   (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 \(\mu\) and sometimes called micron when modifying meters (e.g., 24 micron = 24 \(\mu\)m).
   (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) = \(1.496 \times 10^8\) km (average distance between Earth and Sun)
      ii. \(1\) Å (Ångstrom) = \(10\) nm
      iii. \(1\) Ly (light-year) = \(9.46 \times 10^{12}\) km (distance light travels in a year in a vacuum)
      iv. \(1\) pc (parsec) = \(3.09 \times 10^{13}\) km
      v. \(1\) R\(_{\odot}\) (or R\(_{\odot}\); solar radii) = 695,000 km
      vi. \(1\) R\(_{\oplus}\) (or R\(_{\oplus}\); earth radii) = 6,378 km
      vii. \(z\) (redshift) = \(\frac{\lambda_{\text{observed}} - \lambda_{\text{rest}}}{\lambda_{\text{rest}}} = \frac{v}{c}\),
          where \(\lambda_{\text{observed}}\) is the observed wavelength, \(\lambda_{\text{rest}}\) is the at rest wavelength of the light, \(v\) is velocity, and \(c\) is the speed of light.
   (b) Mass:
      i. \(1\) M\(_{\odot}\) (or M\(_{\odot}\); solar masses) = \(2 \times 10^{30}\) kg
      ii. \(1\) M\(_{\oplus}\) (or M\(_{\oplus}\); solar masses) = \(5.97 \times 10^{24}\) kg
      iii. \(1\) u = 931.5 MeV/c\(^2\)

<table>
<thead>
<tr>
<th>Particle</th>
<th>Mass</th>
<th>(kg)</th>
<th>(u)</th>
<th>(MeV/c(^2))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron (e(^-))</td>
<td></td>
<td>9.109 \times 10^{-31}</td>
<td>5.486 \times 10^{-4}</td>
<td>0.51099991</td>
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<tr>
<td>Proton (p(^+))</td>
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<td>1.672 \times 10^{-27}</td>
<td>1.0073</td>
<td>938.2723</td>
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<tr>
<td>Neutron (n(^0))</td>
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<td>1.675 \times 10^{-27}</td>
<td>1.0087</td>
<td>939.5656</td>
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<tr>
<td>Deuteron (D)</td>
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<td>3.344 \times 10^{-27}</td>
<td>2.0136</td>
<td>1875.6134</td>
</tr>
<tr>
<td>Helium-4 (^4He)</td>
<td></td>
<td>6.645 \times 10^{-27}</td>
<td>4.0015</td>
<td>3727.3803</td>
</tr>
</tbody>
</table>

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) = \( X^\circ C \), where \( X \) is any number

iii. \( 1 \text{LSUN} \) (or \( \text{L}_\odot \); solar luminosity) = \( 3.8 \times 10^{26} \) watts (W), where \( 1 \text{W} = 1 \text{joule/s} \) (or J/s)

iv. \( 1 \text{J} = 1 \text{kg m}^2 \text{s}^{-2} \)

v. \( 1 \text{eV} = \frac{1.602 \times 10^{-19}}{9.87 \times 10^{-1}} \text{J} \)

vi. \( 1 \text{Pa} = 1 \text{N/m}^2 \) (pressure)

vii. \( 1 \text{N} = 1 \text{kg m s}^{-2} \)

3. Useful constants and common symbols:

(a) \( c \) (speed of light) = \( 3 \times 10^5 \text{km/s} \)

(b) Wien’s Law constant \( \kappa = 2.898 \times 10^6 \text{nm K} \)

(c) Stefan-Boltzmann constant \( \sigma = 5.67 \times 10^{-8} \text{W m}^{-2} \text{K}^{-4} \)

(d) Gravitational constant \( G = 6.67 \times 10^{-11} \text{m}^3 \text{kg}^{-1} \text{s}^{-2} \)

(e) Planck constant \( h = 6.626 \times 10^{-34} \text{J s} = 4.136 \times 10^{-15} \text{eV s} \)

(f) Boltzmann constant \( k = 1.381 \times 10^{-23} \text{J/K} = 8.617 \times 10^{-5} \text{eV/K} \)

(g) Hubble constant \( H_0 = 70 \text{km s}^{-1} \text{Mpc}^{-1} \)

(h) Solar units

i. \( \text{LSUN} \) (or \( \text{L}_\odot \); solar luminosity) = \( 3.8 \times 10^{26} \) watts (W), where \( 1 \text{W} = 1 \text{joule/s} \) (or J/s)

ii. \( \text{MSUN} \) (or \( \text{M}_\odot \); solar masses) = \( 2 \times 10^{30} \) kg

iii. \( \text{RSUN} \) (or \( \text{R}_\odot \); solar radii) = 695,000 km

(i) \( \lambda \) (wavelength)

(j) \( \Delta \) in front of a term indicates a change in the value. For example, \( \Delta E \) indicates a change in energy.

4. Equations

(a) Wien’s Law: \( \lambda_{\text{peak}} = \kappa T^{-1} \)

(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 \( \nu \) is the frequency in \( s^{-1} \) (or cycles per second) and \( \lambda \) is the wavelength in meters to get \( c \) in meters per second.

(e) Photon energy: \( E = \hbar \nu = \frac{hc}{\lambda} \)

(f) Average kinetic (i.e., motion) energy of particles: \( E = k T \)

(g) Mass-energy equivalence: \( E = mc^2 \),
   where \( m \) is mass and \( c \) is the speed of light.

(h) Hubble’s Law: \( v = H_0 d \)

(i) Gravitational force: \( F_{\text{grav}} = \frac{GMm}{r^2} \)
(j) Pressure: $P = F/A,$
where $F$ is a force and $A$ is the area.

(k) Newton’s version of Kepler’s 3rd Law: $p^3 = \frac{4\pi^2}{G(M + m)} a^3,$
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.