Sample Problems-Interstellar Medium

1. The luminosity of the central star $L_\nu$ is given by $A/\nu^1$. The photoionization cross section $a_\nu$ is given by $a_\nu = a_0/\nu^1$ for $\nu\geq\nu_0$. What is the rate of photoionization in $\text{cm}^3\text{s}^{-1}$ in a gas of density $n$ $\text{cm}^{-3}$? Ignore optical depth effects.

2. The rate of recombination in an ionized gas is $\alpha(T)n_e^2$ $\text{cm}^{-3}\text{s}^{-1}$ where $n_e$ is the electron density. If the ionization source is switched off at time $t_0$, when the electron density is $n_e(t = 0)$, how does $n_e$ vary with time?

3. A star lies at a distance of 500 pc and has a visual extinction of five magnitudes due to dust grains, assumed to be spherical with a radius of 500 nm. If the dust absorbs radiation with unit efficiency, what is the mean density of dust grains along the line of sight to the star?