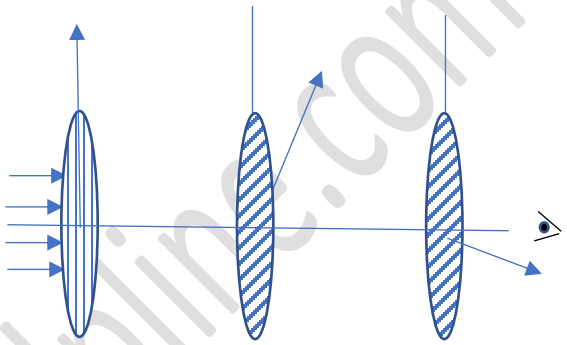
Q- Un-polarized light enters a series of three polarizers. The axis of polarization of second makes an angle of 60 degree with that of second and the angle between the axis of second and third is 45 degree. What percentage of the initial intensity of light is transmitted through the system of polarizers?

Solution:

The question is based on the Malus' law according to which when a linearly polarized light is passed through an analyzer the intensity of the light varies as

$$I = I_0 \cos^2 \theta$$

Here θ is the angle between the direction of polarization of incident beam and the axis of polarization of the analyzer.



Let the intensity of the incident un-polarized beam is I_0.

As for any direction, the intensity of the transmitted light is proportional to $\cos^2 \theta$, and average value of $\cos^2 \theta$ over θ is 0.5, the intensity of the wave transmitted from the first polarizer is $I_1 = 0.5\ I_0$.

Now the transmitted beam is linearly polarized in the direction parallel to the axis of the first polarizer.

As this polarized beam is again incident on the second polarizer whose axis is making angle 60 degree with the direction of polarization of incident beam the intensity of wave after transmission from the second polarizer (analyzer) is given by Malus' law as

$$I_2 = I_1 \cos^2 60^0 = 0.5\, I_0 * \cos^2 60 = 0.5 * 0.25\, I_0 = 0.125\, I_0$$

And similarly

$$I_3 = I_2 \cos^2 45^0 = 0.125\, I_0 * \cos^2 45 = 0.125 * 0.5\, I_0 = 0.0625\, I_0$$

Hence percent of the light transmitted from the system will be

$$= 0.0635 * 100 = 6.25\ \%$$