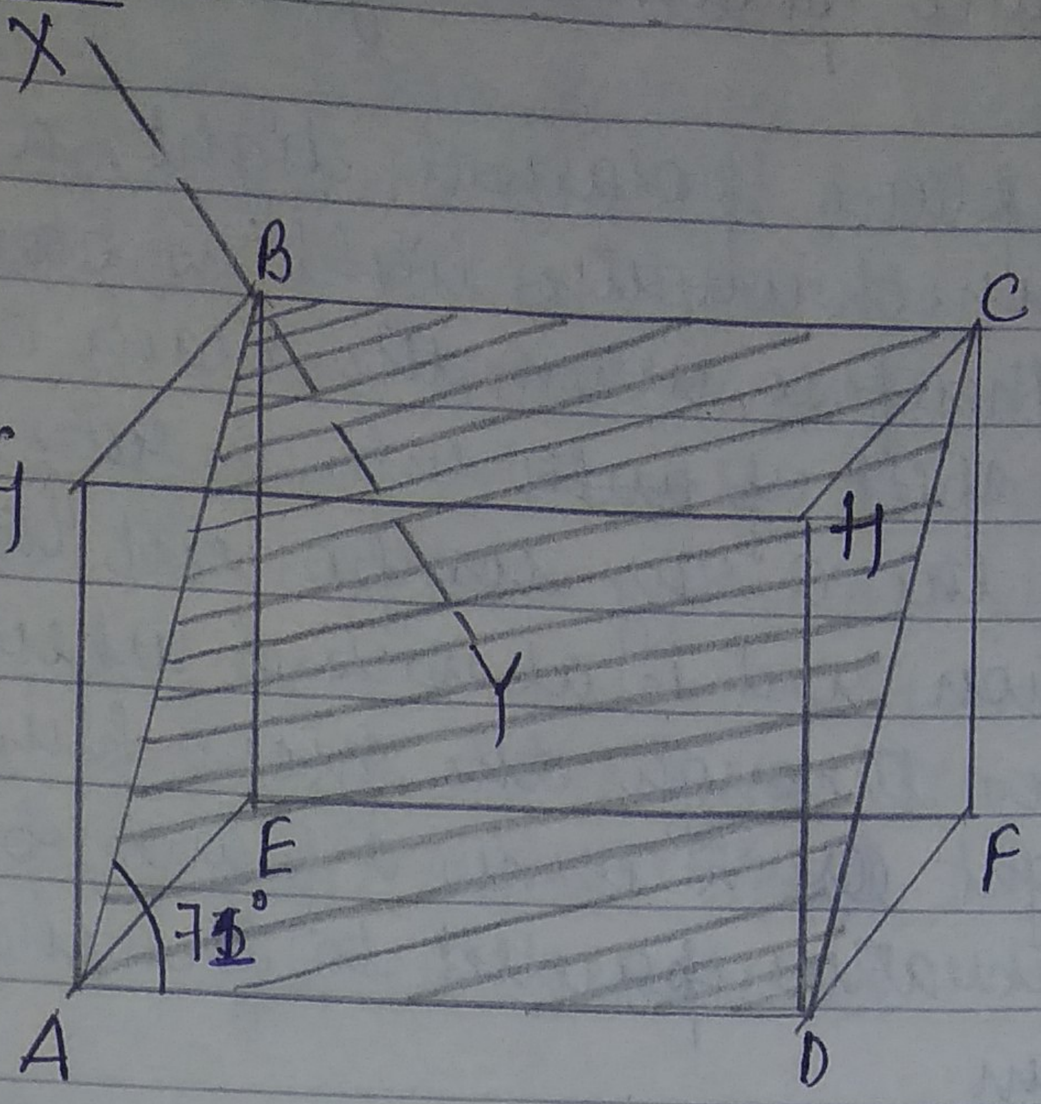

Figure (1.)

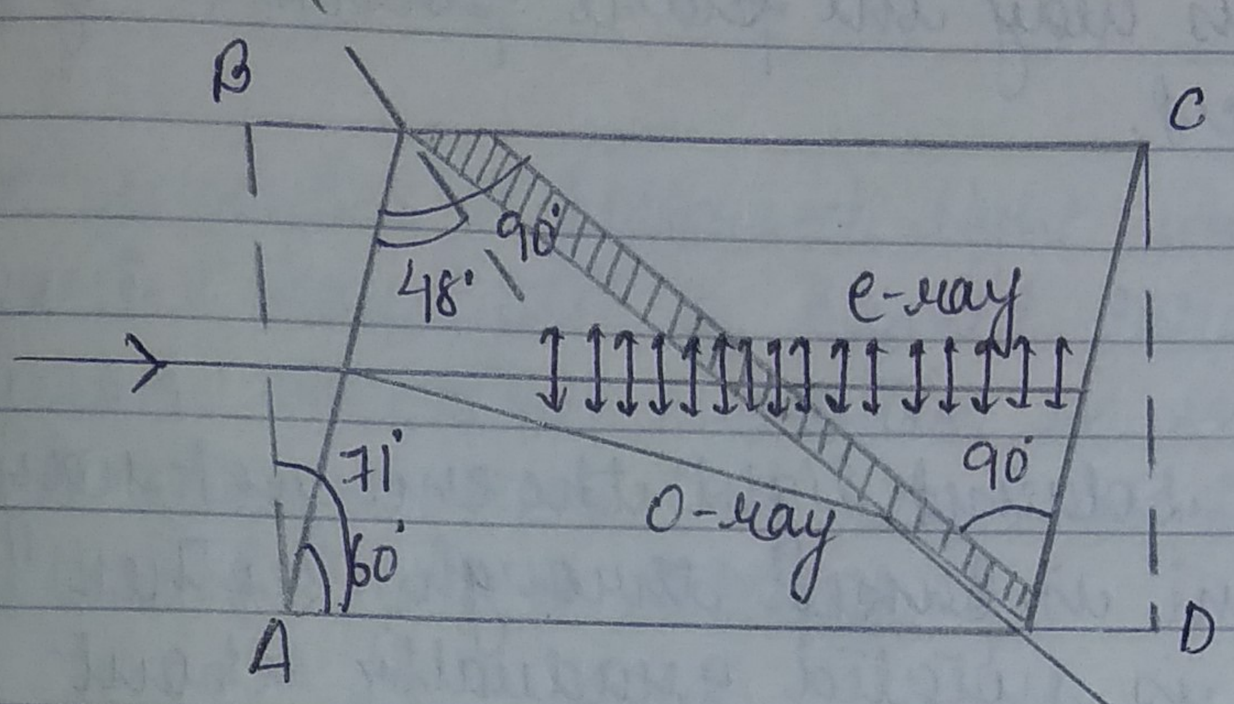

Figure (2.)

A Calcite crystal whose length is 3 times its breadth is taken. A crystal ABFGBC in which ABCD as a principal section of the crystal with ∠BAD = 71°

The end faces of the crystal are cut in such a way that they make angles of 68° and 112°. Therefore the crystal is cut into two pieces as indicated in the diagram. By the help of the nicol prism we can produce and analyse the plane polarised light, circularly polarised light and elliptically polarised light.

• Production and Detection :-

Production and Detection of plane, circularly and elliptically polarised light

(1) Production of plane polarised light :-

To produce the plane polarised light, a beam of unpolarised monochromatic light is passed through a nicol prism. Therefore, when the beam enters the nicol prism it split up ~~with~~ into O-ray and e-ray components. But the O-ray component is totally internally reflection and is absorbed whereas e-ray component passes through the nicol prism, thus the emergent light ~~is~~ becomes a plane polarised light and its vibration parallel to the end face of the nicol prism

Hence, in this way the plane polarised light is ~~polarised~~ produced.

Detection :-

To Detect the plane polarised light the emergent ray of the nicol prism is passed through another nicol prism which is rotated gradually about the direction of propagation of light. If the intensity of the emerging light from rotating nicol prism ~~remains constant~~ varies from 0 to maximum Then the light is actually a plane polarised light. Hence in this way the plane polarised light is detected

(3)

(2) Production of circularly polarised light :-

We know that for the circularly polarised light, the amplitude of O-ray ~~is the same~~ and e-ray is the same and having a phase diffcence $\frac{\pi}{2}$ between them. For the purpose of circularly polarised light the ordinary monochromatic light is passed through,

a nicol prism and Hence the emerging light from the nicol prism is plane polarised light and this plane polarised light is allowed to fall normally on a quarter wave plate whose path difference '$\frac{\lambda}{4}$' or phase difference '$\frac{\pi}{2}$' when such conditions is satisfies then the plane polarised light entering into the quarter wavelength. This quarter waveplate is split up into o-ray and e-ray components having the same amplitude and hence the emerging light from the quarter waveplate is circularly polarised light. Hence in this way the circularly polarised light is produced

- Detection :-

The circularly polarised light ~~energy~~ emerging from the quarter waveplate is passed through a rotating nicol prism shows no variation in intensity i.e. the constant intensity is seen and hence in this way the circularly polarised light is detected.

(3) Production of elliptically polarised light :-

We know that for elliptically polarised light the amplitude of e-ray and o-ray are unequal but the phase difference between them is '$\frac{\pi}{2}$' or a path diff '$\frac{\lambda}{4}$' for these purpose the ordinary monochromatic light is passed through a nicol prism is a plane polarised light this plane polarised light is then allowed to fall normally on a quarter waveplate which satisfies the above condition and hence the emerging light from the quarter waveplate becomes elliptically polarised light. Hence in this way the elliptically polarised light is produced

- **Detection :-**

To detect the elliptically polarised light which is passed through a rotating nicol prism. If the intensity of the emerging light with minimum intensity not zero then we can say that the emerging light becomes an elliptically polarised light. Hence in this way we can produce and detect the plane polarised light, circular polarised light and elliptically polarised light.