A. SI Units

The System International (SI) was developed to reconcile differences in the way chemists and physicists use metric units. In SI units, the standard for mass is the kilogram and the standard for length is the meter the standard for volume is the cubic decimeter. These standards represent quantities that are larger than those usually encountered in the chemistry laboratory. In our class, we will continue to consider the gram as the standard for mass. We will use the meter as the standard for length, although most of the distances we will measure will be on the scale of centimeters or millimeters (see below). We will refer to the cubic decimeter by its more common name, the liter. Most of the volumes we encounter will be on the scale of milliliters.

B. Metric Prefixes

Various units in the metric system are related to one another through the use of prefixes, each of which has a specific numerical value. Some of the more commonly used prefixes and their numerical values (written in a variety of forms) are listed below.

<table>
<thead>
<tr>
<th>prefix</th>
<th>conventional</th>
<th>decimal</th>
<th>exponential</th>
</tr>
</thead>
<tbody>
<tr>
<td>kilo– (k)</td>
<td>1,000</td>
<td>-</td>
<td>$10^3$</td>
</tr>
<tr>
<td>hecto– (h)</td>
<td>100</td>
<td>-</td>
<td>$10^2$</td>
</tr>
<tr>
<td>deka– (da)</td>
<td>10</td>
<td>-</td>
<td>$10^1$</td>
</tr>
<tr>
<td>deci– (d)</td>
<td>1/10</td>
<td>0.1</td>
<td>$10^{-1}$</td>
</tr>
<tr>
<td>centi– (c)</td>
<td>1/100</td>
<td>0.01</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>milli– (m)</td>
<td>1/1000</td>
<td>0.001</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>micro– (µ)</td>
<td>1/1,000,000</td>
<td>0.000001</td>
<td>$10^{-6}$</td>
</tr>
<tr>
<td>nano– (n)</td>
<td>1/1,000,000,000</td>
<td>0.000000001</td>
<td>$10^{-9}$</td>
</tr>
<tr>
<td>pico– (p)</td>
<td>1/1,000,000,000,000</td>
<td>0.00000000001</td>
<td>$10^{-12}$</td>
</tr>
</tbody>
</table>
C. Conversions between Metric Prefixes

1 kilometer (km) = 10^3 meters (m)

0.001 km = 1 m

1 centimeter (cm) = 10^-2 meter (m)

100 cm = 1 m

1 milliliter (mL) = 10^-3 liter (L)

1000 mL = 1 L

Example 1: In the SI version of the metric system, 1L = 1 dm^3. Find the number of cubic centimeters in a milliliter.
(1 cubic centimeter = 1 cc = 1 cm^3)

Solution: 1L = 1 dm × 1 dm × 1 dm

but 1 dm = 10^-1 m

1L = 10^-1 m × 10^-1 m × 10^-1 m

and 10^-1 m = 10 (10^-2 m) = 10 cm

Thus,

1L = 10 cm × 10 cm × 10 cm

1L = 10^3 cm^3 = 1000 cc = 1000 mL

Exercise 1: Determine the number of iron atoms in regular cube that measures exactly 10 cm on an edge. The density of iron is 7.86 g/cm^3.

Answer: 8.47 × 10^{25} atoms
D. English System Conversions

Length

1 mile (mi) = 5,280 feet (ft)
1 yard (yd) = 3 feet (ft)
1 foot (ft) = 12 inches (in)

Weight

1 pound (lb) = 16 ounces (oz)

Volume

1 gallon (gal) = 4 quarts (qt)
1 quart (qt) = 2 pints (pt)
1 pint (pt) = 2 cups (cu)
1 cup (cu) = 8 fluid ounces (fl oz)

E. English Metric Conversions

1 in = 2.54 cm (exactly)
1 kg = 2.205 lb
1 L = 1.059 qt

Example 2: A child whose birth weight is below 2.5 kg is considered to be premature. Express the mass, 2.5 kg, in units of lb and oz.

Solution: 2.5 kg × (2.205 lb/kg) = 5.5 lb
0.5 lb × (16 oz/lb) = 8 oz

2.5 kg = 5.5 lb = 5 lb 8 oz

Exercise 2: If the thickness of a 500 page pamphlet is 1.00 inch, what is the thickness of one page of the book, in units of meters? of nanometers?

Answer: 5.08 × 10⁻⁵ m; 50,800 nm ( = 5.08 × 10⁴ nm)