AY5, Summer Session I, 2008:
Constants, Equations, Conversion Factors

Draft 1: July 11, 2008

1. Common prefixes (http://physics.nist.gov/cuu/Units/prefixes.html)
   (a) Giga = 10^9 or billion; denoted as G (*e.g.*, 13.7 billion years = 13.7 Gyr).
   (b) Mega = 10^6 or million; denoted as M (*e.g.*, 100 million years = 100 Myr).
   (c) Kilo = 10^3 or thousand; denoted as k (*e.g.*, 11 kiloparsec = 11 kpc).
   (d) Centi = 10^{-2} or one-hundredth; denoted as c (*e.g.*, 3 centimeters = 3 cm)
   (e) Milli = 10^{-3} or one-thousandth; denoted as m (*e.g.*, 5 millimeters = 5 mm)
   (f) Micro = 10^{-6} or one-millionth; denoted as μ and sometimes called *micron* when modifying meters (*e.g.*, 24 micron = 24 μm).
   (g) Nano = 10^{-9} or one-billionth; denoted as n (*e.g.*, 10 nanoseconds = 10 ns).

2. Common measurement units:
   (a) Distance/length:
      i. 1 AU (astronomical unit) = 1.496×10^8 km (average distance between Earth and Sun)
      ii. 1 Å (Ångstrom) = 10 nm
      iii. 1 Ly (light-year) = 9.46×10^{12} km (distance light travels in a year in a vacuum)
      iv. 1 pc (parsec) = 3.09×10^{13} km
      v. 1 R_{SUN} (or $R_\odot$; solar radii) = 695,000 km
      vi. 1 R_{EARTH} (or $R_\oplus$; earth radii) = 6,378 km
      vii. z (redshift) = $\frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}} = \frac{v}{c}$,
      where $\lambda_{observed}$ is the observed wavelength, λ_{rest} is the at rest wavelength of the light, v is velocity, and c is the speed of light.
   (b) Mass:
      i. 1 M_{SUN} (or $M_\odot$; solar masses) = 2×10^{30} kg
      ii. 1 M_{EARTH} (or $M_\oplus$; solar masses) = 5.97×10^{24} kg
      iii. 1 u = 931.5 MeV/c^2

Particle	Mass		
	(kg)	(u)	(MeV/c^2)
Electron (e^-)	9.109×10^{-31}	5.486×10^{-4}	0.5109991
Proton (p^+)	1.672×10^{-27}	1.0073	938.2723
Neutron (n^0)	1.675×10^{-27}	1.0087	939.5656
Deuterium (D)	3.344×10^{-27}	2.0136	1875.6134
Helium-4 (^{4}He)	6.645×10^{-27}	4.0015	3727.3803

Table 1: From *Modern Physics, 2nd Ed.* by Kenneth Krane

   (c) Miscellaneous:

    i. c (speed of light) $= 3 \times 10^5$ km/s
    ii. X K + 273 K (Kelvin) $= X°$ C, where X is any number
    iii. 1 L_{SUN} (or $L_\odot$; solar luminosity) $= 3.8 \times 10^{26}$ watts (W), where 1 W = 1 joule/s (or J/s)
    iv. 1 J = 1 kg $m^2\,s^{-2}$
    v. 1 eV $= 1.602 \times 10^{-19}$ J
    vi. 1 Pa = 1 $N/m^2 = 9.87 \times 10^{-6}$ atm (pressure)
    vii. 1 N = 1 $kg\,m\,s^{-2}$

3. Useful constants and common symbols:
    (a) c (speed of light) $= 3 \times 10^5$ km/s
    (b) Wien's Law constant $\kappa = 2.898 \times 10^6$ nm K
    (c) Stefan-Boltzmann constant $\sigma = 5.67 \times 10^{-8}\,W\,m^{-2}\,K^{-4}$
    (d) Gravitational constant $G = 6.67 \times 10^{-11}\,m^3\,kg^{-1}\,s^{-2}$
    (e) Planck constant $h = 6.626 \times 10^{-34}\,J\,s = 4.136 \times 10^{-15}\,eV\,s$
    (f) Boltzmann constant $k = 1.381 \times 10^{-23}\,J/K = 8.617 \times 10^{-5}\,eV/K$
    (g) Hubble constant $H_0 = 70\,km\,s^{-1}\,Mpc^{-1}$
    (h) Solar units
        i. L_{SUN} (or $L_\odot$; solar luminosity) $= 3.8 \times 10^{26}$ watts (W), where 1 W = 1 joule/s (or J/s)
        ii. M_{SUN} (or $M_\odot$; solar masses) $= 2 \times 10^{30}$ kg
        iii. R_{SUN} (or $R_\odot$; solar radii) $= 695,000$ km
    (i) λ (wavelength)
    (j) Δ in front of a term indicates a change in the value. For example, ΔE indicates a change in energy.

4. Equations
    (a) Wien's Law: $\lambda_{peak} = \kappa T^{-1}$
    (b) Stefan-Boltzmann Law: $j = F = \sigma T^4$
    (c) Luminosity-flux relation: $L = A \cdot F$,
    where A is area, in general, and $L = 4\pi R^2 F$ for a sphere.
    (d) Wavelength-frequency relation $c = \lambda\nu$,
    where ν is the frequency in s^{-1} (or cycles per second) and λ is the wavelength in meters to get c in meters per second.
    (e) Photon energy: $E = h\nu = hc/\lambda$
    (f) Average kinetic (*i.e.*, motion) energy of particles: $E = k\,T$
    (g) Mass-energy equivalence: $E = m\,c^2$,
    where m is mass and c is the speed of light.
    (h) Hubble's Law: $v = H_0\,d$
    (i) Gravitational force: $F_{grav} = \frac{G\,M\,m}{r^2}$

(j) Pressure: $P = F/A$,
where F is a force and A is the area.

(k) Newton's version of Kepler's 3rd Law: $p^3 = \dfrac{4\pi^2}{G(M+m)}\, a^3$,
where p is the period of the orbit and a is the average distance between the two masses M and m.

(l) Ideal gas law (gas pressure): $P = n\,k\,T$,
where n is the number of particles per unit volume

(m) Radiation pressure: $P = F/c$,
where F is the flux.

(n) Generic magnitude (not necessarily apparent magnitude): $m_1 - m_2 = -2.5\log_{10}\left(\frac{F_1}{F_2}\right)$,
where object #1 has magnitude m_1 and flux F_1 and object #2 has magnitude m_2 and flux F_2.

(o) Absolute magnitude: $m - M = -5 + 5\log_{10} d$,
where m is the apparent magnitude and M is the absolute (intrinsic) magnitude of the same object and d is the distance from the observer to the object *in parsecs*.