### Prefixes of Ten

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Power of Ten</th>
</tr>
</thead>
<tbody>
<tr>
<td>mega-</td>
<td>10^9</td>
</tr>
<tr>
<td>kilo-</td>
<td>10^3</td>
</tr>
<tr>
<td>thou-</td>
<td>10^-3</td>
</tr>
<tr>
<td>milli-</td>
<td>10^-3</td>
</tr>
<tr>
<td>micro-</td>
<td>10^-6</td>
</tr>
</tbody>
</table>

Below is a table that we will use to express the size of things:

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Unit</th>
<th>Symbol</th>
<th>Prefix</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>weight</td>
<td>gram</td>
<td>g</td>
<td>milligram</td>
<td>10^-9</td>
</tr>
<tr>
<td>temperature</td>
<td>kelvin</td>
<td>K</td>
<td>kelvin</td>
<td>1</td>
</tr>
<tr>
<td>length</td>
<td>meter</td>
<td>m</td>
<td>meter</td>
<td>1</td>
</tr>
<tr>
<td>area</td>
<td>square meter</td>
<td>m²</td>
<td>square meter</td>
<td>1</td>
</tr>
<tr>
<td>volume</td>
<td>cubic meter</td>
<td>m³</td>
<td>cubic meter</td>
<td>1</td>
</tr>
<tr>
<td>power</td>
<td>watt</td>
<td>W</td>
<td>watt</td>
<td>1</td>
</tr>
<tr>
<td>rate</td>
<td>kilometer per hour</td>
<td>km/h</td>
<td>kilometer per hour</td>
<td>10^3</td>
</tr>
<tr>
<td>mass</td>
<td>kilogram</td>
<td>kg</td>
<td>kilogram</td>
<td>1</td>
</tr>
<tr>
<td>distance</td>
<td>meter</td>
<td>m</td>
<td>meter</td>
<td>1</td>
</tr>
</tbody>
</table>

**A.2 About Units**

In this book, we often have to use very large or very small numbers. To make these numbers easier to work with, we use prefixes that indicate how many units go into 1 unit of the base unit. For example, kilo- means 1,000 times larger than the base unit, so 1 kilometer is 1,000 meters. To express these numbers, we use powers of ten.

- **10^3** (one thousand) = 1,000
- **10^6** (one million) = 1,000,000
- **10^9** (one billion) = 1,000,000,000
- **10^-3** (one thousandth) = 0.001
- **10^-6** (one millionth) = 0.000001
- **10^-9** (one billionth) = 0.000000001

When expressing very large or very small numbers, we can use scientific notation. For example, we can write 1,000,000 as **1 × 10^6**.

**Example:**

- The population of the United States is approximately 300,000,000 people. In scientific notation, this is **3 × 10^8**.

Some numbers are so large or so small that it is difficult to express them conveniently by writing them out. In these cases, we use scientific notation. For example, the speed of light is approximately 300,000,000 meters per second, which can be written as **3 × 10^8** meters per second.
Figure A.3: Two electrons orbit a nucleus composed of protons and neutrons. The nucleus is composed of protons and neutrons, not electrons as shown in the right image.

A.3 ABOUT GRAPHS

Ice melts at 32°F and water boils at 212°F.

\[ T_{	ext{water}} = 1.8 \times T_{	ext{ice}} + 32 \]

To convert Fahrenheit to Celsius, the following equation is used:

\[ T_{	ext{Celsius}} = \frac{T_{	ext{Fahrenheit}} - 32}{1.8} \]

Temperature in Kelvins can be obtained from temperature in degrees Celsius by adding 273.15 for reference the melting temperature of ice is 273 K (0°C) and the boiling point of water is 373 K (100°C). To obtain temperature in Kelvin degrees Celsius.

Temperature in Kelvin refers to the absolute temperature scale, which is independent of any reference temperature.
The carbon ion (\(C_4^+\)) is a carbocation that is lost from the product of the above reaction, forming the carbocation. The reaction proceeds with the carbocation, forming the carbocation product, which is then converted back into the original (\(C_4O\)).

There is no net gain of mass in the above reaction. The barium acetate ion (\(Ba\text{[CH}_3\text{CO}_2\text{]}^+\)) is converted into a hydrogen ion (\(H^+\)) and a carbon atom (\(C\)). The barium acetate ion is a protonated form of the acetyl compound (\(HCOO\)).

\[\text{C}_4^+ + \text{H}_2\text{O}^+ \rightarrow \text{C}_4\text{O} \downarrow + \text{H}^+ \downarrow + \text{H}_2\text{O} \downarrow\]

In another organic chemical reaction, many marine plants and animals make carbon in the form of carboxylate esters in ocean water. The reaction begins with the formation of an ester in the presence of a strong base, forming a carbonic acid. The reaction proceeds as follows:

\[\text{C}_4^+ + \text{H}_2\text{O}^+ \rightarrow \text{C}_4\text{O} \downarrow + \text{H}^+ \downarrow + \text{H}_2\text{O} \downarrow\]

In the process of respiration, the carbon cycle runs from right to left, bringing the carbon back into the atmosphere. In this case, the reaction above proceeds from right to left, forming the carbocation and other products.
Solar energy reflected away/local solar energy impinging on planet = albedo of planet

Land area/earth area = fraction of the planet covered by land

Solar constant/area of earth = average intensity of radiation received by earth (W/m²)

Tons of fossil fuel used by the US/US population = average tons used per person

Billions of power products/tons of coal burned = power plant efficiency

Gallons of gas burned/miles driven = efficiency of car (mpg)

Money earned/hours worked = pay rate ($/hr)

Cost of gasoline/miles driven = cost per mile

Miles driven/time = speed (miles per hour)

Consider how this is the case in the following examples:

Quantities by themselves, we often derive an important system property that is not apparent from either of the quantities by themselves, we often derive an important system property. This is often the case. Thus, when we take the ratio of two properties in the system (in this case, the political system) that are no factors apart from each other, we get a system property. Notice that the answer above (77% of government spending went to schools) gives us a system property.

Using:

\[
\text{answer: } \frac{0.500\,000}{0.000\,000} = 0.077 \text{ (or 7.7%)}
\]

[Round to two significant figures]

Example:

\[
\text{What portion of the city budget went to schools?}
\]

Formula:

\[
\frac{\text{denominator}}{\text{numerator}} = \frac{q}{p} = \frac{y}{x}
\]

Ratio: ratio, division, "per" percent

Fractions