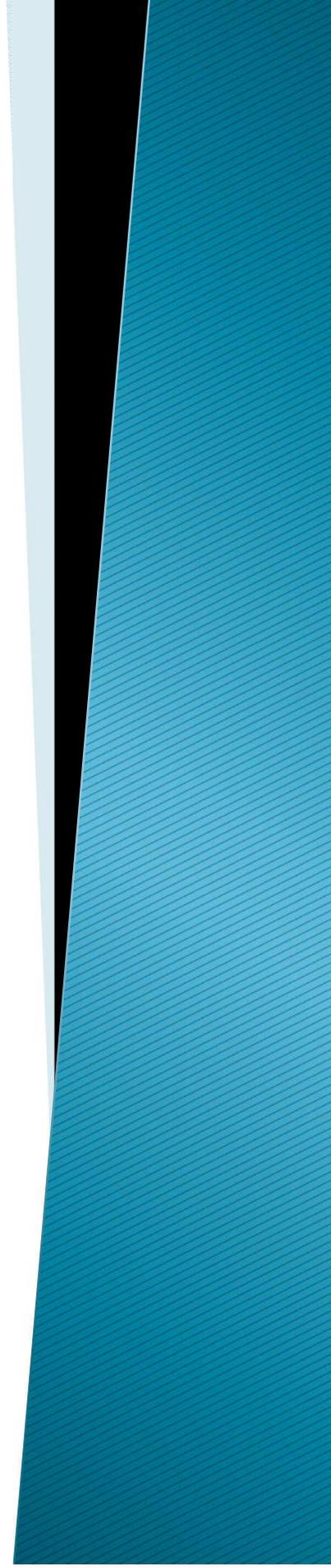


Polarization Practice Problems



Problem #1

Most portable radios have a vertically extendable stick aerial of a metre or so in length to receive signals. TV aerials can have many short horizontal rods attached to them. Explain why the orientations are different.



Answer #1

The local radio wave is vertically polarized for its electric vector, whereas the local TV signal is horizontally polarized.



Problem #2

What must plastic under stress be doing to light to enable passage through crossed Polaroid filters? How can this be used for stress analysis?



Answer #2

The stressed plastic must be rotating the polarization direction of the polarized light.



Problem #3

What determines this amount of rotation?



Answer #3

The amount of stress determines the amount of rotation, increasing the stress slowly moves the bands.



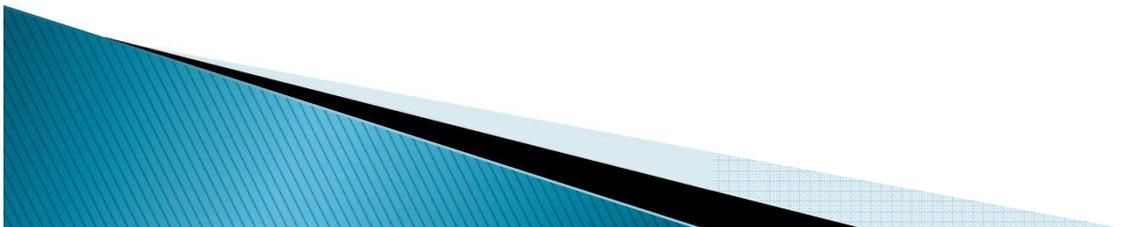
Problem #4

Sugar solution has the ability to rotate the direction of polarization of light depending on the concentration of the solution. Suggest how this could be used in a sugar factory to test the strength of a sugar solution.



Answer #4

Place the solution in a standard rectangular cell between crossed polarizing filters. Some light will pass due to the rotation of the polarization by the sugar solution. If the second polarizing filter is rotated until the light is obscured, the angle through which the filter is rotated is a measure of the degree of rotation and hence of the strength of the solution. (In fact these polarimeters show a good linear response. Sugar is optically active because of asymmetry in its molecular shape – some sugars rotate to the right and some to the left – nature's sugar molecules seem to prefer one sense of rotation!)



Problem #5

If a liquid crystal display on a watch, calculator or laptop computer is viewed through a polarizing filter, the display can be extinguished for certain orientations of the filter. What does this tell you about the construction of such devices?



Answer #5

The displays must already incorporate another polarizing filter, or they produce polarized light.



Problem #6

Unpolarized light passes through two Polaroid filters aligned at 60° to each other. Calculate the intensity of the emerging light.



Answer #6

The intensity is reduced by $\frac{1}{2}$ as it passes through the first Polaroid. The light passing through the second is reduced by

$$I_1 = \frac{1}{2} I_0$$

$$I_2 = I_1 (\cos 60^\circ)^2 = \frac{1}{4} I_1 = \frac{1}{8} I_0$$



Problem #7

If two Polaroid sheets are placed at 90° to each other, what will happen to the intensity of the emerging light if another sheet is placed at 45° between them?



Answer #7

The first polarizer changes the light into plane polarized and reduces the intensity I_0 to $I_1 = \frac{1}{2} I_0$. The second reduces the intensity by $(\cos 45^\circ)^2 = \frac{1}{2} I_1 = \frac{1}{4} I_0$. The light leaving the second polarizer is plane polarized at 45° so the third one reduces the intensity by another $\frac{1}{2}$. The emerging light is $\frac{1}{8}$ of the original.



Problem #8

At what angle should two Polaroids be placed to reduce the intensity of the light to $1/10$?



Answer #8

$$I_1 = \frac{1}{2} I_0$$

$$I_2 = \frac{1}{2} (\cos x^\circ)^2 = 1/10$$

$$(\cos x^\circ)^2 = 0.2$$

$$\cos x = \sqrt{0.2} = \underline{63.4^\circ}$$



Problem #9

Calculate Brewster's angle for lead crystal glass with a refractive index of 1.72.



Answer #9

$$n_2 = \tan \theta_p$$

$$\tan^{-1} \theta_p = 1.72$$

$$\theta_p = \underline{59.8^\circ}$$



Problem #10

What is Brewster's angle for a ray of light in water ($n = 1.33$) that is reflected off a submerged diamond ($n = 2.42$)?



Answer #10

$$n_2/n_1 = \tan \theta_p$$

$$\tan^{-1} \theta_p = 2.44/1.33$$

$$\theta_p = \underline{61.2^\circ}$$

