

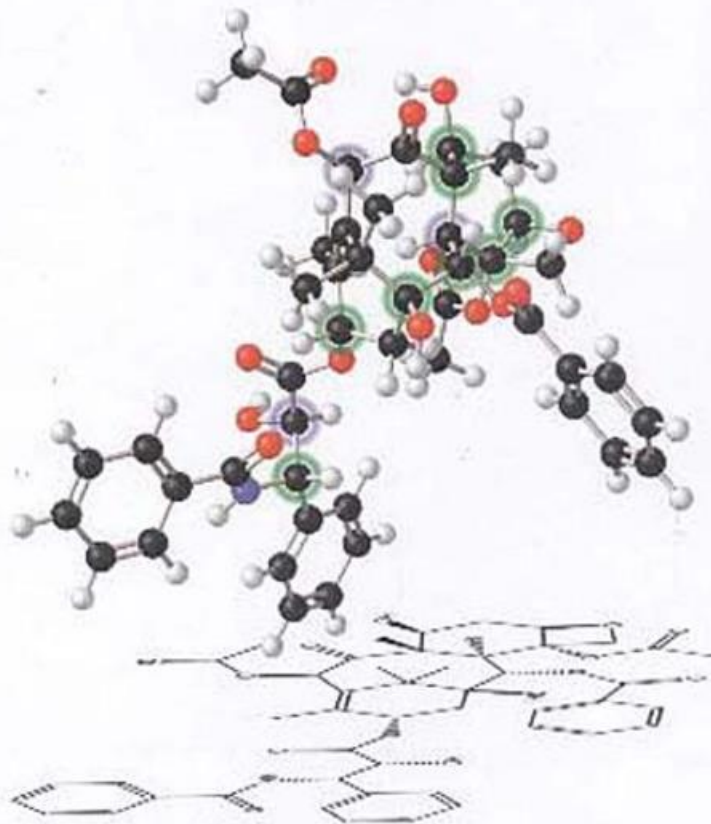
GENERAL CHEMISTRY

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GENERAL CHEMISTRY

Principles and Modern Applications TENTH EDITION

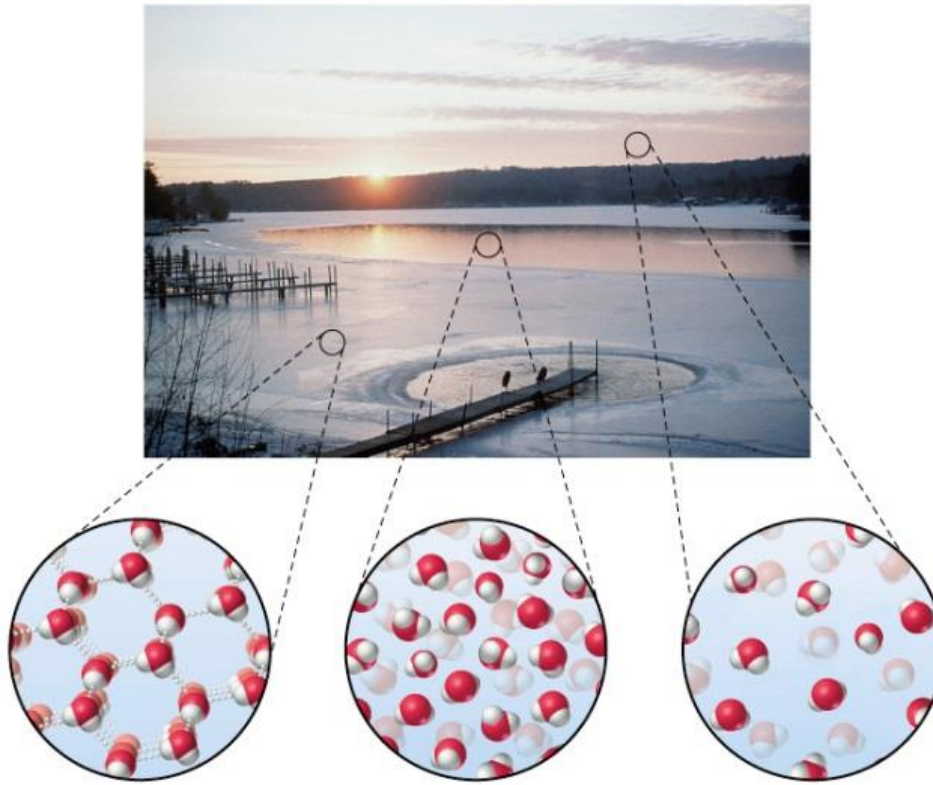


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COURSE CONTENT

WEEKLY CONTENT	Week	Course Content
	1 (Oct 04)	Introduction
	2 (Oct 11)	Matter: Its Properties and Measurement
	3 (Oct 18)	Atoms, Molecules, and Ions
	4 (Oct 25)	Chemical Compounds
	5 (Nov 1)	Chemical Reactions
	6 (Nov 8)	Reactions in Aqueous Solutions
	7 (Nov 15)	Gases
	8 (Nov 22)	Midterm Exam
	9 (Nov 29)	Thermochemistry
	10 (Dec 06)	Electrons in Atoms & Chemical Bonding
	11 (Dec 13)	Liquids and Solids and Their Physical Properties
	12 (Dec 20)	Chemical Kinetics
	13 (Dec 27)	Chemical Equilibrium
	14 (Jan 03)	Acids and Bases



Properties and Measurement of Matter

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1. Purpose of Chemistry

- Chemistry is the study of matter, which includes us and everything around us.
- Chemistry is an integral part of our lives.
- Because chemistry is related to many other fields of science and many areas of human endeavor, it is sometimes referred to as the “central science”

FOR EXAMPLE:

- Chemists who develop new substances to improve electronic devices such as solar cells, transistors, and fiber optic cables work on topics that chemistry shares with physics and engineering.
- Chemists who develop new drugs to be used against cancer or viral diseases work in the common areas of chemistry with pharmacology and medicine.

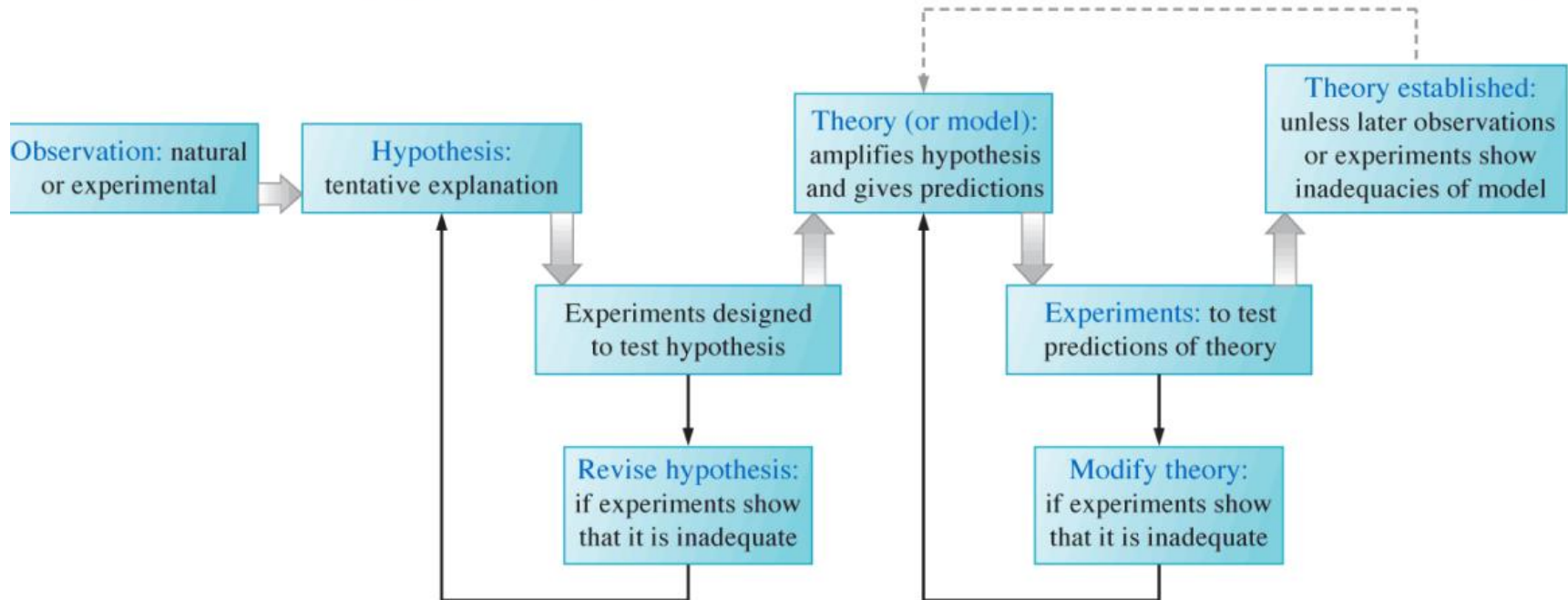
1-1 Scientific Method

- What distinguishes science from other studies is the method scientists use to obtain knowledge and the special importance of this knowledge.
- Scientific knowledge can be used to explain natural events and sometimes to predict future events.
- The scientific method is a combination of observations, experiments, formulation of laws and hypotheses, and theories.

1-1 The Scientific Method

- A **hypothesis** is a **tentative explanation of a natural law**.
- If a **hypothesis survives** testing by experiments, it is often referred to as a **theory**.
- In a broader sense, a **theory is a model or way of looking at nature that can be used to explain natural laws and make further predictions about natural phenomena**

The scientific method is the combination of observation, experimentation and the formulation of laws, hypotheses, and theories.



1-2 Properties of Matter

- **Chemistry** is the science that deals with the composition and properties of matter.
- **Matter** is an object that occupies space, has a property called mass, and has inertia (the state of an object being motionless or at a constant speed).
- **Composition** refers to the components of a sample of matter and their relative proportions within the substance.
- Example: H_2O , 11.19% H and 88.81% O (by mass)
- The properties of matter can generally be grouped into two groups: **physical properties and chemical properties**.

Physical Characteristics and Physical Changes

- **Physical Change:** In a physical change, some physical properties of the substance change, but its composition remains unchanged.
- **Physical Property:** It is the property that does not change the composition of the substance.
- For example, color is a physical property.
- For example, copper can be beaten into sheets. This feature is non-brittleness (malleability).
- For example, when liquid water freezes to form solid water (ice) (a physical change), its composition is still 11.19% hydrogen and 88.81% oxygen by mass, although it certainly looks different.

Chemical Properties and Chemical Changes

- **Chemical change or chemical reaction**, one or more types of substances transform into new substances with different compositions.
- A chemical change is a change in the composition of matter. An example is the burning of paper.
- **Chemical Property**: It is the ability of a sample of a substance to cause (or not to cause) a change in its composition under certain conditions.

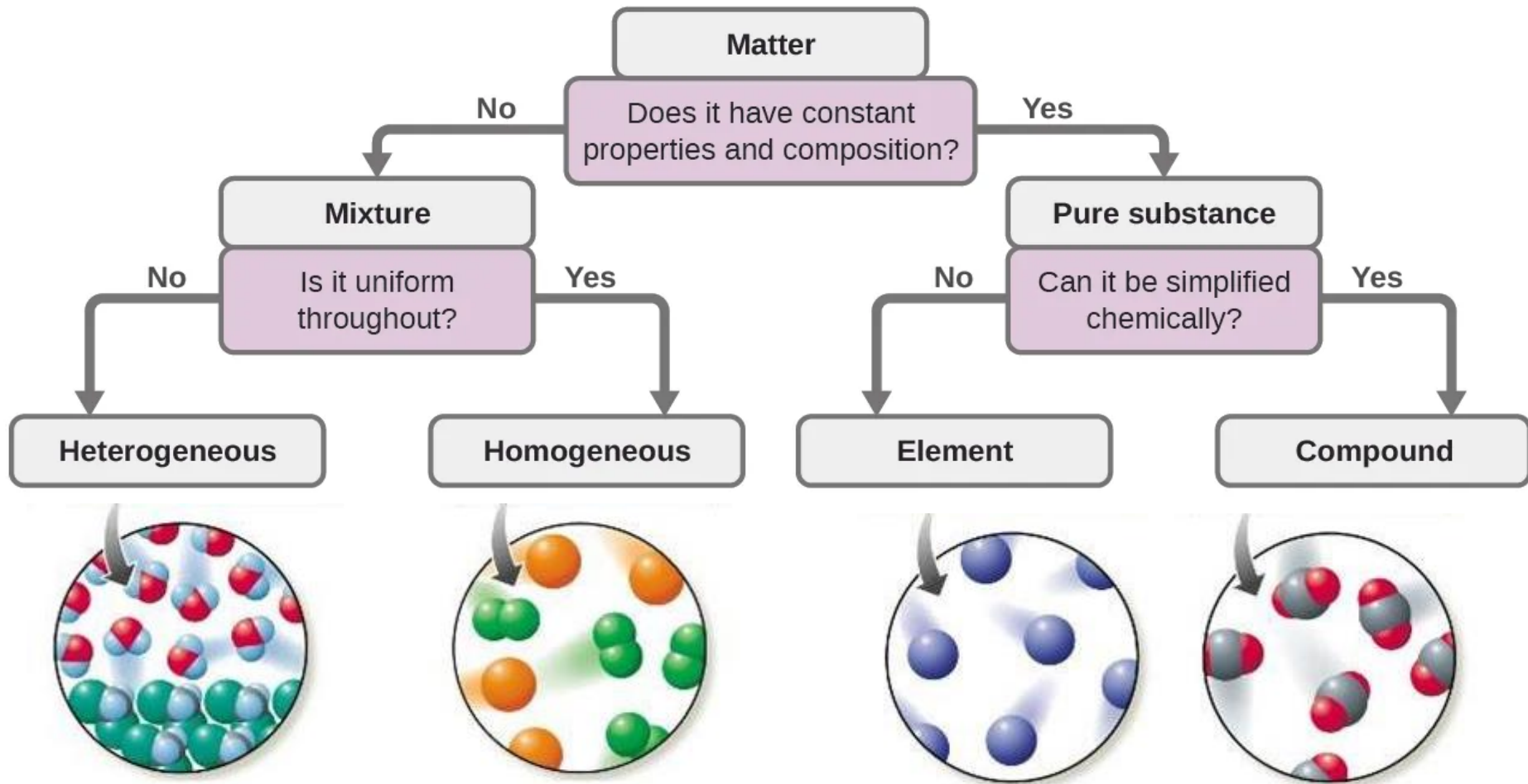
1-3 Classification of Substances

- Matter consists of very small units called atoms.
- Substances consisting of a single type of atom are called "**elements**".

IUPAC (*International Union of Pure and Applied Chemistry*) has defined 120 elements today.

- **Chemical compounds** are substances formed by the combination of two or more different element atoms. Scientists have identified millions of different chemical compounds.
- **A molecule** is the smallest unit that contains the atoms that make up the compound in the same ratio as in the compound. The water molecule is a three-atomic unit in which two hydrogen atoms are bonded to one oxygen atom.

Classification of Matter



The composition and properties of an element or compound are the same throughout a given sample and do not vary from one sample to another. Elements and compounds are called "pure substances".

Classification of Matter

Describing mixtures of pure substances:

- **Homogeneous mixtures or solutions:** They are solutions with uniform composition and properties throughout the solution.
- For example; Air is a homogeneous mixture of various gases, mainly nitrogen and oxygen elements.
- **Heterogeneous mixtures:** Accordingly, the composition and physical properties may vary from one part of the mixture to another. The composition is not uniform throughout the mixture.
- Generally, heterogeneous mixtures can be easily distinguished from homogeneous ones.
- For example; sand and water, the components are separated into different regions.

- Heterogeneous mixtures formed by one liquid in another liquid (mixture of two liquids that are insoluble in each other) are called **emulsion** mixtures. **For example; butter, margarine, milk, cream (oil\water mixture).**
- Heterogeneous mixtures formed when a solid is not completely dissolved in a liquid but dispersed into small particles are called **suspension** mixtures. **For example; ayran, cooked Turkish coffee.**
- Heterogeneous mixtures formed by a liquid and a gas are called **aerosols**. **For example; deodorants, mist, sprays**

Separation of Mixtures: A Physical Process



(a)

(a) Separation of a heterogeneous mixture by filtration:

A mixture can be separated into its components by suitable physical methods. The process of separating a solid from the liquid it is in is known as "filtration".

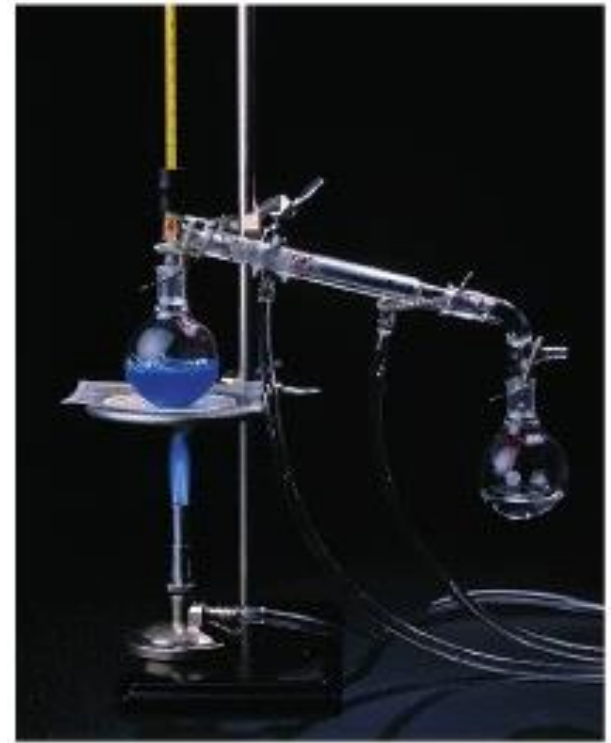
Separation of Mixtures: A Physical Process

b) Separation of a homogeneous mixture by distillation:

Distillation is the process of boiling a liquid and separating the resulting vapor from its other component by condensing it again.

In simple distillation, a volatile liquid is separated from the non-volatile solid dissolved in it.

In fractional distillation, the components of a liquid solution are separated from each other by taking advantage of their different volatilities.



(b)

Separation of Mixtures: A Physical Process



(c)



(d)

(c) Chromatographic separation of ink into its components:

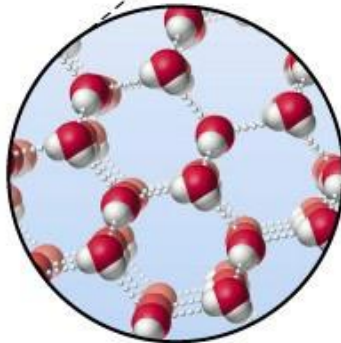
As water passes over the paper, black ink appears as a dark stain.

(d) Water dissolves the colored components of the ink, and these components adhere to different areas on the paper depending on their tendency to adhere to the paper.

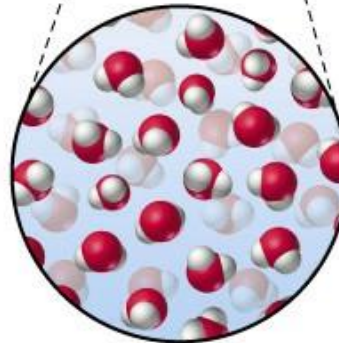
Another separation method is **chromatography**. It is a separation technique based on the difference in the tendency of compounds to adhere (adsorb) to the surfaces of different solid materials such as paper and starch.

States of matter

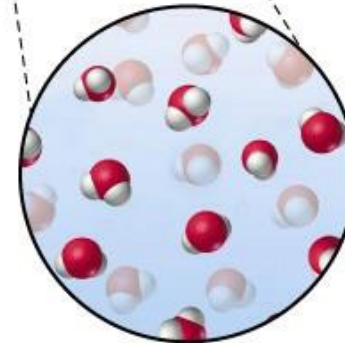
Matter generally exists in one of three states: solid, liquid, and gas.



(a)

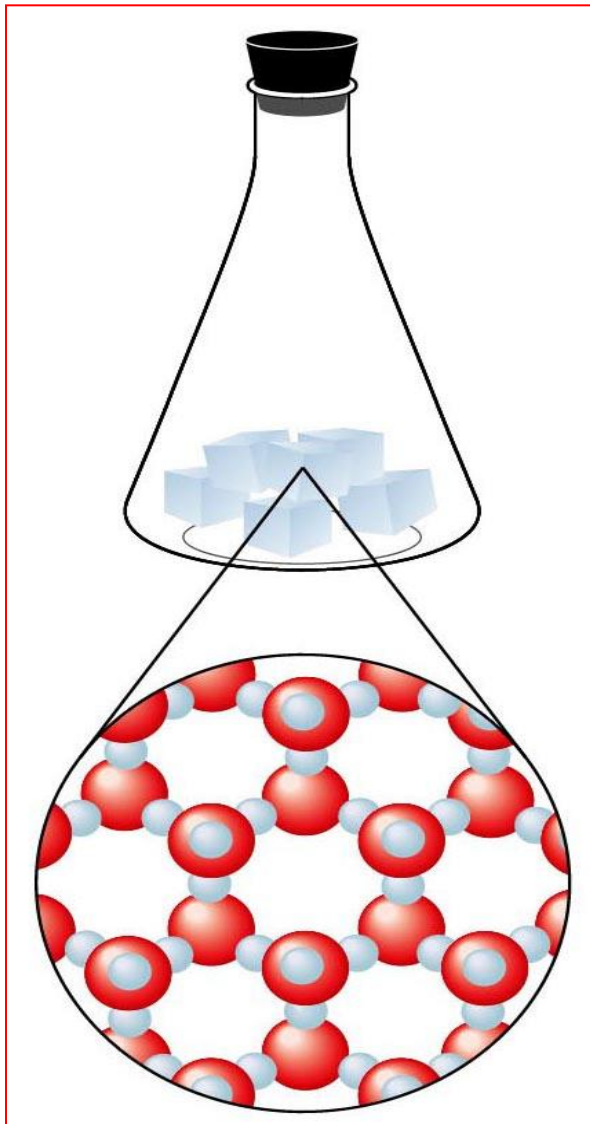


(b)



(c)

Solid

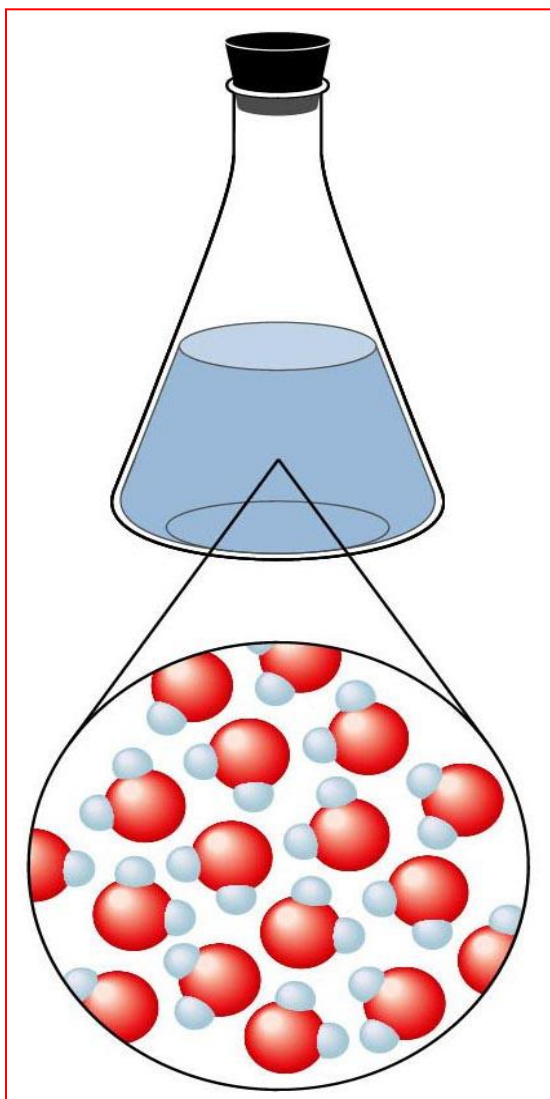


$\text{H}_2\text{O(s)}$ ice



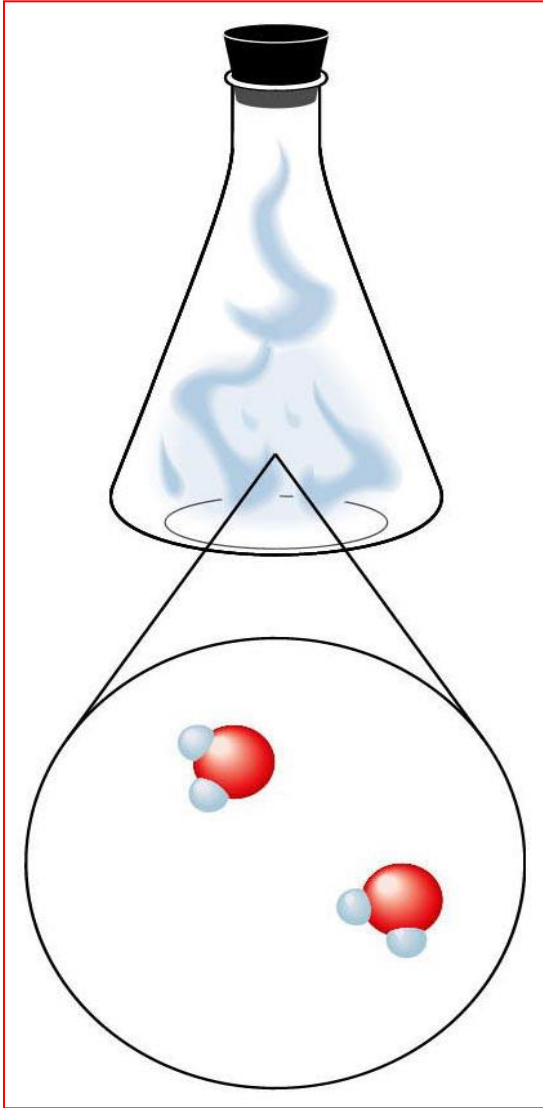
In a **solid**, atoms or molecules are in close contact. Sometimes they have a very regular structure known as crystal.

Liquid



Atoms or molecules in a **liquid** are further away from each other than in a solid. Liquids are fluid.

Gas



$\text{H}_2\text{O}(\text{g})$ vapor



In a **gas**, the distance between atoms or molecules is much larger than in a liquid.

Gases expand to fill the container they are in.

1-4 Measuring Matter: SI (Metric) Units

- **Chemistry** is a quantitative unit. **This means** that in many cases we can measure a property of a substance and compare it to a standard that has a known value.
- The scientific system of measurement is known as the "*International System of Units (Système Internationale d'Unités)*" and is abbreviated as SI.
- This system is the modern form of the metric system, which is based on the unit of length known as the meter (m).
- 1 meter is the distance traveled by light in a vacuum in $1/299.792.458$ seconds,
- As a result of this definition, the speed of light in vacuum is exactly $299.792.458$ m/s and **expressed as approximately 300,000 km per second**

Quantitative data is numbers-based, countable, or measurable.

Units

Basic SI Units

Lenght	meter, m
Mass	kilogram, kg
Time	second, s
Temperature	kelvin, K
Amount of Substance	mol, mole
Electric Current	ampere, A

Derived Units

Force	Newton, kg m s^{-2}
Pressure	Paskal, $\text{kg m}^{-1} \text{s}^{-2}$
Energy	Joule, $\text{kg m}^2 \text{s}^{-2}$

Non-SI Units

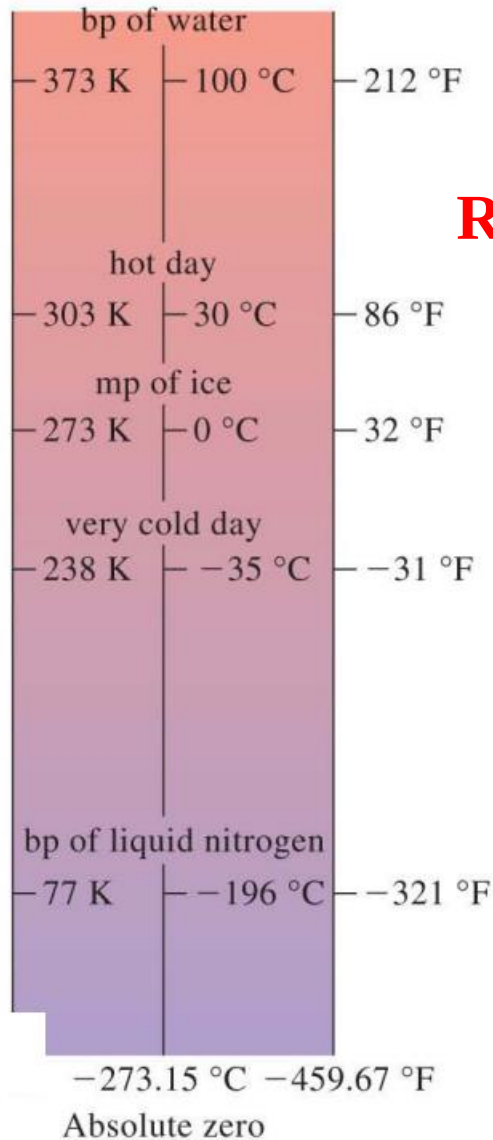
Lenght	angstrom, Å, 10^{-8} cm
Volume	liter, L, 10^{-3} m^3
Energy	calori, kal, 4,184 J
Pressure	Atm = $1,064 \times 10^2 \text{ kPa}$ 1 Atm = 760 mm Hg

TABLE 1.2 SI Prefixes

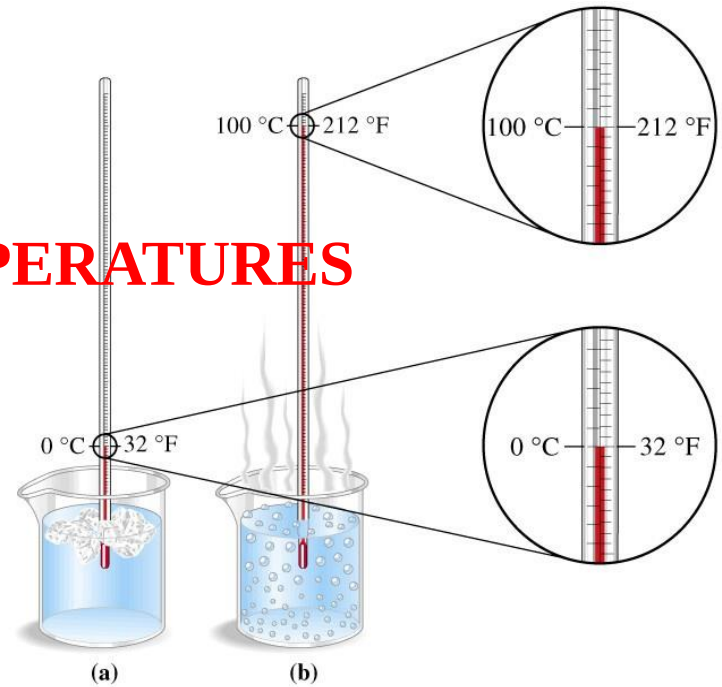
Multiple	Prefix
10^{18}	exa (E)
10^{15}	peta (P)
10^{12}	tera (T)
10^9	giga (G)
10^6	mega (M)
10^3	kilo (k)
10^2	hecto (h)
10^1	deka (da)
10^{-1}	deci (d)
10^{-2}	centi (c)
10^{-3}	milli (m)
10^{-6}	micro (μ) ^a
10^{-9}	nano (n)
10^{-12}	pico (p)
10^{-15}	femto (f)
10^{-18}	atto (a)
10^{-21}	zepto (z)
10^{-24}	yocto (y)

^aThe Greek letter μ
(pronounced “mew”).

Comparison of Temperature Charts



RELATIVE TEMPERATURES



Melting point
of ice

Boiling point of
water

Temperature

$$K = ^\circ C + 273$$

$$^\circ F = \frac{9}{5} ^\circ C + 32$$

$$^\circ C = \frac{5}{9} (^\circ F - 32)$$

Conversions

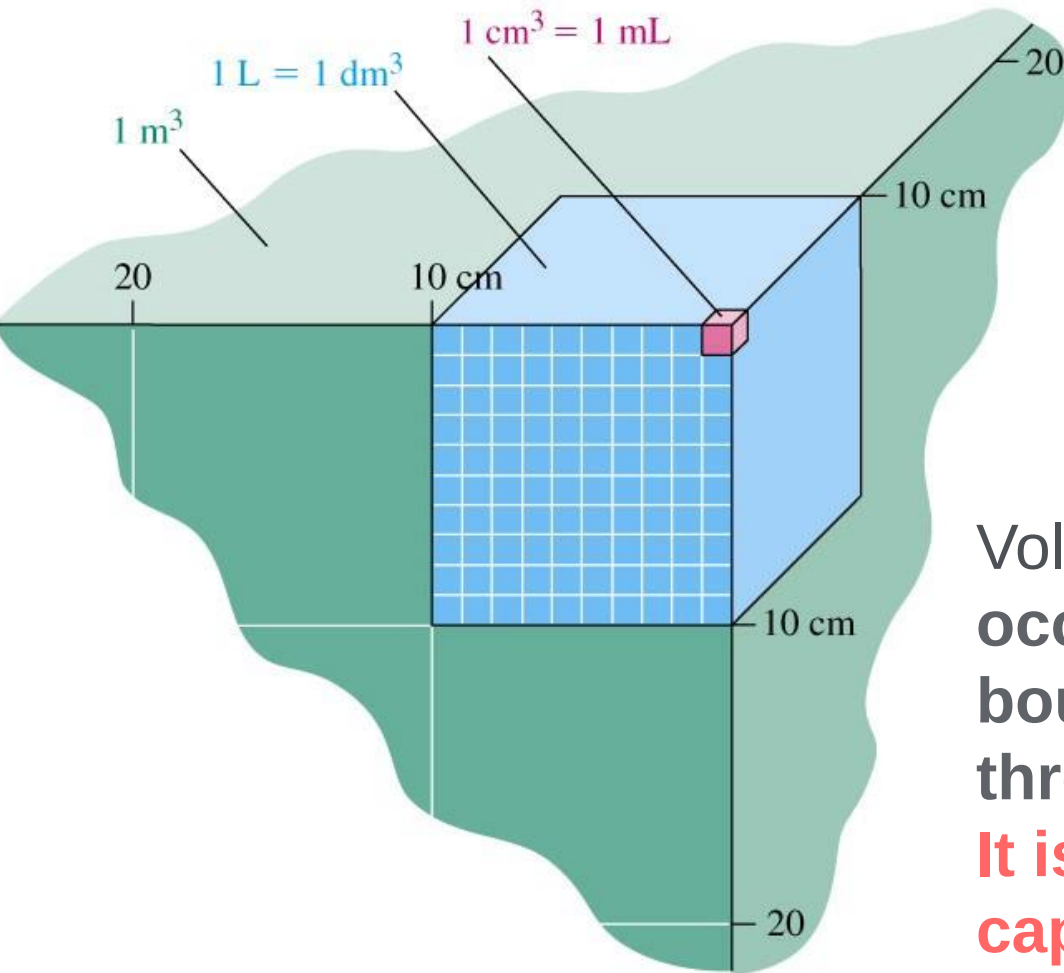
Mass

- **Mass (m)** describes the amount of matter in an object.
- **Weight (W)** is the gravitational force on an object.

$$W = m \times g$$

- Gravitational acceleration (g) varies slightly from one place to another on Earth.
- Although the weight of the object varies from one place to another, its mass is the same everywhere.

Volume



Volume is defined as the space occupied within the boundaries of an object in three-dimensional space.
It is also known as the capacity of the object.

1-5 Using Density and Percent Composition in Solving Questions

Density is the ratio of mass to volume.

$$d = m/V \text{ (g/mL)}$$

- Chemists usually express mass in grams and volume in cubic centimeters or milliliters.
- In general, solids are denser than liquids, and both solids and liquids are denser than gases.

Question

* What is the mass of an osmium cube with a side length of 1.25 inches? (1 inch = 2,54 cm)

$$d = 22,48 \text{ g/cm}^3$$

(converts in. to cm) (converts cm to cm³) (converts cm³ to g osmium)

$$? \text{ g osmium} = \left[1.25 \cancel{\text{ in.}} \times \frac{2.54 \cancel{\text{ cm}}}{1 \cancel{\text{ in.}}} \right]^3 \times \frac{22.48 \text{ g osmium}}{1 \text{ cm}^3} = 719 \text{ g osmium}$$

1-6 Uncertainties in Scientific Measurements

- **Precision:** It shows the degree of repeatability of the measured quantity. That is, it indicates the closeness between the results when the quantity is measured several times.
- **Accuracy:** Shows how close the measurement value is to the accepted or “true” value. Highly precise measurements are not always accurate; It could be a major systematic error. However, measurements with higher precision are more likely to be accurate than those with lower precision.
- **Systematic Errors:** These are errors arising from the structure or nature of measuring instruments
- **Random Errors:** These are errors caused by the experimenter's skill and ability in reading a scientific instrument. Both limits can lead to errors and yield results being found to be too high or too low.

1-7 Significant Numbers

Since numbers are constantly dealt with in engineering, it is very important to express the numbers correctly.

A standard notation should be determined here.

4.567,3 Europe

4,567.3 USA

Both representations may mean the same thing.

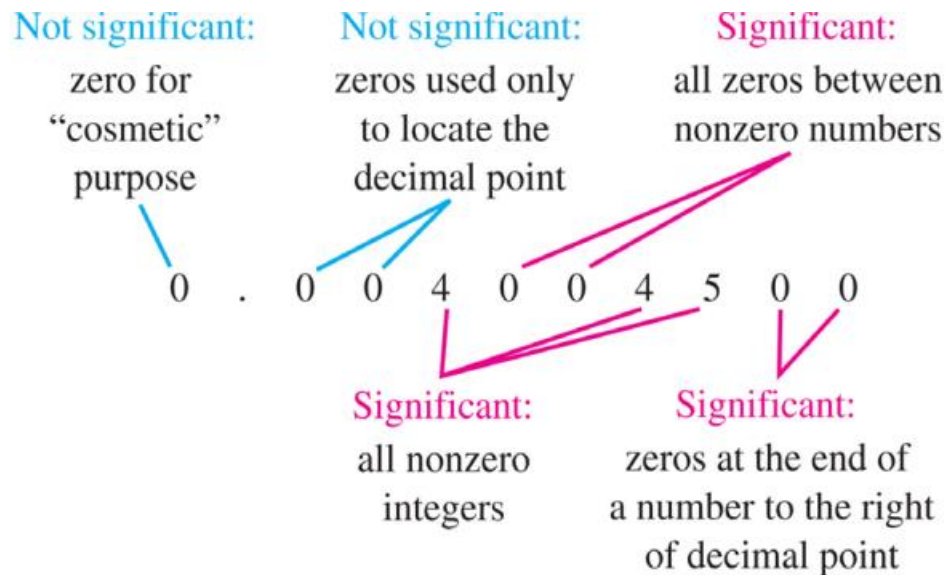
Common notation;

4 567.3

If there is a zero (0) at the end of the whole number, the number is written as an exponent to indicate the number of significant digits.

Number of significant digits for
6300 m

6,3 x 10³ m



If the number after the last digit is less than 5, the last digit is left as is and the following digits are discarded.

54,1875 54,2

54,1275 54,1

For example: 0,016880 1,7 x 10⁻²

168,80 1,7 x 10²