(1) Electromagnetic radiation inside your eyeball consists ordinarily of two components: (a) 310 °K blackbody radiation and (b) visible photons that have entered through the pupil. In order of magnitude, what is the ratio of the total energy in the second form to that in the first when you have your eyes open in a well lighted room?

The power radiated by a surface at 310 °K is 5.7×10^{-5} $(310)^4$ erg cm^{-2} s^{-1}. The energy density is $4/c$ times this, or $2 \times 10^6/c$ erg cm^{-3}. The radiant energy inside the eyeball at any moment is $(2 \times 10^6/c)(\pi d^3/6)$, where d is the diameter of the eyeball. Suppose the room is lit by two 100-watt lamps, giving about 4 watts worth of visible photons. (That the efficiency, in this sense, of a tungsten lamp is about 2%, was mentioned in connection with Problem 1 for November.) One eye pupil, area approximately 0.1 cm^2, is no more or less likely to receive one of these photons than any patch of equal area in the room. The energy in visible light entering the pupil in one second is therefore, in order of magnitude, 4×10^7 erg $\times$ (0.1 cm^2/area of illuminated surfaces in the room). Let's take 10^5 cm^2 for the latter area. Then we have 40 ergs per second entering the pupil. Each photon spends about d/c seconds in the eyeball before it is absorbed at the retina. The energy in this form inside the eyeball at any moment is then $40\, d/c$. If $d = 3$ cm, this is between 10^{-5} and 10^{-6} of the energy in 310 °K blackbody radiation. When you turn out the lights you reduce the radiation incident on the retina by only a few parts in a million. Only quantum mechanics can explain why that makes it dark!