Physics 441/541: Stars and Star Formation
Midterm Formulas March 8, 2022

In addition to this page, you are allowed one side of a letter-sized page for your own notes or formulas.

some possibly useful formulas

(for which I am on purpose not providing more details)

$$\frac{dP}{dr} = -\rho(r)\, g(r) = -\frac{Gm(r)\rho(r)}{r^2} \qquad \langle P\rangle = -\frac{1}{3}\frac{E_{\rm pot}}{V} \qquad T_c \sim \frac{GM\mu m_p}{kR} \qquad P_c \sim \frac{GM^2}{R^4}$$

$$B_\lambda(T) = \frac{2hc^2/\lambda^5}{\exp(hc/\lambda kT) - 1} \qquad F = \sigma T^4 \qquad L = 4\pi R^2 \sigma T_{\rm eff}^4 \qquad f = L/4\pi d^2 \qquad d = 1/p$$

$$m = -2.5\log(f/f_0) \qquad \mu = m - M = 5\log(d/10\ {\rm pc}) \qquad M_{\rm bol} = -2.5\log(L/L_\odot) + 4.74$$

$$P = K\rho^\gamma \qquad \gamma = 1 + 1/n \qquad R \propto M^{(1-n)/(3-n)} \qquad E_{\rm pot} = -\frac{3}{5-n}\frac{GM^2}{R}$$

$$P = \frac{1}{3}aT^4 \qquad P = nkT = \frac{\rho kT}{\mu m_p} \qquad P = \frac{h^2}{5m_e}\left[\frac{3}{8\pi}\right]^{2/3} n_e^{5/3} \qquad P = \frac{hc}{4}\left[\frac{3}{8\pi}\right]^{1/3} n_e^{4/3}$$

$$E_n = -13.6\ {\rm eV}\left(\frac{Z^2}{n^2}\right) \qquad g_n = 2n^2 \qquad \frac{n_m}{n_n} = \frac{g_m}{g_n}\exp\left(-\frac{E_m - E_n}{kT}\right)$$

$$\frac{n_{II}}{n_I} = \frac{2Z_{II}}{n_e Z_I}\left(\frac{2\pi m_e kT}{h^2}\right)^{3/2}\exp\left(-\frac{\chi_I}{kT}\right) \qquad \left|\frac{dT}{dr}\right| > \frac{\gamma-1}{\gamma}\frac{T}{P}\left|\frac{dP}{dr}\right| = \frac{\gamma-1}{\gamma}\frac{\mu m_p}{k}g$$

$$\ell = \frac{1}{n\sigma} = \frac{1}{\rho\kappa} \qquad \frac{dT}{dr} = -\frac{3}{4ac}\frac{\rho\kappa}{T^3}\frac{L}{4\pi r^2} \qquad E = \Delta mc^2 = \epsilon Mc^2 \qquad E_G = (\pi\alpha Z_A Z_B)^2\, 2m_r c^2$$

$$\text{probability} \approx \exp\left[-\left(\frac{E_G}{E}\right)^{1/2}\right] \qquad E_0 = \left[\frac{E_G(kT)^2}{4}\right]^{1/3} \qquad \alpha = \left(\frac{E_G}{4kT}\right)^{1/3} - \frac{2}{3}$$

$$R_{AB} = n_A n_B\left[\frac{8}{\pi m_r}\right]^{1/2}\left[\frac{1}{kT}\right]^{3/2}\int_0^\infty S(E)\exp\left[-\frac{E}{kT} - \left(\frac{E_G}{E}\right)^{1/2}\right]dE \qquad R_{AB} \propto T^\alpha$$

$$\frac{dm}{dr} = 4\pi r^2\rho \qquad \frac{dL}{dr} = 4\pi r^2\rho\epsilon \qquad \kappa_{\rm es} = \frac{n_e\sigma_T}{\rho} \approx 0.2(1+X)\ {\rm cm^2\ g^{-1}} \qquad L_{\rm Edd} = \frac{4\pi GMm_p c}{\sigma_T}$$

$$t_{\rm dyn} = \frac{1}{\sqrt{G\rho}} \qquad t_{\rm KH} = \frac{GM^2}{RL} \qquad t_{\rm nuc} = \frac{E_{\rm nuc}}{L} \approx \frac{f_M\epsilon Mc^2}{L} \qquad t_{\rm dyn} \ll t_{\rm conv} \ll t_{\rm KH} \ll t_{\rm nuc}$$