2019-2020 1st Semester

Lecturers
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Text book:
GENERAL CHEMISTRY
Principles and Modern Applications
Eleventh Edition
Author team: PETRUCCI  HERRING  MADURA  BISSONNETTE

Reference Books:
CHEMISTRY: THE CENTRAL SCIENCE
Author team: BROWN - LEMAY - BURSTEN - MURPHY

Exam | Weight
--- | ---
1.Midterm | 30%
2.Midterm | 30%
Final | 40%

Nonattandance Limit ≤ 30 % !!!!!
Chapters:
- Chap 1: Matter–Its Properties And Measurement
- Chap 2: Atoms And The Atomic Theory
- Chap 3: Chemical Compounds
- Chap 4: Chemical Reactions
- Chap 6: Gases
- Chap 7: Thermochemistry
- Chap 12: Intermolecular Forces: Liquids And Solids
- Chap 13: Spontaneous Change: Entropy And Gibbs Energy
- Chap 14: Solutions And Their Physical Properties
- Chap 15: Principles Of Chemical Equilibrium
- Chap 16: Acids and Bases

Chapter 1
Matter–Its Properties And Measurement

Content of the Chapter
- Properties of Matter
- Classification of Matter
- Measurement of Matter: SI (Metric) Units
- Density and Percent Composition: Their Use in Problem Solving
Chemistry:

The study of matter, its composition and the changes it undergoes.

Matter:
Anything that has mass and takes up space.

Matter = combination of elements

- Atoms are the smallest building blocks of matter.

➢ Each different type of atom is the building block of a different chemical element.
A compound is made of two or more different kinds of elements.

In a molecule two or more atoms are joined in definite arrangement.

**Classification of Matter**

- According to State of Matter
- According to Composition

**1. According to States of Matter**

- **Gas**
  - Molecules apart from each other
  - Move rapidly
  - Colliding with others and wall of container
  - Compressible to smaller volume
  - Expand to larger volumes

- **Liquid**
  - Packed closely together
  - Still move rapidly
  - Its own volume is independent than container
  - No specific shape

- **Crystalline solid**
  - Tightly packed
  - Indefinite arrangement
  - definite shape
  - Definite volume

NOTE! Neither liquids nor solids can not be compressed to any appreciable extent
2. According to Composition

Properties of Matter

- Physical Properties:
  - Must be observed without changing composition.
    - Boiling point, density, mass, volume, color, odor, etc.
- Chemical Properties:
  - Can only be observed when a compound/element change its composition.
    - Flammability, corrosiveness, reactivity with acid, etc.
- Intensive Properties:
  - Independent of the amount of the matter that is present.
    - Density, boiling point, color, etc.
- Extensive Properties:
  - Dependent upon the amount of the matter present.
    - Mass, volume, energy, etc.

Changes of Matter

- Physical Changes:
  - Changes in matter that do not change the composition of a substance.
    - Changes of state, temperature, volume, etc.
- Chemical Changes:
  - Changes that result in new substances.
    - Combustion, oxidation, decomposition, etc.
  Example: \[ \text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O} \]
In the course of a chemical reaction, the reacting substances are converted to new substances.

Example: Which of the following is physical or chemical?

a) Evaporation of alcohol
b) Burning of lamp oil
c) Bleaching of hair with hydrogen peroxide
d) Forming of frost on a cold night
Two common unit systems are available:

- English System (in USA)
- Metric System (in the rest)

*Système International d’Unités* (International System of Units): is is abbreviated as *SI Unit*, based on metric unit system. Scientists use this system.

### Units of Measurement

**SI Units**

<table>
<thead>
<tr>
<th>Physical Quantity</th>
<th>Name of Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass</td>
<td>Kilogram</td>
<td>kg</td>
</tr>
<tr>
<td>Length</td>
<td>Meter</td>
<td>m</td>
</tr>
<tr>
<td>Time</td>
<td>Second</td>
<td>s</td>
</tr>
<tr>
<td>Temperature</td>
<td>Kelvin</td>
<td>K</td>
</tr>
<tr>
<td>Amount of substance</td>
<td>Mole</td>
<td>mol</td>
</tr>
<tr>
<td>Electric current</td>
<td>Ampere</td>
<td>A</td>
</tr>
</tbody>
</table>

### Metric System

<table>
<thead>
<tr>
<th>Prefix</th>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giga</td>
<td>G</td>
<td>$10^9$</td>
<td>1 gigameter (Gm) = $1 \times 10^9$ m</td>
</tr>
<tr>
<td>Mega</td>
<td>M</td>
<td>$10^6$</td>
<td>1 megameter (Mm) = $1 \times 10^6$ m</td>
</tr>
<tr>
<td>Kilo</td>
<td>k</td>
<td>$10^3$</td>
<td>1 kilometer (km) = $1 \times 10^3$ m</td>
</tr>
<tr>
<td>Deci</td>
<td>d</td>
<td>$10^{-1}$</td>
<td>1 decimeter (dm) = 0.1 m</td>
</tr>
<tr>
<td>Centi</td>
<td>c</td>
<td>$10^{-2}$</td>
<td>1 centimeter (cm) = 0.01 m</td>
</tr>
<tr>
<td>Milli</td>
<td>m</td>
<td>$10^{-3}$</td>
<td>1 millimeter (mm) = 0.001 m</td>
</tr>
<tr>
<td>Micro</td>
<td>$\mu$</td>
<td>$10^{-6}$</td>
<td>1 micrometer ($\mu$m) = $1 \times 10^{-6}$ m</td>
</tr>
<tr>
<td>Nano</td>
<td>n</td>
<td>$10^{-9}$</td>
<td>1 nanometer (nm) = $1 \times 10^{-9}$ m</td>
</tr>
<tr>
<td>Pico</td>
<td>p</td>
<td>$10^{-12}$</td>
<td>1 picometer (pm) = $1 \times 10^{-12}$ m</td>
</tr>
<tr>
<td>Femto</td>
<td>f</td>
<td>$10^{-15}$</td>
<td>1 femtometer (fm) = $1 \times 10^{-15}$ m</td>
</tr>
</tbody>
</table>

*This is the Greek letter mu (pronounced “mew”).*
**Mass & Weight**

- **Mass** is the quantity of matter within it.
- **Weight** is a measure of gravitational pull on the matter.

- **My WEIGHT on Earth is around 560N**
- **My WEIGHT on the moon is around 90N**
- **My MASS is always 56kg!!**

**Temperature**

- Temperature measures the hotness/coldness of objects.
- Temperature determines the direction of heat flow.

**Temperature Scales**

- **K = °C + 273.15**
- **°F = 9/5(°C) + 32**
- **°C = 5/9(°F-32)**
**Question:** A recipe in an American cookbook calls for roasting a cut of meat at 350 °F. What is this temperature on the Celsius scale?

**Volume**

- The most commonly used metric units for volume are the liter (L) and the milliliter (mL).
  - A liter is a cube 1 dm (10 cm) long on each side.
  - A milliliter is a cube 1 cm long on each side.

**Density:**

Physical property of a substance

Intensive.

\[ d = \frac{M}{V} \]

- g/cm\(^3\) or g/mL are generally used as density units.
- Temperature must be given together with density because volume of substances change with heating or cooling.

**Question:** What is the mass of a cube of osmium that is 1.25 inches on each side? (density of osmium = 22.59g/cm\(^3\))

**Question:** To determine the density of trichloroethylene, a liquid used to degrease electronic components, a flask is first weighed empty (108.6 g). It is then filled with 125 mL of the trichloroethylene to give a total mass of 291.4 g. What is the density of trichloroethylene in grams per milliliter?
Density of selected substances

<table>
<thead>
<tr>
<th>Substance</th>
<th>Density (g/cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>0.001</td>
</tr>
<tr>
<td>Balsa wood</td>
<td>0.16</td>
</tr>
<tr>
<td>Ethanol</td>
<td>0.79</td>
</tr>
<tr>
<td>Water</td>
<td>1.00</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>1.09</td>
</tr>
<tr>
<td>Table sugar</td>
<td>1.59</td>
</tr>
<tr>
<td>Table salt</td>
<td>2.16</td>
</tr>
<tr>
<td>Iron</td>
<td>7.9</td>
</tr>
<tr>
<td>Gold</td>
<td>19.32</td>
</tr>
</tbody>
</table>

Percent Composition as a Conversion Factor

- A common way of referring to composition is through percentages.
- Percent (per centum) is the Latin for per (meaning for each) and centum (meaning 100). Thus, percent is the number of parts of a constituent in 100 parts of the whole.
- To say that a seawater sample contains 3.5% sodium chloride by mass means that there are 3.5 g of sodium chloride in every 100 g of seawater.

Example: What is the percent composition of H₂O?

Example: Calculate the percentage of nitrogen, by mass, in Ca(NO₃)₂.

4A. How many kilograms of ethanol are present in 25 L of a gasohol solution that is 90% gasoline to 10% ethanol by mass? The density of gasohol is 0.71 g/mL.