Homework # 4
due Wednesday Oct 20 at 5PM

Reading: Hecht 3.1-3.5, 4.1-4.2

Problems:

1. (Hecht 5.84) It is determined that a patient has a near point at 50 cm. If the eye is approximately 2.0 cm long,
(a) How much power does the refracting system have when focused on an object at infinity? When focused at 50 cm?
(b) How much accommodation is required to see an object at a distance of 50 cm?
(c) What power must the eye have to see clearly an object at the standard near-point distance of 25 cm?
(d) How much power should be added to the patient's vision system by a correcting lens?

2. (Hecht 3.14) A light bulb puts out 20W of radiant energy (most of it IR). Assume it to be a point source and calculate the irradiance 1.00 m away.

3. Show that by assuming $\Psi(r,t) = \Psi(r)e^{2\pi i \nu t}$, where $\Psi(r,t)$ is a solution to the wave equation, one can arrive at the time-independent Helmholtz equation $\nabla^2\Psi(r) + k^2\Psi(r) = 0$, where $k = \dfrac{2\pi\nu}{c}$ is the wave number. Prove that a spherical wave (of the form $\Psi(r) = \dfrac{A_0}{r}e^{ikr}$) is a solution to the Helmholtz equation.

4. Two waves of the same amplitude, speed, and frequency travel together in the same region of space. The resultant wave may be written as a sum of the individual waves. $\Psi(y,t) = A\sin(ky+\omega t) + A\sin(ky-\omega t+\pi)$. With the help of complex exponentials, show that $\Psi(y,t) = 2A\cos(ky)\sin(\omega t)$.

5. Show that, in order to conserve flux, the amplitude of a cylindrical wave must vary inversely with $r^{1/2}$. A cylindrical wave is of the form $\Psi(r,t) = \dfrac{A_0}{\sqrt{r}}e^{ik(r-vt)}$

6. (Hecht 3.29) Derive an expression for the radiation pressure when the normally incident beam of light is totally reflected. Generalize this result to the case of oblique incidence at an angle θ with the normal.

7. (Hecht 3.32) A surface is placed perpendicular to a beam of light of constant irradiance (I). Suppose that the fraction of the irradiance absorbed by the surface is α. Show that the pressure on the surface is given by $\mathrm{P} = (2-\alpha)I/c$.

8. (Hecht 3.46) A lightwave travels from point *A* to point *B* in vacuum. Suppose we introduce into its path a flat glass plate (n_g=1.50) of thickness L = 1.00 mm. If the vacuum wavelength is 500 nm, how many waves span the space from *A* to *B* with and without the glass in place? What phase shift is introduced with the insertion of the plate?

9. What is the distance that yellow light travels in water in 1 s?