Modern Optics: Homework 6

Due: 4 September 2015

1 Bennett, *Principles of Physical Optics*, 2.15, page 42.

2 Bennett, *Principles of Physical Optics*, 2.24, page 51.

3 Bennett, *Principles of Physical Optics*, 2.26, page 51.

4 Bennett, *Principles of Physical Optics*, 2.27, page 51. An isotropic point source produces spherical waves.

5 Energy and complex representations of harmonic waves

Consider the harmonic electromagnetic waves described by

$$\mathbf{E}(\mathbf{r}, t) = \tilde{\mathbf{E}}_0 \, e^{i(\mathbf{k}\cdot\mathbf{r} - \omega t)}.$$

a) Suppose that $\tilde{\mathbf{E}}_0$ is real. Show that the irradiance associated with this is

$$I = \frac{1}{2} \, c\epsilon_0 \mathbf{E}(\mathbf{r}, t)^* \cdot \mathbf{E}(\mathbf{r}, t).$$

b) It is possible to have complex $\tilde{\mathbf{E}}_0 = \mathbf{E}_0 e^{i\varphi}$ where $\mathbf{E}_0$ is real. Here φ represents the phase of the wave. Show that the irradiance associated with this is also

$$I = \frac{1}{2} \, c\epsilon_0 \mathbf{E}(\mathbf{r}, t)^* \cdot \mathbf{E}(\mathbf{r}, t).$$

6 Bennett, *Principles of Physical Optics*, 3.37, page 116.

7 Light passing through a prism

A beam of light traveling through air is incident upon one surface of a triangular prism, which forms an equilateral triangle. Suppose that the angle between the incident beam and the prism surface is 40° and that the index of refraction of the prism material is 1.50. Determine the direction in which the beam eventually emerges from the prism.