Stellar
Midterm Review Topics

Equations to memorize

$$F = \frac{L}{4\pi d^2} \tag{1}$$

$$d = \frac{1}{p[''']}\,\mathrm{pc} \tag{2}$$

$$L = L_\odot \left(\frac{M}{M_\odot}\right)^\alpha (\alpha \simeq 4) \tag{3}$$

$$m_1 - m_0 = -2.5 \log_{10}(F_1/F_0) \tag{4}$$

$$\frac{F_1}{F_0} = 10^{0.4(m_0 - m_1)} \tag{5}$$

$$M_1 - M_0 = -2.5 \log_{10}(L_1/L_0) \tag{6}$$

$$\frac{L_1}{L_0} = 10^{0.4(M_0 - M_1)} \tag{7}$$

$$m - M = 5 \log d - 5 \tag{8}$$

$$\lambda_{\max} = \frac{0.2898}{T(\mathrm{K})}\,\mathrm{cm} \tag{9}$$

$$L = A\sigma T^4 \tag{10}$$

$$\tau_\nu = \int \kappa_\nu \rho ds \tag{11}$$

$$\frac{dP}{dr} = -G\frac{M_r \rho(r)}{r^2} = -\rho g \tag{12}$$

$$\frac{dM_r}{dr} = 4\pi r^2 \rho(r) \tag{13}$$

$$\tau_{ff} \propto (G\rho)^{-1/2} \tag{14}$$

$$\lambda = \frac{1}{n\sigma}, \tag{15}$$

$$t \simeq \frac{1}{n\sigma v}, \tag{16}$$

$$\Omega = \alpha \frac{GM^2}{R}. \tag{17}$$

$$P = nkT. \tag{18}$$

$$P_{\mathrm{rad}} = 1/3 a T^4. \tag{19}$$

$$P = K_a \rho^{(\phi+1)/\phi} = K_a \rho^{\gamma_a}, \tag{20}$$

$$\kappa = \kappa_0 \rho^a T^b, \tag{21}$$

Equations I would give you

$$B_\nu = \frac{2h\nu^3}{c^2}\frac{1}{e^{h\nu/kT} - 1} \tag{22}$$

$$B_\lambda = \frac{2hc^2}{\lambda^5}\frac{1}{e^{hc/\lambda kT} - 1} \tag{23}$$

$$f(v) = \sqrt{\left(\frac{m}{2\pi kT}\right)^3}\, 4\pi v^2 e^{-\frac{mv^2}{2kT}} \tag{24}$$

$$\frac{n_i}{n_j} = \frac{g_i}{g_j} e^{-E_{\mathrm{ij}}/k\,T_{\mathrm{ex}}} \tag{25}$$

$$\frac{n_{i+1} n_e}{n_i} \simeq 2\left(\frac{2\pi m_e kT}{h^2}\right)^{3/2} \frac{g_{i+1}}{g_i} \exp\left[-\frac{\Phi_r}{kT}\right] \tag{26}$$

$$\frac{dL_r}{dr} = 4\pi r^2 \rho \epsilon \tag{27}$$

$$\left.\frac{dT}{dr}\right|_{\mathrm{rad}} = -\frac{3}{4ac}\frac{\bar{\kappa}\rho}{T^3}\frac{L_r}{4\pi r^2} \tag{28}$$

$$P_{\mathrm{e,deg}} = K_1' \left(\frac{\rho}{\mu_e}\right)^{5/3}, \tag{29}$$

$$P_{\mathrm{e,deg}} = K_2' \left(\frac{\rho}{\mu_e}\right)^{4/3}, \tag{30}$$

Units

Parallax
Apparent and absolute magnitudes

Stars

Ranges for physical properties
Spectral types
Lifetimes
H-R diagram

Blackbodies

Planck function
Colors, temperatures, and blackbodies

Stellar Equations

LTE
Mass conservation
Hydrostatic equilibrium
The Virial Theorem
Gravitational Potential
Timescales

Gas Physics

Equations of state
The pressure integral
Various pressures and when they are applicable
Ionization state (Saha)
Electronic state (Boltzmann)
The adiabatic exponent
Opacity
The temperature gradient

Fusion

Computing reaction rates
Proton-proton, CNO, triple alpha, with temperature scalings
r– and s–processes

Radiative Transfer

The equation of radiative transfer and its solutions
The linear absorption coefficient, emission coefficient, and optical depth
Kirchoff’s Laws
Line broadening
Equivalent width