FORMULA SHEET

Formulas

Circum. of circle	$C = 2\pi R$
Area of disk	$A = \pi R^2$
Surf. area of sph.	$S = 4\pi R^2$
Volume of sphere	$V = \frac{4}{3}\pi R^3$
Density of object	$\rho = M/V$
Small-angle form.	$\theta \approx D/d$
Force of gravity	$F = Gm_1m_2/d^2$
Ideal gas law	$P = nk_BT$
Kepler's 3rd law	$P^2 = a^3$
Newton's form	$P^2 = \frac{4\pi^2}{G(m_1+m_2)}a^3$
Convenient form	$\frac{m_1+m_2}{\mathrm{M}_\odot} = (\frac{a}{\mathrm{AU}})^3/(\frac{P}{\mathrm{yr}})^2$
Mass balance	$m_1r_1 = m_2r_2$
Momentum bal.	$m_1v_1 = m_2v_2$
Kinetic energy	$KE = \frac{1}{2}mv^2$
Mass-energy eq.	$E = mc^2$
Grav. pot. energy	$GPE = -Gm_1m_2/r$
Orbital energy	$E = KE + GPE$
Circ. orbit speed	$v_{\mathrm{circ}} = \sqrt{GM/R}$
Escape speed	$v_{\mathrm{esc}} = \sqrt{2GM/R}$
Orbital speed law	$v = \sqrt{GM_r/r}$, $M_r = rv^2/G$

Cluster gas temp.	$T \approx GMm_H/k_BR$
Cluster mass	$M = \langle v^2\rangle R/G$
Redshift	$z \equiv (\lambda_{\mathrm{obs}} - \lambda_{\mathrm{emit}})/\lambda_{\mathrm{emit}}$
Doppler shift	$z = v_{\mathrm{rad}}/c$ ($v_{\mathrm{rad}} \ll c$)
Wien's law	$\lambda_{\mathrm{max}} = (0.002898\ \mathrm{m\ K})/T$
Steph.-Boltz. law	$F_{\mathrm{emit}} = \sigma T^4$
Flux-lumin. rel.	$F_{\mathrm{obs}} = L/4\pi d^2$
Stellar lumin.	$L = 4\pi R^2\sigma T^4$
Parallax	$d = 1/p$, d in pc, p in arcsec
Mag. system	$m_2 - m_1 = 2.5\log_{10}(F_1/F_2)$
Distance mod.	$m - M = 5\log_{10}(d/10\ \mathrm{pc})$
Jeans mass	$M_J = (5k_BT/Gm_p)^{3/2}(3/4\pi\rho)^{1/2}$
Main seq. lifetime	$\tau \approx 1.0\times10^{10}(M/\mathrm{M}_\odot)^{-2.5}$ yr
Lorentz factor	$\gamma = 1/\sqrt{1 - v^2/c^2}$
Special relativity	$t = \gamma t_{\mathrm{prop}}$, $l = l_{\mathrm{prop}}/\gamma$, $m = \gamma m_{\mathrm{prop}}$
Schwarz. radius	$R_S = 2GM/c^2 \simeq 3(M/\mathrm{M}_\odot)$ km
Grav. redshift	$z = 1/\sqrt{1 - R_S/r} - 1 \simeq GM/c^2r$
Hubble's law	$v_r = H_0d$ or $d = cz/H_0$ ($z \ll 1$)
Eddington lumin.	$L_{\mathrm{Edd}} \simeq 30{,}000(M/\mathrm{M}_\odot)\ \mathrm{L}_\odot$
Cosmo. redshift	$z = R_{\mathrm{now}}/R_{\mathrm{then}} - 1$
Critical density	$\rho_{\mathrm{crit}} = 3H^2/8\pi G$

Units

Astronomical unit	$1\ \mathrm{AU} = 1.496\times10^{11}$ m
Light-year	$1\ \mathrm{ly} = 9.461\times10^{15}$ m $= 6.324\times10^4$ AU
Parsec	$1\ \mathrm{pc} = 3.086\times10^{16}$ m $= 3.262$ ly $= 2.063\times10^5$ AU
Year	$1\ \mathrm{yr} = 365.25\ \mathrm{d/yr}\times24\ \mathrm{h/d}\times60\ \mathrm{min/h}\times60\ \mathrm{s/min} = 3.15576\times10^7$ s
Degree of arc	$1^\circ = 60'$ (arcmin) $= 3600''$ (arcsec); $180^\circ = \pi$ rad
Electron-Volt	$1\ \mathrm{eV} = 1.602\times10^{-19}$ J

Quantities

Mass of Sun	$M_\odot = 1.989\times10^{30}$ kg
Radius of Sun	$R_\odot = 6.955\times10^8$ m
Effective temperature of Sun	$T_\odot = 5.778\times10^3$ K
Observed flux from Sun	$F_\odot = 1.361\times10^3$ W m^{-2} (app. mag. -26.7)
Luminosity of Sun	$L_\odot = 3.839\times10^{26}$ W (abs. mag. $+4.83$)
Mass of hydrogen atom	$m_{\mathrm{H}} = 1.674\times10^{-27}$ kg
Hubble constant	$H_0 = \sim 70$ km s^{-1} Mpc^{-1} $= 2.3\times10^{-18}$ s^{-1}

Metric Prefixes

n (nano)	10^{-9}
μ (micro)	10^{-6}
m (milli)	10^{-3}
k (kilo)	10^3
M (mega)	10^6
G (giga)	10^9
T (tera)	10^{12}

Constants

Speed of light	$c = 2.998\times10^8$ m s^{-1}
Gravitational constant	$G = 6.673\times10^{-11}$ m^3 kg^{-1} s^{-2}
Planck's constant	$h = 6.626\times10^{-34}$ m^2 kg s^{-1}
Stefan-Boltzmann constant	$\sigma = 5.670\times10^{-8}$ W m^{-2} K^{-4}
Boltzmann constant	$k_B = 1.381\times10^{-23}$ J K^{-1}