1 (a) LOOK AT OSTERBROCK FIG 5.3: A [SII] FLUX RATIO OF 1.05 GIVES $\boxed{n_e = 5\times10^2\ cm^{-3}}$

(b) $n_e = 1.2 n_H$ IF $n_{He} = 0.1 n_H$, H AND He FULLY IONIZED

$n_O = 7\times10^{-4} n_H = \frac{7\times10^{-4}}{1.2} n_e$

MASS DENSITY → $\rho = n_H m_H + n_{He} m_{He} = n_H m_p + 0.1 n_H 4 m_p = 1.4 n_H m_p$

$$\underbrace{F_{\lambda5007} + F_{\lambda4959}}_{n_e \ll n_e(crit)} = \underbrace{\left[n_e n_{O^+} q(^3P, ^2D)\right]}_{\#\text{ EXCITATIONS TO } ^2D \text{ PER VOL PER TIME}} \underbrace{(Vol)}_{\text{VOLUME OF EMITING GAS}} \underbrace{(h\bar{\nu})}_{\text{ENERGY PER EMISSION}} \underbrace{\frac{1}{4\pi d^2}}_{\text{TO CONVERT LUMINOSITY TO FLUX}}$$

FOR THESE LINES, SO EVERY COLLISIONAL EXCITATION LEADS TO A RADIATIVE DE-EXCITATION

$$\frac{\text{ENERGY}}{\text{TIME}} = \text{LUMINOSITY}$$

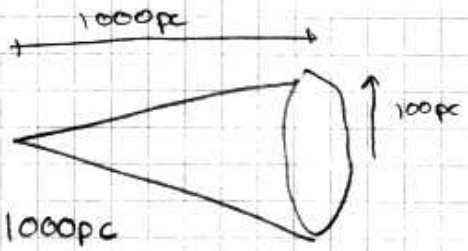
$$Vol = \frac{(F_{\lambda5007} + F_{\lambda4959})(4\pi d^2)}{\underbrace{\left(\frac{7\times10^{-4}}{1.2} n_e^2 \sqrt{\frac{2\pi}{kT}} \frac{\hbar^2}{m_e^{3/2}} e^{\frac{-hc}{kT(5000\text{Å})}} \frac{\Omega(^3P,^1D)}{\omega_{3P}}\right)}_{n_e n_{O^+} q} (h\bar{\nu})}$$

$\omega_{3P} = 9$; $h\bar{\nu} = \frac{hc}{A(5007)+A(4959)}\left[\frac{A(5007)}{5007\text{Å}} + \frac{A(4959)}{4959\text{Å}}\right]^{-1} = 4.0\times10^{-12}$ erg

PLUG IN: $Vol = 8.3\times10^{59}\ cm^3$

(c) VOLUME OF CONE

KATIE TOLD ME



$\frac{1}{3}\pi(100pc)^2\,1000pc$

$= 10^7\ pc^3 = 3.1\times10^{62}\ cm^3$

FILLING FACTOR $= \frac{8.3\times10^{59}}{3.1\times10^{62}} = 3\times10^{-3}$