Physics 200 Problem Set 5

Problem 1

Estimate how many photons enter your eye per second if you are looking in the direction of the sun on a clear day. About how many photons per second enter your eye from the faintest stars visible at a dark site? Approximately how often would a photon enter your eye from one of the faintest stars visible using the Hubble Space telescope? Note: you'll probably need to look some things up for this one.

Problem 2

Given that accelerating charges radiate energy at a rate (in SI units) of

$$P = \frac{e^2 a^2}{6\pi\epsilon_0 c^3} \ ,$$

estimate the lifetime of a "classical" atom whose electron is initially in a circular orbit with radius $10^{-10}m$. (Hint: try to figure out an equation for how the radius R changes with time. To simplify things, you can assume that the acceleration and the energy at any time are those for a circular orbit).

Problem 3

In a given frame, a massless particle with energy E moves in some direction, and an observer is moving at speed v in a direction that makes an angle θ with the massless particle's direction. What energy does the observer see for the massless particle? If this massless particle is a photon, what is the observed wavelength in terms of the wavelength in the original frame.

Problem 4

Lucky Linda finds a shiny bar of metal one day. She brings it back to her lab and finds that she can produce photoelectrons using electromagnetic radiation with any wavelength less than 300nm. To get a good supply of photoelectrons, Linda uses a beam of electromagnetic radiation with wavelength 250nm. Later, Linda decides to adjust her beam to change the properties of the photoelectrons emitted. What can Linda do to

a) produce electrons at double the rate (with the same maximum velocity)?

b) produce electrons with double the maximum velocity?