# ASTR367
# Final Review Topics

## Equations to memorize

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

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

$$m_1 - m_0 = -2.5\log_{10}(F_1/F_0) \tag{3}$$

$$\frac{F_1}{F_0} = 10^{0.4(m_0 - m_1)} \tag{4}$$

$$M_1 - M_0 = -2.5\log_{10}(L_1/L_0) \tag{5}$$

$$\frac{L_1}{L_0} = 10^{0.4(M_0 - M_1)} \tag{6}$$

$$m - M = 5\log d - 5 \tag{7}$$

$$\lambda_{\mathrm{max}} = \frac{0.2898}{T(\mathrm{K})}\ \mathrm{cm} \tag{8}$$

$$L = A\sigma T^4\ (\mathrm{Stephan-Boltzmann;}\ \ A = 4\pi R^2\ \mathrm{for\ spheres}) \tag{9}$$

$$\tau_\nu = \int \kappa_\nu \rho ds \tag{10}$$

$$z = \frac{\Delta\lambda}{\lambda_0} = \frac{\Delta\nu}{\nu_0} = \simeq \frac{v_r}{c}\,. \tag{11}$$

$$R_s = \frac{2GM}{c^2} \tag{12}$$

$$P^2 = \frac{4\pi^2}{G(M+m)}a^3\,, \tag{13}$$

## Equations I would give you

$$B_\nu = \frac{2h\nu^3}{c^2}\frac{1}{e^{h\nu/kT} - 1} \tag{14}$$

$$B_\lambda = \frac{2hc^2}{\lambda^5}\frac{1}{e^{hc/\lambda kT} - 1} \tag{15}$$

$$f(v) = \sqrt{\left(\frac{m}{2\pi kT}\right)^3}\,4\pi v^2 e^{-\frac{mv^2}{2kT}} \tag{16}$$

$$\frac{n_i}{n_j} = \frac{g_i}{g_j}e^{-E_{\mathrm{ij}}/k\,T_{\mathrm{ex}}} \tag{17}$$

$$\frac{n_{i+1}n_e}{n_i} \simeq 2\left(\frac{2\pi m_e kT}{h^2}\right)^{3/2} \frac{g_{i+1}}{g_i} \exp\left[-\frac{\Phi_r}{kT}\right] \tag{18}$$

$$I_\nu(\tau_\nu) = I_\nu(0)e^{-\tau_\nu} + B_\nu(T)(1 - e^{-\tau}) \tag{19}$$

$$\frac{dP}{dr} = -G\frac{M_r\rho(r)}{r^2} = -\rho g \tag{20}$$

$$\frac{dM_r}{dr} = 4\pi r^2\rho(r) \tag{21}$$

$$\frac{dL_r}{dr} = 4\pi r^2\rho\epsilon \tag{22}$$

$$\frac{dT}{dr}_{\text{rad}} = -\frac{3}{4ac}\frac{\bar{\kappa}\rho}{T^3}\frac{L_r}{4\pi r^2} \tag{23}$$

$$\frac{dT}{dr}_{\text{conv}} = -\left(1 - \frac{1}{\gamma}\right)\frac{\mu m_H}{k}\frac{GM_r}{r^2} \tag{24}$$

$$(ds)^2 = \left(cdt\sqrt{1 - 2GM/rc^2}\right)^2 - \left(\frac{dr}{\sqrt{1 - 2GM/rc^2}}\right)^2 - (rd\theta)^2 - (r\sin\theta d\phi)^2\,, \tag{25}$$

$$\frac{m_2^3}{(m_1 + m_2)^2}\sin^3 i = \frac{P}{2\pi G}v_{1,\text{r}}^3\,. \tag{26}$$

$$T_{\text{disk}} = \left(\frac{GM_1\dot{M}}{8\pi\sigma R^3}\right)^{1/4} \tag{27}$$

$$L_{\text{disk}} = G\frac{M\dot{M}}{2R} \tag{28}$$

$$R_J \simeq \sqrt{\frac{kT}{G\mu\rho}}\,. \tag{29}$$

$$M_J = \left(\frac{5kT}{G\mu}\right)^{3/2}\left(\frac{3}{4\pi\rho}\right)^{1/2} \tag{30}$$

## Units

cgs vs SI
Degrees minutes seconds
Solid angle
Intensity, flux, luminosity definitions and their relationships to each other
Parallax
Apparent and absolute magnitudes
Astronomical filters and colors

## Blackbodies

Units of blackbodies
How filters and blackbodies interact for astronomical colors
Color-magnitude diagrams

## Stellar Spectra

Kirchoff's Laws
Optical depth
Sources of opacity
Maxwell-Boltzmann speed distribution
Boltzmann equation
Saha equation
Local Thermodynamic Equilibrium
Line Broadening mechanisms
Curve of growth and equivalent width

## Stars

Basic property ranges and reasons
Initial mass function
Spectral types
Mass-Luminosity relation
Metallicty definition
H-R diagram including accurate axes

## Stellar Interiors

Hydrostatic equilibrium
Eddington luminosity
Radiation vs. convection
Nucleosynthsis and main fusion reactions

## Star Formation

Jean’s mass/radius from hydrostatic equilibrium
Jean’s mass/radius from Virial theorem
Virial theorem itself
Free-fall time
Zero-age main sequence

## Stellar Evolution

Electron degeneracy pressure
Red giants, asymptotic giants, horizontal branch, planetary nebulae, white dwarfs

## Supernovae

Massive star evolution
Types of supernovae and their observables
Nucleosynthis in supernovae

## Stellar Pulsations

Types of variable stars and their basic characteristics
The period-luminosity relation for Cepheids
Pulsation rate dependence

## White Dwarfs

Basics of electron degeneracy pressure
Chandrasekhar mass limit
Basics of WD cooling

## Neutron Stars

NS spin rate and temperature derived from collapse
Pulsars, including how we can derive pulsar luminosity from rotational energy

## GR and Black Holes

Redshift definition
Gravitational redshift
Schwartzchild metric, and all the various situations
Schwatzchild radius
What happens as matter falls into a black hole
Hawking radiation

## Brown Dwarfs

Initial mass function
Rough sizes, temperatures, classes

## Binaries

Kepler's Laws
Spectroscopic binaries and the mass function
The light curves of eclipsing binaries
Lagrangian points
Accretion disks
Binary evolution for all stellar masses
Novae
Supernovae Type 1a

## The sun

Basic properties
Solar layer definitions and rough properties
Solar magnetic field and its effects
Sunspot cycles