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Polarimetry

Polarimetry was discovered by Étienne-Louis Malus, a French engineer who was studying reflective glass. Several years later another Frenchman, Jean-Baptiste Biot, found that molecules such as sugar could rotate polarized light as well.

Optical rotation and Specific rotation

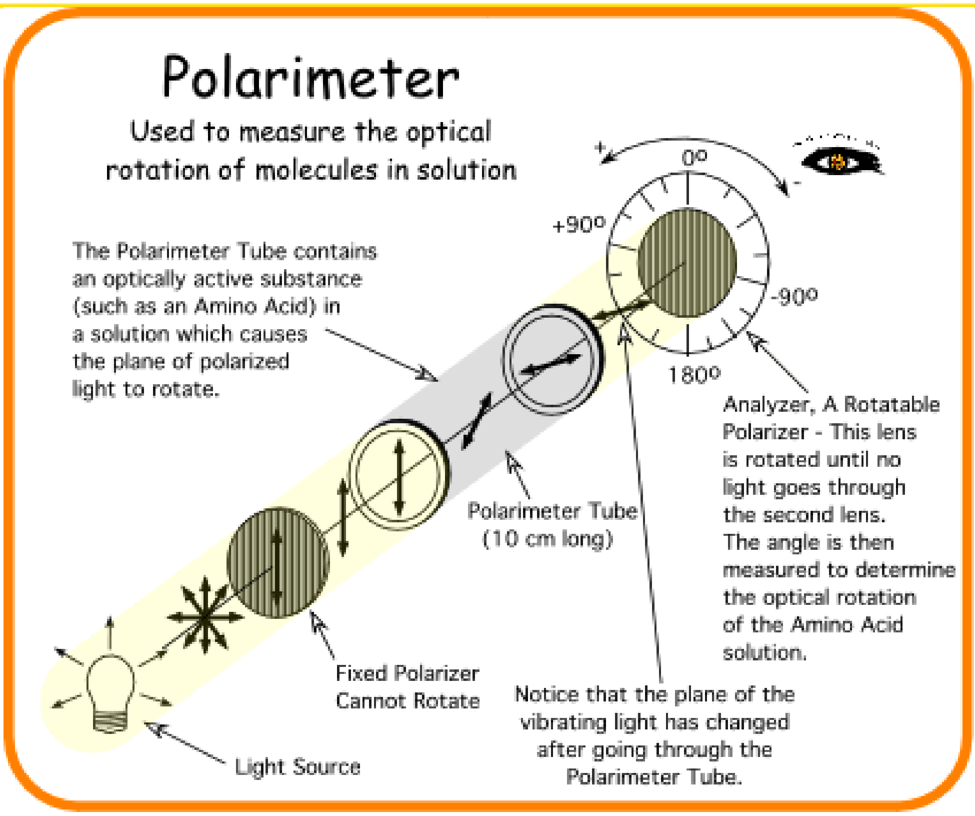
Many substances possess the inherent property to rotate the plane of incident polarized light; this property is called optical activity.

Optical rotation

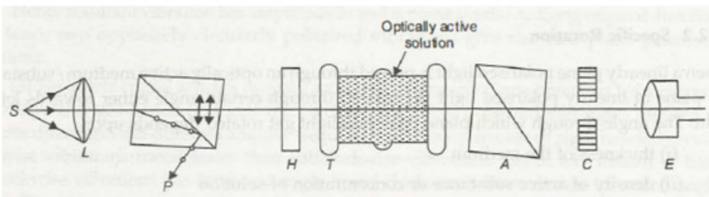
The optical rotation is the angle through which the plane of polarization is rotated when polarized light passes through a layer of a liquid. Substances are described as dextrorotatory or levorotatory according to whether the plane of polarization is rotated clockwise or counterclockwise, respectively, as determined by viewing towards the light source. Dextrorotation is designated (+) and levorotation is designated (-)

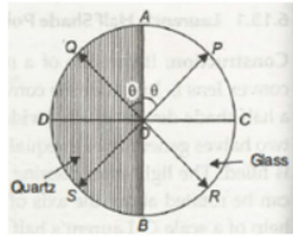
Specific rotation

The specific optical rotation of a liquid substance is the angle of rotation measured as specified in the monograph, calculated with reference to a layer 100 mm thick, and divided by the relative density (specific gravity) measured at the temperature at which the rotation is measured.



Half Shade Polarimeter

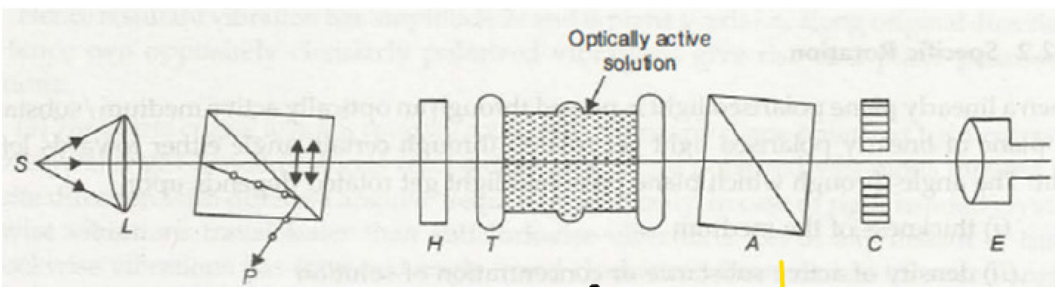


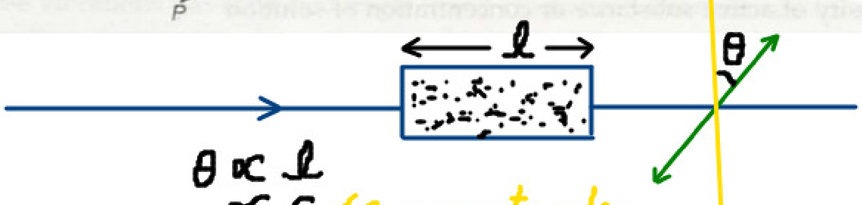


This polarimeter consists of a collimated linearly polarized light source (S, L and P) that is passed through the sample tube T (which will rotate the polarization if the sample is optically active), and then polarized (A) and seen through a telescope E.

The half-shade H goes between the polarized light source and the sample, and it consists of two half-disks of equally absorptive material. One half, ACB, is glass, and it lets the polarized light pass through unchanged. The other half, ADB, is made of quartz, with the optical axes along AOB and DOC, and it is cut to half-wave-plate thickness; in essence, this means that if the original polarization was along SOP, in the quartz half it gets reflected over into ROQ, i.e. orthogonal to SOP.

Specific Rotation





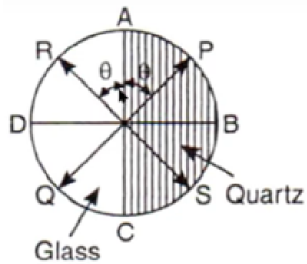
$\theta \propto l$

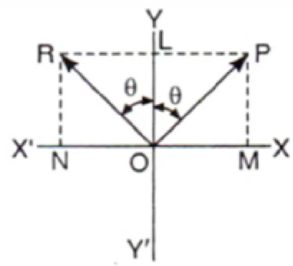
$\propto C$ (Concentration of Solution)

$\theta \propto l.c$

$\theta = \delta l c \rightarrow \boxed{\delta = \frac{\theta}{lc}}$ $\frac{deg.}{dm \times g/cm^3}$

δ = Specific Rotation





Laurent's half-shade plate consists of a semi-circular half-wave plate ABC of quartz and a semi-circular glass plate ADC. The quartz part is cut parallel to optical axis, so that it introduces a phase change of 180 deg. between e-ray and o-ray and path difference of ($\lambda/2$).

Application: **Determination of specific rotation of an optically active solution.**

(i) First, fill polarimeter tube with water and rotate nicole prism in a way that the intensity from both semi-cirular parts be same.

(ii) Then, fill this tube with sugar solution and rotate prism in a way that the intensity from both semi-circular parts be same.

(iii) Measure angle (θ) between first and second positions.

(iv) Calculate specific rotation using its formula. Take different readings.

$$S = \frac{\theta}{l \cdot C}$$