690.

Problem 48.3 (RHK)

A beam of unpolarized light of intensity 12.2 mW m^{-2} *falls at normal incidence upon a polarizing sheet*. (a) *We have to find the maximum value of the electric field of the transmitted beam*; *and* (c) *calculate the radiation pressure exerted on the polarizing sheet*.

Solution:

(a)

When unpolarized light passes through a polarizing sheet its intensity is halved. Therefore, the intensity of the beam after its transmission from the polarizing sheet will be

$$I_{pol} = 6.1 \text{ mW m}^{-2}.$$

We recall that the intensity I of a wave and the maximum value of its electric field are related by the equation

$$I = \frac{1}{2\mu_0 c} E_m^2.$$

Therefore, the maximum value of the electric field of the transmitted beam will be

$$E_m = \left(2\mu_0 cI\right)^{1/2}$$

$$= \left(2\times1.26\times10^{-6}\times3\times10^{8}\times6.1\times10^{-3}\right)^{1/2} \text{ N C}^{-1}$$

$$= 2.14 \text{ V m}^{-1}.$$

(b)

The radiation pressure exerted on the polarizing sheet will be given by the amount of energy absorbed per second per square meter divided by the speed of light. Therefore, the pressure exerted on the polarizing sheet by the incident radiation will be

$$P_{rad} = \frac{6.1\times10^{-3}}{3\times10^{8}} \text{ Pa} = 20.3\times10^{-12} \text{ Pa} = 20.3 \text{ pPa}.$$