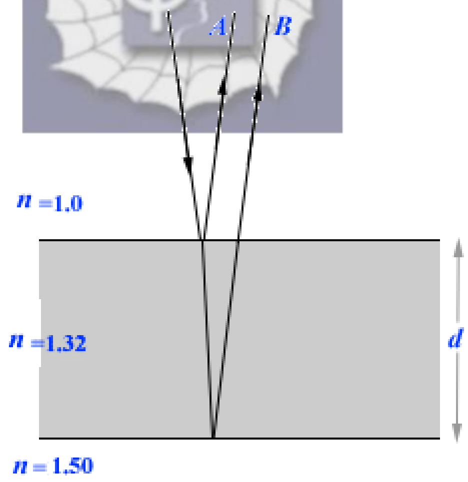
639.

<u>Problem 45.33 (RHK)</u>

A plane wave of monochromatic light falls normally on a uniformly thin film of oil that covers a glass plate. The wavelength of the source can be varied continuously. Complete destructive interference of the reflected light is observed for wavelengths of 485 *and* 679 nm *and for no wavelengths between them. If the index of refraction of the oil is* 1.32 *and that of the glass is* 1.50, *we have to find the thickness of the film.*



<u>Solution:</u>

Both rays A and B undergo one reflection each from the interface of media with different refractive indices, the refractive index of the transmitted ray side being more than of the incident ray side. Therefore, both rays undergo additional phase change of π. Let the thickness of the oil film be *d*. The condition of destructive interference of rays *A* and *B* is

$$\frac{2\pi}{\lambda_{n_2}} \times 2d = (2m+1)\pi, \ \mathrm{m} = 0,1,2,3..$$

$$\therefore \ d = \frac{(2m+1)\lambda}{4\times 1.32}.$$

It is given that complete destructive interference of the reflected light is observed for wavelengths of 485 and 679 nm and for no wavelengths between them. We therefore construct the set of values of *d* for wavelengths of 485 and 679 nm and find their intersection.

$$d_{485\text{ nm}} = \frac{(2m+1)\times 485}{4\times 1.32} \text{ nm, for } m = 0,1,2,3...$$

$$= \{91.8,\ 275.5,\ 459.3,\ 642.9,..\} \text{ nm.}$$

And,

$$d_{679\text{ nm}} = \frac{(2m+1)\times 679}{4\times 1.32} \text{ nm, for } m = 0,1,2,3...$$

$$= \{128.5,\ 385.7,\ 642.9,..\} \text{ nm.}$$

Therefore,

$$d_{485\text{ nm}} \cap d_{679\text{ nm}} = 642.9 \text{ nm.}$$

The thickness of the oil film is 642.9 nm.