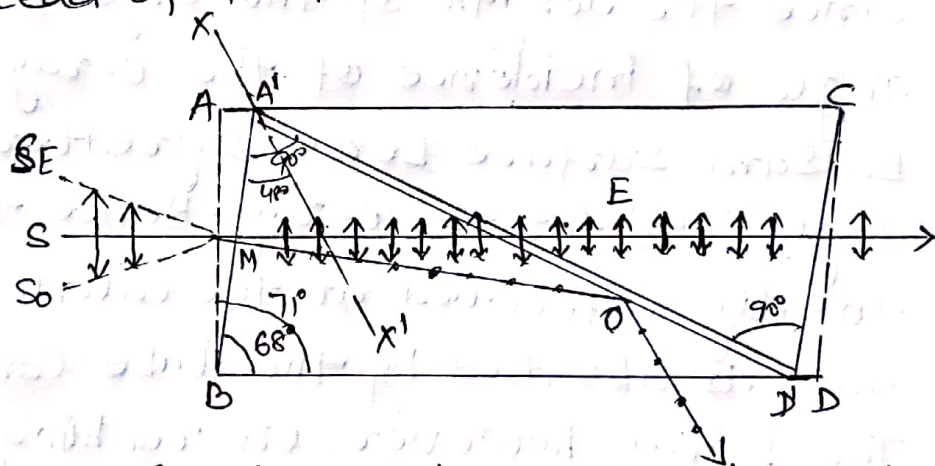


Nicol's prism

Nicol's prism:— It is an optical device made from calcite crystal for producing and analysing plane-polarised light.

Construction:— A calcite crystal ABCD about three times as long as it is wide is taken. Its end faces AB and CD are cut such that the angles in the principal section become 68° and 112° instead of 71° and 109° .



The crystal is then cut apart along the plane $A'D'$ perpendicular to both the principal section and the end faces $A'B'$ and $C'D'$. The two cut surfaces are ground and polished optically flat. They are then cemented together by Canada balsam which is a transparent liquid of refractive index 1.55 for sodium light. The crystal is then enclosed in a tube blackened inside.

Action:— when a ray SM of unpolarised light nearly parallel to BD' is incident on the face

At B, it is split up into two refracted rays, the O-ray and E-ray. Both the rays are plane polarised. The O-ray has vibrations perpendicular to the principal section of the crystal while the E-ray has vibrations in the principal section.

Now the refractive index of Canada balsam is less than the refractive index of calcite for the O-ray (1.658), but greater than the refractive index ~~for~~ of calcite for the E-ray (1.486). Therefore when the O-ray reaches the layer of the Canada balsam, it is passing from an optically denser to rarer medium. Since the length of the crystal is large, the angle of incidence of the O-ray at the calcite-balsam surface becomes greater than the critical angle (69°) for the O-ray. Hence the O-ray is totally reflected at the calcite-balsam surface and is absorbed by the tube containing the crystal. The E-ray however, on reaching the calcite-balsam surface passes from a rarer to a denser medium and is transmitted. Since the E-ray is plane polarised, the light emerging from the Nicol is plane-polarised with vibration parallel to the principal section. These vibrations are parallel to the shorter diagonal of the end face of the crystal.

Limitation:— The Nicol prism works only when the incident beam is slightly convergent or slightly divergent. If the incident ray makes

angle much smaller than SMB with the face $A'B$, the o-ray will strike the Calcite-balsam surface at an angle less than the critical angle (69°). Therefore the o-ray will also be transmitted and the light emerging from the Nicol will not be plane-polarised.

If the incident ray makes an angle much greater than SMB , the E-ray will become more and more parallel to the optic axis xx' so that its refractive index will increase and become greater than that of balsam. Then the E-ray will also be totally reflected from the Calcite-balsam surface and no light will emerge from the Nicol. Hence to obtain plane-polarised light, the incident beam should not be too wide. With the dimensions chosen, the semi-vertical angle of the cone of incident light, SMB , should not exceed 14° .

The Nicol prism can be used both as a polariser and as an analyser.