699.

Problem 48.20 (RHK)

We have to find the greatest number of quarter-wave plates, to be used with the light of wavelength 488 nm, which could be cut from a dolomite crystal 0.250 mm thick.

Solution:

For a dolomite crystal the refractive indices for the ordinary and the extraordinary rays are $n_o = 1.681$ and $n_e = 1.500$, respectively.

As we want to cut greatest number of quarter-wave plates from the given thickness of the crystal, we will determine the minimum thickness of the crystal which will produce a phase difference of $\pi/2$ in a linearly polarized ray after it has passed through the crystal. We assume that the faces of the crystal are parallel to the optic axis. Let *x* be the thickness of the crystal which will result in a phase difference of $\pi/2$ between the *o*-rays and *e*-rays.

We thus have the following equation from which x can be found:

$$\frac{2\pi x}{\lambda}\left(n_o - n_e\right) = \frac{\pi}{2},$$

or

$$x = \frac{\lambda}{4} \times \frac{1}{\left(n_o - n_e\right)} = \frac{488}{4 \times \left(0.181\right)} \text{ nm} = 674 \text{ nm}.$$

Therefore, the greatest number of quarter-wave plates that can be cut from a dolomite crystal of thickness 0.250 nm will be

$$N = \frac{0.250 \text{ mm}}{674 \times 10^{-6} \text{ mm}}; \ 370.$$