CH. 3.2

METRIC SYSTEM

SI measurement

• Le Système international d’unités
• The only countries that have not officially adopted SI are Liberia (in western Africa) and Myanmar (a.k.a. Burma, in SE Asia), but now those are reportedly using metric regularly
• Metrication is a process that does not happen all at once, but is rather a process that happens over time.
• Among countries with non-metric usage, the U.S. is the only country significantly holding out. The U.S. officially adopted SI in 1866.

Chemistry In Action

On 9/23/99, $125,000,000 Mars Climate Orbiter entered Mars’ atmosphere 100 km lower than planned and was destroyed by heat.

1 lb = 1 N
1 lb = 4.45 N

“This is going to be the cautionary tale that will be embedded into introduction to the metric system in elementary school, high school, and college science courses till the end of time.”
Standards of Measurement

When we measure, we use a measuring tool to compare some dimension of an object to a standard. For example, at one time the standard for length was the king’s foot. What are some problems with this standard?

Stating a Measurement

In every measurement there is a

- Number followed by a
- Unit from a measuring device

The number should also be as precise as the measurement!

UNITS OF MEASUREMENT

Use SI units — based on the metric system

- Length: Meter, m
- Mass: Kilogram, kg
- Volume: Liter, L
- Time: Seconds, s
- Temperature: Celsius degrees, °C, kelvins, K
Mass vs. Weight

• Mass: Amount of Matter (grams, measured with a BALANCE)
• Weight: Force exerted by the mass, only present with gravity (pounds, measured with a SCALE)

Can you hear me now?

Some Tools for Measurement

Which tool(s) would you use to measure:
A. temperature
B. volume
C. time
D. weight

Learning Check

Match L) length M) mass V) volume

M  A. A bag of tomatoes is 4.6 kg.
L  B. A person is 2.0 m tall.
M  C. A medication contains 0.50 g Aspirin.
V  D. A bottle contains 1.5 L of water.
**Metric Prefixes**

<table>
<thead>
<tr>
<th>Height</th>
<th>Volume</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>skyscraper</td>
<td>bottle</td>
<td>cat</td>
</tr>
<tr>
<td>0.35 kilometers</td>
<td>0.001 liters</td>
<td>8 kilograms</td>
</tr>
<tr>
<td>3.5 decameters</td>
<td>0.003 liters</td>
<td>50 kilograms</td>
</tr>
<tr>
<td>35 decimeters</td>
<td>0.2 liters</td>
<td>500 kilograms</td>
</tr>
<tr>
<td>350 centimeters</td>
<td>3 liters</td>
<td>5000 kilograms</td>
</tr>
<tr>
<td>3500 millimeters</td>
<td>2000 liters</td>
<td>500000 kilograms</td>
</tr>
</tbody>
</table>

- millimeters
- meters
- kilometers

- milligrams
- grams
- kilograms

- millimeters
- meters
- kilometers

- millimeters
- meters
- kilometers

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**Learning Check**

Select the unit you would use to measure:

1. Your height
   - a) millimeters
   - b) meters
   - c) kilometers

2. Your mass
   - a) milligrams
   - b) grams
   - c) kilograms

3. The distance between two cities
   - a) millimeters
   - b) meters
   - c) kilometers

4. The width of an artery
   - a) millimeters
   - b) meters
   - c) kilometers

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**Temperature Scales**

- Fahrenheit
- Celsius
- Kelvin

Anders Celsius

1701-1744

Lord Kelvin
(William Thomson)

1824-1907
### Temperature Scales

<table>
<thead>
<tr>
<th>Fahrenheit</th>
<th>Celsius</th>
<th>Kelvin</th>
</tr>
</thead>
<tbody>
<tr>
<td>212 °F</td>
<td>100 °C</td>
<td>373 K</td>
</tr>
<tr>
<td>180 °F</td>
<td>100 °C</td>
<td>100 K</td>
</tr>
<tr>
<td>32 °F</td>
<td>0 °C</td>
<td>273 K</td>
</tr>
</tbody>
</table>

Boiling point of water: 100 °C (100 K)
Freezing point of water: 0 °C (273 K)

Notice that 1 kelvin = 1 degree Celsius

### Calculations Using Temperature

- Generally require temp's in kelvins
- \( T (K) = t (^\circ\text{C}) + 273.15 \)
- Body temp = 37 °C + 273 = 310 K
- Liquid nitrogen = -196 °C + 273 = 77 K