———— CELESTIAL COORDINATES ————	
Law of Sines	$\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$
Law of Cosines	$\cos a = \cos b \cos c + \sin b \sin c \cos A$
Parallax	$\Delta\alpha = M + N \sin\alpha \tan\delta$ $\Delta\delta = N \cos\alpha$ *Where* $M = 1.28123T + 0.0003879T^2 + 0.00001$ $N = 0.55675T - 0.0001185T^2 - 0.000011$ $T = (t - 2000.0)/100$ where t is the date, in years
Distance travelled	$(\Delta\theta)^2 = (\Delta\alpha \cos\delta)^2 + (\Delta\delta)^2$
———— CELESTIAL MECHANICS ————	
Ellipse equations	$b^2 = a^2(1 - e^2)$ $r = \frac{a(1-e^2)}{1+e\cos\theta}$ $r = \frac{L^2/\mu^2}{GM(1+e\cos\theta)}$
Parabola, where p is min distance	$r = \frac{2p}{1+\cos\theta}$
Hyperbola	$r = \frac{a(e^2-1)}{1+e\cos\theta}$
Reduced mass	$\mu = \frac{m_1 m_2}{m_1+m_2}$ $M = m_1 + m_2$
Angular Momentum	$L = \mu\sqrt{GMa(1 - e^2)}$
Kepler's Second Law	$\frac{dA}{dt} = \frac{1}{2}\frac{L}{\mu}$
Perihelion-aphelion	$v_p^2 = \frac{GM}{a}\left(\frac{1+e}{1-e}\right)$ $v_a^2 = \frac{GM}{a}\left(\frac{1-e}{1+e}\right)$
Velocity	$v^2 = G(m_1 + m_2)\left(\frac{2}{r} - \frac{1}{a}\right)$

Kepler's Third Law	$P^2 = \frac{4\pi^2}{G(m_1+m_2)}a^3$
————— LIGHT —————	
Doppler Shift: Regular and relativistic	$\frac{\lambda_{obs}-\lambda_{rest}}{\lambda_{rest}} = \frac{\Delta\lambda}{\lambda_{rest}} = \frac{v_r}{c}$ $\lambda_{obs} = \lambda_{rest}\sqrt{\frac{1+v_r/c}{1-v_r/c}}$
Redshift Parameter	$z \equiv \frac{\lambda_{obs}-\lambda_{rest}}{\lambda_{rest}} = \frac{\Delta\lambda}{\lambda_{rest}}$ $z = \sqrt{\frac{1+v_r/c}{1-v_r/c}} - 1$ $z + 1 = \frac{\Delta t_{obs}}{\Delta t_{rest}}$
————— MAGNITUDE —————	
Parsec Distance: d in parsecs, p'' in arcseconds.	$d = \frac{1}{p''}$pc
Rayleigh Criterion: Angular resolution, in radians, wavelength, aperture	$\theta = 1.22\frac{\lambda}{D}$radians
Luminosity, Flux:	$F = \frac{L}{4\pi r^2}$
Magnitude Scale, where M_{Sun} = +4.74, L_{Sun} = 3.839*10^26, $F_{10,Sun}$ = 3.208*10^-10	$m - M = 5\log_{10}(d) - 5 = 5\log_{10}(\frac{d}{10pc})$ $M = M_{Sun} - 2.5\log_{10}(\frac{L}{L_{Sun}})$ $m = M_{Sun} - 2.5\log_{10}(\frac{F}{F_{10,Sun}})$
Magnitude Scale (reverse)	$d = 10^{(m-M+5)/5}$pc $\frac{L_2}{L_1} = 100^{(M_1-M_2)/5}$
Stefan-Boltzmann, where σ = 5.67*10^-8	$L = 4\pi R^2\sigma T_e^{\ 4}$
Bolometric Correction	$BC = m_{bol} - V = M_{bol} - M_V$
—————RELATIVITY —————	
Lorentz Factor	$\gamma = \frac{1}{\sqrt{1-u^2/c^2}}$ $\Delta t_{moving} = \gamma\Delta t_{rest}$ $x_{moving} = \frac{1}{\gamma}x_{rest}$

De Broglie Wavelength	$\lambda = \frac{h}{p}$
—————— **TELESCOPES, OPTICS** ——————	
Snell's Law	$n_1 \sin \theta_1 = n_2 \sin \theta_2$
Lensmaker's Formula: where n_λ is index of refraction, and R_1 R_2 are the radii of curvature, positive when convex and negative when concave	$\frac{1}{f_\lambda} = (n_\lambda - 1)(\frac{1}{R_1} - \frac{1}{R_2})$
Plate Scale: Angular separation vs linear separation	$\frac{d\theta}{dy} = \frac{1}{f}$
Focal Ratio: Telescopes are usually labeled in the form f/F	$F \equiv \frac{f}{D}$
Refracting telescopes	$angular\ magnification = \frac{f_{obj}}{f_{eye}}$
—————— **BINARY SYSTEMS** ——————	
Some equations, where d is the distance to the binary system, α_1 α_2 are measured in radians	$\frac{m_1}{m_2} = \frac{r_2}{r_1} = \frac{a_2}{a_1}$ $\alpha_1 \equiv \frac{a_1}{d}, \alpha_2 \equiv \frac{a_2}{d}$
Angle of inclination (0 = plane is orthogonal, 90 = plane is on line of sight)	$\frac{m_1}{m_2} = \frac{\alpha_2}{\alpha_1} = \frac{\alpha_2 \cos i}{\alpha_1 \cos i} = \frac{\beta_2}{\beta_1}$
Kepler's Third Law, where $\beta = \beta_1 + \beta_2$	$m_1 + m_2 = \frac{4\pi^2}{G}\frac{(\alpha d)^3}{P^2} = \frac{4\pi^2}{G}(\frac{d}{\cos i})^3 \frac{\beta^3}{P^2}$
Mass Function, when i is not known, $3\pi/16$ is a reasonable estimate for $\sin^3 i$	$\frac{m_2^3}{(m_1+m_2)^2}\sin^3 i = \frac{P}{2\pi G} v_{1r}^3$
Eclipsing Binaries—brightness: where B is brightness (basically flux * area * constant) B_0 is when both are visible, B_p is primary minimum, B_s is secondary minimum.	$\frac{B_0 - B_p}{B_0 - B_s} = (\frac{T_s}{T_l})^4$
—————— **STARS** ——————	
Hydrostatic Equilibrium	$\frac{dP}{dr} = -G\frac{M_r \rho}{r^2} = -\rho g$
Mass conservation equation	$\frac{dM_r}{dr} = 4\pi r^2 \rho$
Radiation Pressure, a = 7.566*10^-16	$P_{rad} = \frac{1}{3} a T^4$
Radiative Temperature Gradient	$\frac{dT}{dr} = -\frac{3}{4ac}\frac{\kappa\rho}{T^3}\frac{L_r}{4\pi r^2}$
Adiabatic Temperature Gradient, where $\gamma \approx 5/3$	$\frac{dT}{dr} = (\frac{1}{\gamma} - 1)\frac{\mu m_H}{k_b}\frac{GM_r}{r^2}$

Magnetic Energy Density	$u_m = \frac{B^2}{2\mu_0}$
Period-luminosity relation, where P_d is in days	$M_V = -[2.76(\log_{10}P_d - 1)] - 4.16$
————— **COSMOLOGY** —————	
Schwarzschild Radius	$R_s = 2GM/c^2$
Density, where ρ_0 is density today	$\rho(z) = \rho_0(1+z)^3$
Critical Density. $[\rho_{c,0}]_{WMAP} = 9.47 \times 10^{-27}$, and baryonic $[\rho_{b,0}]_{WMAP} = 4.17 \times 10^{-28}$	$\rho_c(t) = \frac{3H^2(t)}{8\pi G}$ $\rho_{c,0} = \frac{3H_0^2}{8\pi G}$
Density Parameter. The WMAP result for average density of baryonic and dark matter is $[\Omega_{m,0}]_{WMAP} = 0.27 \pm 0.04$. This corresponds to a mass density of $[\rho_{m,0}]_{WMAP} = 2.56 \times 10^{-28}$	$\Omega(t) \equiv \frac{\rho(t)}{\rho_c(t)} = \frac{8\pi G\rho(t)}{3H^2(t)}$ $\Omega_0 \equiv \frac{\rho_0}{\rho_{c,0}} = \frac{8\pi G\rho_0}{3H_0^2}$