Chemistry is the study of matter. Chemistry is the study of matter.

**Characteristics of matter**
- How can we describe it?

**Behavior of matter - changes**
- Chemical change – one substance is used to produce a new substance; matter changes its identity.
- Physical change – one substance changes appearance but keeps its identity.

**An Overview of the semester**

- Tools
  - Units & Prefixes
  - Scientific Notation
  - Dimensional Analysis

- Elements
  - The Periodic Table

- Atoms
  - Theories
  - Subatomic Particles
  - Groups and Subgroups
  - Electron Configurations
  - Periodic Law

- Molecules
  - Bond Formation

- Pure Substances
  - States of Matter
  - Energy
  - Ideal Gas Law
  - Types of Reactions

- Mixtures
  - Solutions
  - Osmosis
  - Acids & Bases
Objectives

- Be able to identify the SI Units of Measurement
- Be able to express a number in Scientific Notation
- Understand the SI/Metric unit prefixes and the relationships between the prefixes
- Use equalities and dimensional analysis to solve scientific problems.

Problems: 1.2, 1.5-1.12, 1.41-1.48, 1.53-1.66

Units of Measurement

- The metric system is the common system used around the world.
- The uniform accepted system of use is System International (SI)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Metric</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>Meter (m)</td>
<td>Meter (m)</td>
</tr>
<tr>
<td>Volume</td>
<td>Liter (L)</td>
<td>Cubic meter (m³)</td>
</tr>
<tr>
<td>Mass</td>
<td>Gram (g)</td>
<td>Kilogram (kg)</td>
</tr>
<tr>
<td>Time</td>
<td>Second (s)</td>
<td>Second (s)</td>
</tr>
<tr>
<td>Temperature</td>
<td>Celsius (°C)</td>
<td>Kelvin (K)</td>
</tr>
</tbody>
</table>

Metric Prefixes

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Symbol</th>
<th>Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>nano-</td>
<td>n</td>
<td>10⁻⁹</td>
</tr>
<tr>
<td>micro-</td>
<td>µ</td>
<td>10⁻⁶</td>
</tr>
<tr>
<td>milli-</td>
<td>m</td>
<td>10⁻³</td>
</tr>
<tr>
<td>centi-</td>
<td>c</td>
<td>10⁻²</td>
</tr>
<tr>
<td>deci-</td>
<td>d</td>
<td>10⁻¹</td>
</tr>
<tr>
<td>unit</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>deka-</td>
<td>da</td>
<td>10</td>
</tr>
<tr>
<td>kilo-</td>
<td>k</td>
<td>10³</td>
</tr>
<tr>
<td>mega-</td>
<td>M</td>
<td>10⁶</td>
</tr>
<tr>
<td>giga-</td>
<td>G</td>
<td>10⁹</td>
</tr>
</tbody>
</table>
**Metric Prefixes**

- Fill in the blanks with correct prefix
  - 1000 grams = _______ gram
  - .001 L = _______ L
  - .000000001 meter = _______ meter

- Fill in the blanks with the correct number
  - 1 megahertz = _______ hertz
  - 1 µs = _______ second

**Metric Conversions**

- To convert from one unit back to the base unit (i.e. from cm, to m), multiply by the factor given in the table.
- To convert from the base unit to one of the other units, divide by the factor given.
- Fill in the missing numbers
  - 10 cm = _______ m
  - 1000 µL = _______ L
- If this is not intuitive for you as well as for longer problems, use the factor label method we will discuss later.

**Scientific Notation**

- Sometimes numbers are not given in the metric system, or they are so large there are no prefixes for the unit
- Scientific or exponential notation is used to represent very large or very small numbers as powers of 10
  - 1,000 = 1x 10x 10 x 10 = 1x 10^3
  - 0.001 = 1/ 10/ 10 / 10 = 1/10^3 = 1x 10^-3
  - 5,000 = 
  - 5,500 = 5.5 x _______
Scientific Notation

Coefficient $6.2 \times 10^4$ Exponent

- The coefficient is written in the “ones” place followed by a decimal and the other digits in the number.
- The exponent tells how to move the decimal to make the final number
  - Positive exponent moves the decimal to the ___________
  - Gives what size number?
  - Negative exponent moves the decimal to the ___________
  - Gives what size number?
- What is the only way to represent a negative number?

Converting a number to scientific notation

- To make the coefficient, move the decimal to give a number between 1 and 10
  - 56,000 has a coefficient, 5.6
- The exponent is how many places you moved the decimal
  - 4 places
- Determine the sign of the exponent according to the original number
  - $>1$ positive exponent
  - $< 1$ negative exponent

Scientific Notation: Examples

- Write the numbers in ordinary notation
  - $7.0 \times 10^5$ grams
  - $2.3 \times 10^{-3}$ meters
- Write the numbers in scientific notation
  - 2,350,000 liters
  - 0.00045 mL
- Note that changing to scientific notation does not change the size of the number, so units do not change!
Scientific Notation: Examples

- Choose the largest number from the group below:
  - $7.5 \times 10^4$
  - $9.85 \times 10^3$
  - $7.5 \times 10^6$

- Choose the largest number below:
  - $8 \times 10^3$
  - $8 \times 10^{-5}$
  - $9 \times 10^{-6}$

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Metric & English Systems

<table>
<thead>
<tr>
<th>Table 1.7</th>
<th>Some Common Equalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>U.S.</td>
</tr>
<tr>
<td>Length</td>
<td>1 ft = 12 in.</td>
</tr>
<tr>
<td></td>
<td>1 yard = 3 ft.</td>
</tr>
<tr>
<td></td>
<td>1 mile = 5280 ft</td>
</tr>
<tr>
<td>Volume</td>
<td>1 gal = 4 quarts</td>
</tr>
<tr>
<td></td>
<td>1 pt = 2 pt.</td>
</tr>
<tr>
<td></td>
<td>1 gal = 4 pt.</td>
</tr>
<tr>
<td>Mass</td>
<td>1 lb = 16 oz</td>
</tr>
<tr>
<td></td>
<td>1 oz = 1 g</td>
</tr>
<tr>
<td>Time</td>
<td>1 hr = 60 min</td>
</tr>
</tbody>
</table>

- You don’t have to know these, but we will learn how to use them in conversions.

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Setting up Equalities and Conversion Factors

- Many problems involve changes in units.
- Equalities are used to make conversion factors.
  - a ratio, including units, used as a multiplier to change from one system or unit to another
  - Use any equality relationship as a ratio
Example

- We have already used some equalities in changing units within the metric system.
  - Example: How many milligrams are in 50 grams?
    Intuitively you probably say 50,000 mg.
    Equality: 1000 mg = 1g
    Conversion factor: 1000mg/1g
    (The Fraction is equal to 1 because numerator=denominator)

Problem Solving

- Determine what question is being asked
  - What final units are needed?
- What units are given?
- What is the relationship between the units given and the units needed?
- How do you need to write the conversion factor to give the units needed?
  - Factor label method or dimensional analysis

Example 2

- Convert 381 grams to pounds
  - Needed: lbs
  - Given: grams
  - Equality: 1 lb = 463.6 g
  - Conversion factor: 1lb/463.6 g

\[
381 \text{ g} \times \frac{1 \text{ lb}}{453.6 \text{ g}} = 0.840 \text{ lb}
\]

- Sometimes there won’t be a single equality to relate the two units.
Example 3

- Convert 1.844 gallons to milliliters

Make sure to use the factor label method to keep up with your units!

Multiple conversion factors: Example

- How long is a football field, from goal line to goal line in meters?
  - What are our starting and ending units?
  - What relationships can we form between them? (table 1.7)

Problem Solving with dimensional analysis

- A doctor prescribes 75 mg Effexor per day. How many 25 mg tablets are needed to fill a one month (30 day) prescription?
More problem solving

- You are asked to prepare five 1 liter bottles of saline. Your storage room contains gallon jugs of saline. How many jugs will you need to bring in to prepare the saline? How many 1 liter bottles will you be able to prepare from what you bring in?